1981

Further studies on the inelastic overload response of steel multi-girder bridges, March 1981, 110p.

J. C. Hall

C. N. Kostem

Recommended Citation

Hall, J. C. and Kostem, C. N., "Further studies on the inelastic overload response of steel multi-girder bridges, March 1981, 110p." (1981). *Fritz Laboratory Reports.* Paper 2213.
http://preserve.lehigh.edu/engr-civil-environmental-fritz-lab-reports/2213

50272-101

REPORT DOCUMENTATION PAGE	1. REPORT NO. FHWA-PA-87-009+77-1	2.	3. Recipient's Accession No.

4. Title and Subtitle

USERS MANUAL FOR PROGRAM BOVAS

5. Report Date

August 1987

6.

FEL 435.2

7. Author(s)

Celal N. Kostem

8. Performing Organization Rept. No.

9. Performing Organization Name and Address

Fritz Engineering Laboratory
Lehigh University
Bethlehem, Pennsylvania 18015

10. Project/Task/Work Unit No.

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

(C)

(G)

12. Sponsoring Organization Name and Address

U.S. Dept. of Transportation
FHWA
400 Seventh Street
Washington, D.C. 20590

PA Dept. of Transportation
Office of Research & Special Studies
905 T & S Bldg.
Harrisburg, PA 17120

13. Type of Report & Period Covered

Interim Report
1977-1984

14.

15. Supplementary Notes

Research Project: 77-1
Project Manager: H. Koretzky
Bureau: Bridge and Roadway Technology

16. Abstract (Limit: 200 words)

This users manual contains the description of the application of computer program BOVAS (Bridge OVerload Analysis - Steel). The program is designed to predict the elastic and inelastic behavior of simple span or continuous steel multigirder bridge superstructures with a reinforced concrete deck slab and steel girders.

Program BOVAS could be used in the determination of the overload response of bridges or in the rating of bridges with the above characteristics. The program can predict the damage to the bridge superstructure, if any, in the form of cracking and crushing of concrete; yielding and strain hardening of steel; buckling of plate girder webs and compression flanges.

The report presents the assumptions and describes the input required and output generated. Three example problems are also included to illustrate the various input and output options in the application of the program.

17. Document Analysis a. Descriptors

structural engineering, highway bridges, steel bridges, overloading, bridge rating, finite element method, inelastic analysis, steel girders, computer program

b. Identifiers/Open-Ended Terms

Program BOVAS

c. COSATI Field/Group

18. Availability Statement:

Available from National Technical Information Service, Springfield, VA

19. Security Class (This Report)

none

20. Security Class (This Page)

none

21. No. of Pages

265

22. Price

(See ANSI-Z39.18) See Instructions on Reverse

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

COMMONWEALTH OF PENNSYLVANIA

Department of Transportation

Bureau of Research and Special Studies

Project 77-1: Overloading Behavior of Steel Highway Bridges

USERS MANUAL FOR PROGRAM BOVAS

by

Celal N. Kostem

This work was sponsored by the Pennsylvania Department of Transportation and the U.S. Department of Transportation, Federal Highway Administration.

LEHIGH UNIVERSITY

Office of Research

Bethlehem, Pennsylvania

August, 1987

Fritz Engineering Laboratory Report No. 435.2

TABLE OF CONTENTS

ABSTRACT

This users manual contains the description of the application of computer program BOVAS (Bridge Overload Analysis - Steel). The program is designed to predict the elastic and inelastic behavior of simple span or continuous steel multigirder bridge superstructures with reinforced concrete deck slab and steel girders.

Program BOVAS could be used in the determination of the overload response of bridges or in the rating of bridges with the above characteristics. The program can predict the damage to the bridge superstructure, if any, in the form of cracking and crushing of concrete; yielding and strain hardening of steel; buckling of plate girder webs and compression flanges.

The report presents the assumptions and describes the input required and output generated. Three example problems are also included to illustrate the various input and output options in the application of the program.

FOREWORD

Computer Program BOVAS (Bridge OVerload Analysis - Steel) is the result of an extremely sophisticated analytical investigation carried out to predict the elastic and inelastic behavior of simple span or continuous bridge superstructures with a reinforced concrete deck slab and steel girders.

In view of the complex nature of the analysis scheme, and consequently the resulting computer program, it is essential that the prospective users of the program study the contents of this manual thoroughly prior to the use of the program. The author recognizes that the manual does not contain all the information, observations, and experiences that have been accumulated on the inelastic behavior, serviceability limits of bridges, effects of overloads, and many other tributary fields. Consequently, this document should be considered in its intended mission, which is the introduction to the use of computer program BOVAS. Based on the researcher's experience with computer program BOVA (Bridge OVerload Analysis) (Ref. 13), Program BOVAC (Bridge OVerload Analysis - Concrete) (Ref. 16), and other similar tools in the rating of highway bridges and overload response of these bridges, a number of chapters could have been added to this manual. These chapters would have been highly technical and would have been confusing for the average user of the program. Additional technical details that are not included in this manual can be found in References 5, 6, 7, 11, 14, and 18. However, the manual as it stands can be studied by the prospective users without the need for the technical references.

The reader of the manual and especially the prospective users of program BOVAS are strongly encouraged to study the examples provided in detail. Even though these examples may seem rather routine, they are designed to transmit all the pertinent aspects of program BOVAS to the users.

Computer program BOVAS was developed and extensively tested at Lehigh University Computing Center's (LUCC) Control Data Corporation (CDC) computers. The initial development was carried out using CDC 6400 computer. The program was later transported to CDC CYBER 730 and CDC CYBER 850 computers. Various versions of CDC FORTRAN IV, i.e. FORTRAN-66, compilers were successfully employed. Throughout the development and testing cycles various operating systems and various versions of these operating systems were used: SCOPE, NOS/BE, and NOS. The program utilizes the "overlaying" concept. It can be compiled and executed on computer systems with non-virtual memory. Testing of this program program on computers with virtual memory has not been successful so far. The program is continually updated and maintained at LUCC's CYBER computer system with FORTRAN IV compiler.

I. INTRODUCTION

This users' manual is intended to assist users of computer program BOVAS (Bridge OVerload Analysis - Steel) in the preparation of input data and in the interpretation of the output. Program BOVAS is a sophisticated computer program for predicting the elastic and inelastic response of simple span or continuous steel multigirder bridge superstructures. The program is capable of analyzing steel beams or girders of constant or varying cross section. The bridge deck, however, must be a monolithic reinforced concrete slab.

Provisions for the nonlinearity of stress-strain relationships are included in the computer program for the concrete and steel. The program is also capable of predicting the type of damage (cracking and crushing of concrete, yielding and strain hardening of steel, buckling of beam compression flanges, and/or buckling of plate girder webs and compression flanges), its location, and its approximate severity.

Program BOVAS considers the dynamic loading of the bridge superstructure by the application of an impact factor to the live loads. The impact factor is computed for simple spans in accordance with AASHTO (American Association of State Highway and Transportation Officials' Standard Specifications for Highway Bridges) (Ref. 2). For continuous bridges an average span length is used in the impact factor formula. The program can only analyze one load pattern or positioning for each computer run or analysis. If more than one loading condition is desired, a separate analysis is required for each new loading condition.

1.1 Purpose of Program BOVAS

Program BOVAS was developed primarily for implementation in two specific areas:

(a) rating of bridges, and more importantly,
(b) overloading permit activities.

The bridges to be analyzed may either be existing bridges or may exist only in design drawings. The bridges may also contain some imperfections and deterioration. Through the careful input of the design dimensions and material parameters the structural behavior of the bridge can be simulated for each user defined vehicular loading and positioning.

It is envisioned that program BOVAS should be used for rating or overload permit operations when the loading of the bridge superstructure poses a challenge to the bridge engineer or the permit officer. The following examples illustrate cases where this challenge may exist. The engineer or permit officer may not be able to extrapolate from their past experiences with bridges to a bridge which is of unique geometry. If the bridge superstructure exhibits certain deterioration, then the rating or permit operations may require more precise results prior to the rating or issuance of the overload permit. The major usage of the program would correspond to the case where the vehicle under consideration may not permit the bridge engineer or permit officer to relate that vehicle to the vehicles they might have previously encountered because of common axle loads and axle spacings. In view of the continually increased gross vehicular weights and the rearrangement of the axles, the vehicles that are being considered for rating and overload permit operations have gradually deviate from the "standard design vehicle." (Ref. 2). Consequently the bridge engineer's visualization of the structural behavior of the bridge subjected to a standard design vehicle and the actual behavior of the bridge when subjected to an arbitrary overload vehicle are losing commonalties. The use of program BOVAS would allow the bridge engineer or permit officer to make realistic estimates on the actual behavior of the bridge and predictions of damage, if any, to the superstructure for any given vehicular loading.

1.2 Purpose and Scope of Users Manual for BOVAS

The purpose of this report is to acquaint the users with the input and output options of program BOVAS. The input for BOVAS has been divided into "units." Each unit represents either a set of parameters needed by the program to define a particular phase of the problem or a logical subdivision of physical data. A complete and detailed description of the input is provided in Chapter-III. Examples of input to solve three sample problems will be presented in Chapter-IV, while a discussion of the output for these example problems is contained in Chapter-V. However, a brief theoretical description of the analytical model provided by program BOVAS will be presented in the next chapter before the input and output information.

1.3 Disclaimer

The attainment of perfection in a computer program is an elusive goal. The program has been tested in a number of studies and appears to be totally debugged and operational. However, there may be problem areas which may not have surfaced, and thus are unnoticed by the developers, which may be uncovered by the users. It is strongly recommended that any unusual results obtained from the use of program BOVAS be transmitted to the developers for necessary actions.

A great deal of responsibility for sensible output from the program rests with the user. Preparation of the best possible input model will result in the best possible solution. In the same vein, incorrect input will result in a detailed solution by the program, however, this will not correspond to the problem on hand. Regardless of all warnings in the manual and the program, the ultimate decisions rest with the user through profuse employment of common sense and engineering judgment.

THE DEVELOPERS OF THE COMPUTER PROGRAM AND THE SPONSORS OF THE RESEARCH ACTIVITY WHICH LED TO THE DEVELOPMENT OF THE COMPUTER PROGRAM DISCLAIM ANY SPECIAL, CONSEQUENTIAL OR INCIDENTAL DAMAGES ARISING FROM THE USE OF THE PROGRAM. THE DEVELOPERS AND SPONSORS FURTHER DISCLAIM ANY AND ALL LIABILITY ARISING FROM VALIDITY, ACCURACY, OR APPLICABILITY OF THE RESULTS OBTAINED FROM THE USE OF THE PROGRAM.

1.4 Predefined Control Variables

In an attempt to simplify the input to program BOVAS for the user, there was a need to internally assign values to many control parameters. While the user can not alter any of these predefined values, they can be modified easily by a computer programmer. For example, at present the execution of the program will terminate if the stress in any steel girder layer exceeds 75% of the yield stress of that steel material. This value of 75% was set in accordance with the 1978 AASHTO Manual for the Maintenance Inspection of Bridges (Ref. 1); however, if this value changes in the future, programmer can easily update the change with minimal maintenance. Many of these key control variables and their numerical values are defined in Appendix-4 of this manual. If the programmer modifies these control variables, the programmer must prepare revisions/updates to this users manual and must disseminate the information to all users.

II. ANALYTICAL MODEL - PROGRAM BOVAS

Program BOVAS employs the finite element displacement method and incremental tangent stiffness formulation. A description of these concepts and the detailed description of different phases of the overall formulation are beyond the scope of this users manual. The reader can easily use the program without mastering the theoretical developments, however, a basic understanding of the finite element method and modeling is helpful. Therefore, the purpose of this chapter is to familiarize the reader with the fundamental concepts and terminology involved. If a more detailed explanation of the analytical formulation is desired, the readers should refer to References 5, 6, and 7.

The ultimate goal of the user of program BOVAS is to correctly simulate the bridge superstructure via a mathematical, or analytical, model. Because of the complexity of this type of formulation, the use of a computer based solution is essential. However, there are a few issues regarding the computerized approach that the user must be aware of before using program BOVAS. The issues include:

1. The accuracy of the computer results must be verified. Regardless of the "exactness" of the formulation that might be employed, there always exists the possibility that some systematic error in the program might have gone unnoticed. The accuracy of program BOVAS has been tested by using field and laboratory test results that have been conducted and reported in the literature. All comparisons have indicated that program BOVAS yields results that are fully acceptable.

2. If the user misinterprets the information contained in the manual, then systematic errors could be introduced have a magnitude as great as the errors referred to in the previous paragraph.

3. Accidental errors that can be committed by the user, either in the input of the computer program or the interpretation of the output, are comparable to any other engineering computation.

4. Common sense and engineering judgment must be employed by the user. Even though a number of controls have been incorporated into the program, no controls and checks can be developed to check the accuracy of a consistently careless user.

5. The user should never consider the computer program printout as indisputable fact. The results provided by the program must always be critically examined by the user. If the results do not make any sense, this should not be attributed to the complexity of the problem or to a new en-

gineering finding. It usually corresponds to an error committed by the user.

6. If after a number of checks, the user is convinced that no error on his/her part has been committed; and the results can not be fully justified by the user, then the prudent approach would be to contact the program developer. Even though the program has been tested to the fullest extent employing the available results, there is still a possibility that some error might have gone unnoticed. An interaction between the user and the program developer will provide an occasion to test the validity of the data and a possible check of the program.

2.1 Bridge Superstructure

Program BOVAS is capable of analyzing steel bridges having the following characteristics:

1. The bridge can be simple span or continuous construction.

2. While full composite interaction between the deck slab and the girders is usually assumed, non-composite or partial composite interaction can also be assumed. However, the reliability of the results is not guaranteed if the user assumes slip exists between the girders and the slab.

3. The bridge deck must be monolithic reinforced concrete slab.

4. Steel beams and girders of varying constant cross section may be used.

5. Girder spacing must be constant for a given bridge.

6. It is assumed that the diaphragm and cross-bracing do not contribute to the structural stiffness of the superstructure.

7. It is assumed that the bridge girders may deform in shear and major axis bending.

8. The stresses in the slab are due to the biaxial bending of the slab and the axial forces that may develop in the deck in the longitudinal and transverse directions.

9. Shear punching of the deck slab will not take place.

10. While the program has been developed for bridges with 90-degree or no-skew (i.e. right bridges), previous research (Refs. 16 and 22) indicate that bridges with moderate skew down to 60-degree can be analyzed with little loss of ac-

curacy. This was observed in prestressed concrete bridges. It could be assumed that it is also true for steel girder bridges; however, at this time no substantiation of this extrapolation is available. At present the user can not analyze skewed bridges without modifications to the program by a computer programmer.

11. The other assumptions of a more technical nature have been listed in References 5, 6, and 7.

2.1.1 Deck Slab

Program BOVAS assumes a monolithic reinforced concrete slab is placed at the top of the girders. The user can define the concrete slab by inputting the span length, width, and slab thickness. The steel reinforcement pattern can be manually inputted by the user or automatically generated by the program. If the automatic option is selected, the top and bottom longitudinal and transverse reinforcements are computed according to a table from Pennsylvania Department of Transportation (PennDOT) Bridge Design Standard-101A. This table is reproduced as Table-I in the users manual from Reference 10 (the user should reference Fig. 1 for Table-I). The amount of reinforcement is related to the clear transverse direction between the girders. Since the girder spacing is assumed to be constant and the user must input the bridge width, and the number of girders, the program can compute the girder spacing and the effective span between girders which defines the reinforcement pattern if the automatic option was selected. For continuous bridge the top two longitudinal layers of reinforcement are assumed to be present for the entire span length instead of stopping the second layer at three feet outside the negative moment region. This simplification does not appear to effect the results in limited testing since the extra reinforcement is in compression instead of tension.

2.1.2 Bridge Girders

The girders can be of constant or varying cross section. Each and every girder may also differ from each other. These assumptions allow the girders to have coverplates, hybrid construction, or haunches as well as exhibit varying degrees of deterioration. For example, one bridge may have one girder with a hole in the web near the support while the second girder might have a severely deteriorated flange near midspan.

2.2 Loading

The program expects and accepts three types of loads on the bridge superstructure. They are, in order of input,

(1) dead loads on the beams due to the weight of the superstructure,

(2) dead loads on the composite superstructure due to curbs, parapets, or additional wearing surface, and

(3) live loads applied to the bridge deck.

The user is cautioned against inputting zero as a load intensity for any of the load types. The program will terminate execution if it encounters a zero load for any of the three types of loads during its calculation. However, a small "fictitious" load can be applied to simulate a zero load intensity. For example, if the user does not wish to enter a dead load on the composite superstructure, a fictitiously small load over a small area far from the point of interest should be entered. While the load is not truly zero, the effects of the "fictitious" load on the final result are minimal.

All loads applied to the bridge are defined as area loads (<u>rectangular in shape</u>). The loads are assumed to be acting vertically on the bridge deck. The loads are defined by the distance from the centroid of the area with respect to the origin of the coordinate system (see Section 2.3.1). Length and width of this area load as well as load intensity need also be defined. All distances or lengths should be input in inches, and all loads should be defined in units of force per unit area, or specifically kips per square inch (ksi). The reader should refer to the example problems in Chapter-V for the illustration of loading.

The user should be cognizant that program BOVAS considers the dynamic loading of the bridge superstructure by the internal application of an impact factor to the live loads. The impact factor is computed for simple spans in accordance with Reference 2. For continuous bridges an average span length is used in the impact factor formula. If the user desires to remove the effect of the impact factor in a controlled overload, the user should input the load as the actual vehicular load divided by the computed impact factor. The researchers stress that the "static" load should only be applied in controlled overloads. A controlled overload is a vehicle which traverses the bridge at a crawl speed, i.e. not exceeding 5 mph, and has an escort vehicle controlling the loading.

2.2.1 Dead Load on the Girder

The loads for the dead load on the beam solution should be placed as line loads over each girder in the model. Since all loads must be input as area loads, an area load on each girder should run for the full length of the finite element model and should be 0.01 inches wide.

The load intensity of the dead load on the beam solution on each girder should include the weight of the effective width of the wet concrete of the deck slab, the steel girder, and any cover plates. The weight of any coverplates should not be distributed over the full length of the girder. The effective width of the deck slab on any interior girder is equal to the spacing between the girders, while the effective width of the deck slab on any exterior girder is equal to the sum of the overhang width and one-half of the spacing between girders. Therefore, for example, in problem No.1 in Chapter-IV the effective widths for the interior and exterior girders are 60 and 66 inches, respectively (see Fig. 2). Because of the difference in effective widths, the load on the exterior girders will be slightly heavier, for this example, than the load on the interior girders, even though all girders are identical.

The following method can be used to calculate the load intensity for each girder. First, determine the line load (kips per inch) of each part (i.e. girder, coverplate, deck) of the total load. For rolled steel sections the weight is usually given in Reference 3 in pounds per foot. For example, a W36x170 section weighs 170 pounds per foot. This value should be converted to kips per inch. For built-up girders, coverplates, and the concrete deck the weight is usually unknown. In order to compute the line load, calculate the cross-sectional area of each part and multiply by unit weight of the material. Assume 0.0000868 kips per cubic inch (150 pounds per cubic foot) for the reinforced concrete deck and 0.0002836 kips per cubic inch (490 pounds per cubic foot) for the steel. After computing the line load of each part, sum the parts together and divide by the width of the area loaded (0.01 inches) to determine the load intensity for the girder.

2.2.2 Dead Load on Composite Superstructure

The dead load on the composite superstructure solution should include any curbs, parapets, or future wearing surface load that the user wishes to include in the analysis. The loads must be input as area loads and should be placed on the structure as accurately as possible. A procedure similar to the method presented in Section 2.2.1 can be used to calculate the load intensities; however, the width of the area load will probably be greater than 0.01 inches.

2.2.3 Live Loads

The live loads will usually consist of truck or dolly and/or lane loads. Lane loads should be accurately placed to simulate actual travel lanes and should be computed in accordance with Reference 2. Truck or dolly loads should be placed in such a manner to cause a worst case loading. For example, the drive axle of an HS20-44 truck is placed typically at the point of maximum moment on the superstructure. Both the negative and positive moment regions should be considered in the analysis if the bridges are continuous structure.

The load intensity of truck and dolly loading can be calculated in many ways depending on the placement of the wheel or axle loads. For example, if the "vehicle" under consideration is a four axle eight wheel per axle dolly, then because of the close proximity of the wheels, which is usually the current practice, the whole dolly can be simulated by one area load. This area load is a rectangle which envelopes all wheels. A typical 18 wheeler truck with front axle (2 wheels), drive axle group (2 axles, 4 wheels per axle), and rear axle group (2 axles, 4 wheels per axle) could be identified by six area loads. Two of these will come from the front axle, and two each from the drive and rear axle groups. Due to the close proximity of the tandem wheels on the drive and rear axle group, each axle group could be simulated by two area loads per axle group each, one for the right and one for the left side tandem group each. In all cases, the total wheel or axle load in each area load should be distributed uniformly over the area load.

2.3 Analytical Modeling

The analytical modeling of the steel bridge superstructures as employed in this reported research is extremely detailed. The characteristic features of the model are based upon bridge engineering, engineering mechanics, finite element theory, and many other ancillary fields. Rather than confuse the reader with a number of theoretical details, it is preferred to describe only the most important aspects of the modeling scheme. If a deeper understanding of the theory is desired, the reader should refer to References 5, 6, and 7.

2.3.1 Coordinate System

The best way to visualize the coordinate system would be the consideration of a rectangle (see Fig.3). Left and right sides of the rectangle are the supports, and the top and bottom lines are the free edges of the bridge deck. The origin of the coordinate system lies at the lower left corner of the rectangle. The x-axis emanates longitudinally from the origin toward the right side of the bridge, while the y-axis extends from the origin in the direction towards the top of the rectangle. These axes correspond to the lower free edge of the bridge and the left support line, respectively. The z-axis originates at the origin and extends up towards the top of the bridge.

2.3.2 Finite Element Discretization

The bridge superstructure is composed of the deck slab and girders. In the finite element discretization the deck slab is divided into a series of square or rectangular plate bending elements (see Fig. 4). The elements are interconnected to each other at the corner of the rectangles. These corners are called node points. The other major component of the bridge superstructure is the girders. Girders require discretization into a series of beam finite elements. The length of the beam finite elements coincides with those of the plate bending elements. The plate bending and beam elements are interconnected at nodal points common to those elements.

Each nodal point, beam element, and plate bending element is automatically numbered by the program. The nodal points are numbered starting at the origin and continuing along the left support line. If a beam node is located below the plate node, it is numbered before the next plate node. After completion of node numbering along the left support, the numbering continues at the next section starting at the x-axis and moving in the positive y-direction. This process continues until the right most support line has been numbered. Similarly, the plate bending elements are numbered beginning with the element bounded by x- and y-coordinate axes and moving in the positive y-direction. The process is repeated at each successive row of elements until the plate elements bounded by the right most support line have been numbered. Finally, the beam elements are numbered starting with the girder closest to the x-axis (Girder-1) and numbering from the left support to the right support. The process is repeated for all beams. Refer to Figures 4 and 5 for an example of all three numbering patterns for a full structure. If a symmetry option is selected to model only one-half or one quarter of the bridge (see Section 2.3.3), the numbering stops at the axis of symmetry instead of the free edge and/or the right most support line. The mesh for example Bridge-1 of Chapter-II (see Figure 2) illustrates the numbering pattern for a bridge with two axes of symmetry - one at the midspan and one at the centerline.

Program BOVAS has a number of features to assist the user in the discretization of a bridge. While the user may manually input or automatically generate the finite element lengths in x-direction, the program will always automatically define the element lengths in the y-direction. If the bridge has an overhang, the program will generate one string of elements between the facia girder and the free edge of the deck slab. Between each girder two strings of plate bending elements will be placed. An illustration of this method can be seen in Fig. 4. The user should remember that the program assumes a constant spacing between girders when calculating the element lengths in the y-direction.

In order to develop the rectangular grid the bridge deck must be divided into strings of elements in the lateral direction. The user can either manually input the finite element lengths in the x-direction or internally generate the finite element lengths with the program. Inexperienced users should preferably default to the program's discretization, while the experienced users may wish to enter their own discretization.

If the user defaults to the program, one of several meshes can be generated depending upon the type of symmetry (see Section 2.3.3) and the number of spans in the model. The program divides the model into a minimum of six strings of elements for any model or six strings of elements per span in the model. For example, a simple bridge with an axis of symmetry at the bridge midspan (see Fig. 6) will have six element divisions, while a simple span bridge with no axis of symmetry (Fig. 7) will also have six element divisions in the x-direction. Similarly, a three span continuous bridge with an axis of symmetry at the middle bridge midspan (see Fig. 8) will have nine element divisions, while the three span continuous bridge with no axis of symmetry (Fig. 7) will have 18 element divisions.

The finite element lengths generated by the program are given in terms of percentage of the span lengths in Tables 2 through 5. Figures 6 through 9 also present the lengths in the percentage of span length for simple and three span bridges for any symmetry option (see Section 2.3.3).

If the loading condition is not suitable for the use of automatic discretization, then the user should input his/her own values for the lengths of each element in the longitudinal direction. If the user inputs the finite element lengths, the user should discretize the structure in a manner which will produce the most extreme results. For example, use a cruder mesh (i.e. large element lengths) in regions of little interest and a finer mesh (i.e. small element lengths) where critical regions of interest are located. The user should note that the summation of the input element lengths should be equal to the center-to-center span length of the model.

2.3.3 Modeling with Symmetry

In some problems the user may be able to model the bridge using one or two axes of symmetry. Not only should the axes of symmetry be valid for the bridge components but also for the applied loading. The user should also be cognizant that the symmetry may exist for a new bridge, but will probably not exist on the same bridge after severe non-uniform deterioration. The use of symmetry can either allow for a more economical solution or for a more refined and thus more accurate discretization.

Program BOVAS permits four symmetry options. They are **full, half-longitudinal, half-traverse, and quarter symmetry** (see Fig. 10). Full symmetry models the entire bridge superstructure. Half-longitudinal symmetry assumes that the bridge centerline is an axis of symmetry, while half-traverse symmetry assumes that the bridge midspan is an axis of symmetry. Therefore, only half of the bridge superstructure is modeled for either half symmetry option. Finally, quarter symmetry assumes that an axis of symmetry exists at not only the bridge centerline but also the midspan.

2.3.4 Layering

In any given bridge superstructure and loading configuration, if the load level is below a certain limit, then the bridge superstructure will be in linear elastic state of stress. However, if the load level exceeds that limit, then because of the nonlinearities existing in the stress-strain relationship of steel and especially concrete, parts of the structure will exhibit material nonlinearities. At this load level the structure will not exhibit any damage in most cases. If the load level is increased further some form of damage initiation takes place, usually in the form of cracking of the concrete, yielding of steel, or buckling of girder webs and compression flanges. If the load level is increased even further, the damage begins to propagate and new damage initiates. For example, when the concrete slab starts to crack, the cracking initiates at the outermost extremities of the slab. As the load level increases the damage propagates deeper into the slab as well as initiates at other locations. A similar progression of damage occurs in girders as the girder begins to yield in the flange or coverplate. When the load level increases, more of the girder cross section yields until sometimes a plastic hinge forms at a critical location. Program BOVAS is designed to predict the occurrence of damage characteristics and the progression of failure as the load level increases. In order to simulate penetration of the damage through the members; program BOVAS employs the "**layering**" techniques (Figs. 11 and 12).

Both the girders and the slab are divided into a finite number of layers. Each layer is assumed to be in a state of plane stress. In the case of girders each layer is assumed to be in a state of uniaxial compression or tension, while the slab layers are each assumed to be in a biaxial state of stress. The layering scheme not only provides an accurate picture of the extent of the damage in the slab of the girder but also a picture of the variation of the stresses through the depth of the girder or the slab. This accurate picture of stress and damage becomes very useful to the user when trying to determine the resistance of the bridge superstructure to overloads.

The layering of the bridge deck is automatically performed by the program, and thus is not visible to the user. As shown in Figure 11 the concrete of the deck slab is divided into six layers. Two layers of concrete layers are placed above the reinforcing bars, and two equal layers are placed below the bottom reinforcing bars. The concrete between the top and bottom reinforcement is divided into two equal layers. The top concrete cover is assumed to be 2.5 inches, while the bottom concrete is assumed to be one inch. In addition to the six concrete layers, the slab has four embedded layers of steel reinforcement. Two layers of reinforcement exist in both the top and bottom of the slab. The numbering of the layers of the slab begins with the concrete, with the top most layer being layer-1, and the bottom most layer being layer-6. The top transverse, top longitudinal, bottom longitudinal, and bottom transverse steel reinforcement layers correspond to slab layers seven through ten, respectively. The layering becomes important to the user only in the case of detailed or long output option of program BOVAS (refer to Chapter-V). This option prints the stresses at each layer of each element for each load increment.

The girder is divided into a finite number of layers. For the detailed version of program BOVAS the number of girder layers can vary from bridge to bridge but must remain constant for all girders on a given bridge. Furthermore, each layer of the girder must retain constant thickness for the remaining girders of a given bridge. Therefore, if a girder has a cover-plated section along its length, fictitious steel layer(s) are required in order to accurately model the bridge where no actual steel layer(s) exist. The coverplate layer(s) remain constant thickness and only the material properties of the coverplate layer change. The girder layers are numbered consecutively beginning with the top most layer and ending with the bottom most layers of the girder.

The author recommends the following guidelines to the user in layering the girder for most bridges. Ten to twelve total layers should be used to define the girder cross-section. A minimum of one layer and maximum of two layers should be used to model each coverplate or flange. If two layers are used, divide the component into two layers of equal thickness. The remaining layers should be divided into equal segments in order to model the girder's web. The author recognizes that exceptions to these guidelines exist in complex structures such as the welded three span continuous bridge shown in the Federal Highway Administration's (FHWA) Standard Plans for Highway Bridges (Ref. 19). On this bridge the web depth remains constant, but the flange thickness and flange width vary depending on the span length and the location along the span length. In this case the smallest flange thickness on the top of the flange should be considered at the top flange thickness along the full length of the model. The flange width can vary, but thickness can not change. Any additional thickness beyond the flange thickness should be considered as coverplates. If three flange thicknesses exist on a bridge, then two coverplates will exist for that flange surface. A similar analysis can be done for the bottom flange. The user is cautioned to use engineering judgment when encountering complex bridges.

2.3.5 Plate Girder Web Panels

In the past one of the design criteria for plate girders was based upon the assumption that the load carrying capacity of the web plate was limited by buckling of the web. However, experiments have demonstrated that transversely stiffened plate girder web panels have considerable post buckling strength. In continuous girder slab superstructures, there exists a possibility of web panel buckling due to overloads in the vicinity of the interior supports. To account for the possibility BOVAS allows the user to define the transversely stiffened plate girder web panels at any location in order that the buckling and post buckling phenomena can be modeled accurately. The reliability of this buckling prediction and the theory behind the procedure are presented in depth in References 6 and 7. The reader should be cautioned that the buckling of the plate girder web panel changes the overall structural response characteristics of the bridge superstructure; but in many cases the actual change is not clearly evident until well past the buckling load.

2.3.6 Flange Buckling

Like the web plate panel buckling phenomenon the compression flange of the plate girders and beams can buckle in the negative moment regions because of the possible lack of lateral and torsional restraint. However, unlike the web panel behavior, little post buckling strength exists after the compression flange buckles. Program BOVAS automatically calculates the critical torsional buckling stress for each compression flange; and prints a warning message when such a critical buckling stress is attained in the compression flange. The post buckling behavior of the girder is also effectively modeled in program BOVAS. When web plate panel sections are defined by the user, the critical lateral buckling stress of the plate girder compression flange is calculated automatically. If this critical stress value is reached, a warning message is printed and the post buckling strength is also modeled. A detailed description of these phenomena and how they are included in the analysis scheme is presented in References 6 and 7.

2.3.7 Fatigue

Program BOVAS allows the user to check if fatigue is critical on any given detail of the bridge. The program has a built-in library of the allowable live load stress ranges for nonredundant load path structures for three cycle ranges (see Ref. 2). These cycle ranges correspond to 100,000 (LOW), 500,000 (MEDIUM), 2,000,000 (HIGH) load cycles. By inputting the detail type, location of the detail, and the relative number of load cycles, the program will compute a live load stress range for the detail and compare the computed value to the appropriate allowable stress range of the detail. If the allowable stress range is exceeded by the computed stress range, a warning message is printed for the user. Table-6 lists the allowable stress ranges for the three cycle ranges. Table 7 and 8 and Figure 13 have also been reproduced to aid the user in determining the detail type and stress cycle range.

2.4 Material Properties

It has already been stated that program BOVAS incorporates the linear and nonlinear portions of stress-strain curves for the constituent materials of concrete and steel. The full description of these curves is based upon the compressive cylinder strength for concrete and upon the uniaxial stress-strain curve obtained from a typical tensile test for the steel. Previous research has developed the necessary relationships to establish accurate stress-strain curves for these materials (References 14, 24, and 21 for concrete, and References 5, 6, and 7 for steel). The user need not be concerned about defining these curves but need only to specify the appropriate material constants.

The user can define the concrete properties simply by inputting the concrete's compressive cylinder strength. Similarly, the reinforcement steel is defined simply by inputting the yield strength of the material. Finally, the girder steel properties can be manually input by the user; or the user can define the properties by inputting the construction completion date of the bridge or the American Society for Testing and Materials (ASTM) steel grade classification. Acceptable ASTM steel grade inputs include A7, A8, A36, A94, A242, A440, A441, A514, A517, A529, A572, and A588.

2.5 Analysis Scheme

The analysis scheme does not employ any of the many distribution factor approaches. Thus, any ambiguities pertaining to the approximate distribution factor method have been totally eliminated. The results provided by program BOVAS, which utilizes the finite element displacement method and incremental tangent stiffness formulation, are far more accurate than the best conceivable distribution factor approach.

The description of the analysis of the bridge superstructure using the finite element method is beyond the scope of this manual, especially if the superstructure exhibits material nonlinearities. If interested, the reader can refer to any of the advanced textbooks on the finite element method or specific reports (References 5, 12, 14, 20, and 21). However, the basic mechanism of the analysis procedure could easily be summarized within this report. This summary should then provide a better understanding of program BOVAS.

The solution process consists of four main phases:

(1) Problem Definition
(2) Dead Load Solutions

(3) Scaling Procedure
(4) Overload Solution.

A simplified flow-chart of the relationship between the above phases is shown in Figure 14 with more detailed descriptions of the phases being presented in the following sections.

2.5.1 Problem Definition

To define a problem, the user must provide a complete bridge description and the bridge loading. In order to fully describe the superstructure for the program, the user must provide the following types of information for input:

(1) the bridge superstructure geometry
(2) beam layering
(3) web panel location and details, if any
(4) fatigue location and detail type, if any
(5) material properties for concrete and steel
(6) finite element discretization and symmetry information.

Chapter-III explains in detail the specific information the program requires as input for the above listing. In addition to the bridge description, the user must supply the program with the bridge loadings. Refer to Section 2.2 of this manual as well as Chapter-III for a description of the types of loadings and the input information required to define the loads. After defining the problem, the program can begin the solution process.

2.5.2 Dead Load Solution

Since the analytical technique employed considers material non-linearities, which are stress dependent, an accurate assessment of the stress state prior to the application of the overloads is required. Because of the expected nonlinear behavior of the structure, the principle of superposition can not be employed. Therefore, the superstructure must be analyzed to obtain the following stresses prior to the application of the overload: the stresses in the girders due to the deadweight of the slab and girders; and the stresses in the girders and slab due to the deadweight of the parapets, curbs, and future wearing surface. The initial stress state and any material failures or non-linearities due to the application of these dead loads will thus be reflected prior to the application of the overloads.

2.5.3 Scaling Procedure

As long as the initial solution due to the overload produces elastic or linear response, the load is increased proportionally to the lowest level corresponding to one of the following element stress limitations: 60% of the compressive strength of concrete, 90% of the tensile strength of concrete, 97.5% of the yield strength of steel, or 100% of the buckling stress, whichever is smallest. Because this technique scales up the initial load level, only one elastic solution is obtained. Thus, the number of elastic solutions are kept to a minimum. All subsequent solutions will exhibit nonlinear response.

However, if the initial solution causes any material or stability failure or a nonlinear response, the initial live load is scaled down in order that a linear solution be obtained. Then the scaled down load is incremented until nonlinear response occurs. Once nonlinear response begins, the overload solution is employed.

2.5.4 Overload Solution

The overload problem can be solved using a tangent stiffness approach or piecewise linearization of the nonlinear phenomena. In such an approach the system of equations is assumed to be linear in a given load increment. By computing the tangent to the stress-strain curve for each layer based upon the current stress state, the layer stiffness, element stiffness, and ultimately the global stiffness matrix can be calculated. After calculating the nodal point displacements and element layer strains for the load increment, the corresponding element layer stresses are obtained by the program for the load increment employing the material stress-strain relationship. These incremental stress values are added to the total stress state which existed prior to the application of the load increment, thus arriving at a new current stress state. The process is repeated or iterated with the new current stress state until the solution for the increment converges. If a layer fails during the application of the load increment, the load increment is scaled down so that the layer stress causes "incipient failure." Thus, in this method, which is called the "incremental-iterative" method, the stiffness matrices are continually updated within each load increment or step. It should be noted that the initial solution of each load cycle is based upon the zero stress and displacement increment values; thus the first iteration of each step is based upon the stiffness matrix of the previous load cycle. The overload analysis process terminates when one of the specified termination checks is exceeded.

2.6 Termination Checks

For increasing live load levels the stresses and strains in the deck slab and the girders will increase. At a certain load level for a given bridge and loading configuration, damage to the superstructure will occur. For increased load levels the damage will penetrate or propagate through the depth of the members as well as spread throughout the superstructure. From a serviceability viewpoint certain limits can be imposed on the response of the bridge superstructure such that load levels higher than these limits will not be permitted. If the load levels exceed any of these limits, the serviceability criteria will be violated. The termination checks have been set in terms of maximum deflections, maximum live loads, maximum strains, maximum stresses, number of failed layers, or maximum crack width. Thus, en efficient solution procedure is developed to meet the requirements of an analyst.

2.6.1 Deck Slab Termination Checks

Deck slab is composed of concrete and steel reinforcement. The termination checks for the concrete are:

(1) The maximum allowable strain for concrete is 0.0025 inches per inch.

(2) The maximum allowable tensile stress for concrete is 80% of the compressive cylinder strength.

(3) The maximum allowable compressive strength for concrete is 80% of the compressive strength.

(4) The maximum number of cracked concrete layers is 3.

(5) The maximum number of crushed concrete layer is 1.

The termination checks for the steel reinforcement are:

(1) The maximum allowable strain for reinforcing bars is 100% of the yield strain.

(2) The maximum allowable tensile stress for the reinforcing bars is 100% of the yield stress of the bars.

(3) The maximum allowable compressive stress for the reinforcing bars is 100% of the yield stress of the bars.

(4) The maximum number of yielded steel layers in the deck is 1.

2.6.2 Girder Termination Checks

The termination checks for the steel girders are:

(1) The maximum allowable strain for the girder steel is 75% of the yield strain.

(2) The maximum allowable tensile stress for the girder steel is 75% of the yield stress of the steel.

(3) The maximum allowable compressive stress for the girder steel is 75% of the yield stress of the steel.

(4) The maximum number of yielded steel layers in the girders is zero, i.e. no yielding permitted.

(5) The maximum number of strain-hardened steel layers in the girders is zero.

2.6.3 Other Termination Checks

Other termination checks have been set in order to avoid excessive damages. They include:

(1) The maximum applied load for the overload vehicle is 100% of the computed dynamic load.

(2) The maximum displacement for the monitored node point is 10% of the span length of the longest span of the bridge.

III. INPUT TO PROGRAM BOVAS

This chapter describes the input for program BOVAS. The input is divided into four "units" for ease of presentation and comprehension. Each unit is further subdivided into "sections" with each section representing one line of terminal entry or a series of lines of terminal entries. The exact number of lines of entries depends on the particular problem. Various input options may be selected through the use of certain variable assignments. For example, if one variable is defined to be zero, another option which refers to that variable will be **skipped**. Similarly, some sections of input can be manually inputted by the user or internally defined by the program depending on a value inputted earlier in the data stream. These options are described where applicable. The user can refer to the example problems in Chapter-IV for illustrations of input as well as the flow-chart in Appendix-2, if further assistance is needed.

The variable name, the format, a description of each variable, and any pertinent comments and assumptions are presented in this chapter. The author has also listed recommended input values for certain variables. A detailed treatment of FORMAT specifications can be found in Reference 4 and in Appendix-3. Similarly, a summary of all units and sections is provided for the user's quick reference in Appendix-1.

3.1 Input Information

UNIT-1: INITIAL INPUT PARAMETERS

A. TITLE

1. Identification title for the particular problem.

The title should be unique in order to distinguish easily between different outputs. A maximum of 80 characters can be used in defining the title.

Variable Name: ITITLE
FORMAT: 8A10
Number of Lines: 1 (one)
Note: Proceed to Section-B.

B. NUMBER OF SPANS, NUMBER OF GIRDERS, AND TYPE OF SYMMETRY

1. Number of spans in the bridge superstructure.

At present there is a maximum of four spans permitted. If the half-transverse or quarter symmetry option is selected, the program will model a maximum of two spans. The user should input the total number of spans for the full structure. The program will modify the input values for symmetry, if necessary.

2. Number of girders on the bridge superstructure.

At present there is a maximum of 20 girders permitted. If the half-transverse or quarter symmetry option is selected, the program will model a maximum of ten girders. The user should input the total number of girders on the full structure. The program will modify the input value for symmetry, if necessary.

3. Type of symmetry for the model.

There are four allowable entries for this input. They are FULL, LONG, TRAN, and QUAR which correspond to full, half-longitudinal, half-transverse, and quarter symmetries. Refer to Figure 10 for an illustration of each symmetry type. The user is reminded that **the bridge and loading must both be symmetric about a given axis of symmetry in order to use the LONG, TRAN, and QUAR symmetry options.** See Section 2.3.3 for a more detailed explanation of symmetry options.

Variable names: NSPANS, NOMB, TSYM(I)
FORMAT: 2I5,6X,4A1
Number of lines of entry: 1 (one)
Note: Proceed to Section-C.

C. SUPERSTRUCTURE WIDTH, BRIDGE OVERHANG, and SPAN LENGTH(S)

1. Total width of the structure in inches.

This distance is measured between the two free edges of the superstructure and is assumed constant for a given bridge. Refer to Fig. 14 for an illustration of this dimension.

2. Total width of the bridge overhang in inches.

This distance is measured from the free edge to the centerline of the facia, or first, girder. This distance should also be constant for a given bridge. Refer to Figure 14 for an illustration of this dimension.

3. Span length(s) in inches.

The user should enter NSPANS (see Section-B above) values of the span length. The span length(s) for the full structure should be entered beginning with the left most span and moving right. The distance(s) should be measured as centerline-to-centerline of bearing. Refer to Figure 14 for an illustration of this dimension.

Variable Names: WIDTH, OVHANG, SPANL(I)
FORMAT: 8F10.0
Number of lines of entry: 1 (one)
Note: Proceed to Section-D.

D. OUTPUT OPTION

1. Type of output desired.

There are two allowable entries for this input. They are S and L which correspond to SHORT and LONG output options. The long output option will print everything the short output does as well as all displacements, forces, and stresses for each dead load solution and live load cycle. Refer to Chapter-V for a more detailed explanation of the output and an example of each type of output. The author recommends the short output option for most analyses unless there is a definite need to know the displacements, forces and/or stresses for a particular bridge.

VARIABLE NAME: IPRINT
FORMAT: 4X,A1
Number of lines of entry: 1 (one)
Note: Proceed to Section-E.

E. NUMBER OF ELEMENT DIVISIONS IN THE LONGITUDINAL or X-DIRECTION

1. Number of slab (girder) element divisions in the longitudinal or x-direction.

There are two options for this input. The user may choose to manually input the discretization or have the computer automatically generate the discretization based on the input values for the number of spans and the type of symmetry (see Section-B above). If the user wishes to have the computer generate the discretization, input a "zero" for this input. This option is recommended for inexperienced user. However, if manual discretization is preferred by the user, input the number of element divisions in the longitudinal direction. This value should be greater than zero and less than 50. See Section 2.3.2 for a more detailed explanation of the finite element discretization.

Variable Name: NELX
FORMAT: I5
Number of lines of entry: 1 (one)
Note: Proceed to Section-F.

F. NUMBER OF GIRDER LAYERS, GIRDER SECTIONS AND FATIGUE CHECKS

1. Number of girder layers in the girder.

Recommendations for layering of the girder are presented in Section 2.3.4. Examples of girder layering are given in Chapter-IV for three bridges.

2. Number of changes in girder cross-sections along the girder.

Changes in girder cross-sections should only be defined at locations where the material properties change, where any coverplate starts or ends or where major deterioration exists. In general vertical and horizontal stiffeners do not warrant a new section in the model. The structural response of these stiffeners is usually considered to be neglected. This input value should remain constant for all girders on a given bridge and should always be less than the number of element divisions in the longitudinal direction (see Section-E above). If the user selects the automatic discretization option, this input value should be less than six times the number of spans in the model.

3. Total number of locations at which the live load stress ranges will be checked for fatigue.

If the user wishes to check the live load stress ranges for fatigue, input the total number of details to be checked. If no fatigue checks are to be performed, input "zero." See Section 2.3.7 for more detailed explanation of the fatigue checks.

Variable Names: NULAYB, NBS, NFATG
FORMAT: 3I5
Number of lines of entry: 1 (one)
Note: Proceed to Section-G.

G. NUMBER OF PLATE GIRDER WEB PANEL CHECKS

1. The total number of plate girder web panels to be investigated for buckling of the web and/or flange.

If no panels are to be analyzed for buckling or if the girders are rolled or wide flange sections, the user should input "zero." Otherwise input the number of panels to be checked for buckling. Refer to Sections 2.3.5 and 2.3.6 for more details on the buckling phenomena.

Variable Name: NPNL
FORMAT: I5
Number of lines of entry: 1 (one)
Note: Proceed to Section-H.

H. ELEMENT LENGTHS IN THE LONGITUDINAL OR X-DIRECTION

NOTE: If the automatic discretization option was selected in Section-E (i.e. NELX=0), the user should skip Section-H and Proceed to Section-I.

1. The longitudinal or x-direction lengths of the slab (girder) elements in inches.

This section will be read only if the manual discretization option was selected in Section-E (NELX > 0). The user should input NELX values of element lengths. The sum of the input element lengths should total the complete span length for the finite element model. Refer to Section 2.3.2 for more details on finite element discretization.

Variable Name: SIGX(I)
FORMAT: 8F10.0
Number of lines of entry: 0 (zero) if the automatic discretization option was selected in Section-E (NELX=0) or (NELX)/8 rounded up to the next highest integer when a decimal quantity in the manual discretization option was selected (NELX > 0).
Note: Proceed to Section-I.

I. SLAB THICKNESS

1. The thickness of the reinforced concrete deck slab in inches.

Constant slab thickness should include an assumed one-half inch integral wearing surface. This implies that the structural capability of the slab will be analyzed for a slab in which the thickness will be assumed to be one-half inch less than the thickness inputted by the user.

Variable Name: DT
FORMAT: F10.0
Number of lines of entry: 1 (one)
Note: Proceed to Section-J.

J. GIRDER DEPTH, TOP COVER PLATE THICKNESS, AND BOTTOM COVERPLATE THICKNESS

1. The total girder depth in inches excluding any coverplates.

If the girder is a rolled section, the depth is usually given in Reference 3. If the girder is a built-up section and the flange thickness is not constant for the length of the girder, the smallest flange thickness should be entered as part of the girder depth. The remaining flange thickness should be considered as a coverplate.

2. The top coverplate thickness in inches.

If no coverplate exists, input the value as 0.0. The user is reminded that a portion of the top flange may be considered as a coverplate if a built-up girder has different flange thickness along its length.

3. The bottom coverplate thickness in inches.

If no bottom coverplate exists, input the value of 0.0. The user is reminded that a portion of the bottom flange may be considered as a coverplate if a built-up girder has different flange thickness along its length.

Variable Names: BDEPTH, TCP, BCP
FORMAT: 3 F10.0
Number of lines of entry: 1 (one)
Note: Proceed to Section-K

K. FLANGE WIDTH AND THICKNESS AND WEB THICKNESS

1. Flange width of the girder in inches.

If the girder is a rolled section, the flange width is usually given in Reference 3. If the flange width is not constant for the length of the girder, input the smallest non-deteriorated or design flange width.

2. Flange thickness of the girder in inches.

If the girder is a rolled section, the flange thickness is usually given in Reference 3. If the flange thickness is not constant for the length of the girder, the smallest top non-deteriorated or design flange thickness should be entered.

3. Web thickness of the girder in inches.

If the girder is a rolled section, the web thickness is usually given in Reference 3. If the web thickness is not constant for the length of the girder, the smallest non-deteriorated or design web thickness should be inputted.

Variable Names: BF, TF, TW
FORMAT: 3F10.0
Number of lines of entry: 1 (one)
Note: Proceed to Section-L.

L. GEOMETRY OF PLATE GIRDER WEB PANEL CHECKS

NOTE: If the user input zero for the number of web panel checks in Section-G, proceed to Section-A in Unit-2.

1. The number of the girder which contains the web panel to be checked for buckling.

The numbering of the girders is explained in Section 2.3.3 and illustrated in Figure 4.

2. The longitudinal or x-direction distance to the web panel location from the left most support of the bridge in inches.

3. The expected direction of the "diagonal truss action" of the web panel in degrees.

If counterclockwise shear deformations are expected for the panel (the tension field of the web rises from the bottom left to the top right of the web panel before the intermediate supports), the user should input 0.0. If clockwise shear deformations are expected for the panel (the tension field of the web panel drops from the top left to the bottom right of the web panel after the intermediate support), the user should input 180.0. This phenomenon is illustrated in Figure 16 to further explain this input.

4. The length of the unsupported compression flange for the web panel in inches.

Typically this length is the distance between points of lateral support or cross frame spacing of the span. Values usually range between 240. and 300. inches.

Variable Names: NBM(I), SDIS(I), PHICO(I), USLEN(I)
FORMAT: I5, 3F10.0
Number of lines of entry: NPNL (see Section-G)
Note: Section-L will be read NPNL (see Section-G) times before proceeding to Section-M.

M. WEB PANEL SUPPORT CONDITIONS

1. Web panel support conditions.

If the flanges are assumed to be acting as simple supports, the user should input "zero." If the flanges are assumed to be acting as fixed ended beams, the user should input "one."

Variable Name: IBODRY
FORMAT: I5
Number of lines of entry: 1 (one)
Note: The input for Unit-1 is now completed. Proceed to Section-A of Unit-2.

UNIT 2 - SLAB PROPERTIES AND MATERIALS

A. CONCRETE COMPRESSIVE CYLINDER STRENGTH

1. The 28 day uniaxial compressive strength of the concrete in kips per square inch (ksi).

Variable Name: FC
FORMAT: F10.0
Number of lines of entry: 1 (one)
Note: Proceed to Section-B.

B. STEEL REINFORCEMENT YIELD STRENGTH

1. The yield strength of the steel reinforcement for the slab in ksi.

Older bridges generally used Grade 40 or 40. ksi steel, while the newer bridges sometimes use Grade 60 or 60. ksi steel.

Variable Name: SIGMAP
FORMAT: F10.0
Number of lines of entry: 1 (one)
Note: Proceed to Section-C.

C. STEEL REINFORCEMENT MATERIAL NUMBER

1. The steel reinforcement material number for the slab.

Two entries are permitted for this input option. If the user wishes to input his/her own reinforcement pattern and geometry instead of defaulting to the program, input "one." However, if the user desires to have the reinforcement pattern and geometry automatically generated by the program in accordance with Reference 10, input "zero." Refer to Section 2.1.1 for a more detailed explanation.

Variable name: NSRM
FORMAT: I5
Number of lines of entry: 1 (one)
Note: Proceed to Section-D.

D. STEEL REINFORCEMENT PATTERN GEOMETRY

NOTE: If the user input zero for the steel reinforcement material number (see Section-C), skip Section-D and proceed to Section-A in Unit-3.

1. Steel reinforcement bar size for the layer.

See Table-9 for a listing of the acceptable bar sizes.

2. Spacing of reinforcing bars for the layer in inches.

The spacing is the horizontal distance between bars on centers in the same layer of reinforcement.

3. Centroidal location of the steel layer in inches.

The vertically measured distance for the given layer from the mid-plane of the concrete slab to the centroid of the reinforcing bars should be input here. If the centroid lies above the mid-plane of the slab, than a negative value should be specified, otherwise it will be a positive quantity.

4. Orientation of reinforcing bars in the layer in degrees.

The user should input 0.0 for longitudinal or x-direction reinforcement and -90.0 for transverse or y-direction reinforcement.

> Variable Names: ISIZE(I), SPACE(I), SZC(I), SPHI(I)
> FORMAT: I5, 3F10.0
> Number of lines of entry: None, if the automatic reinforcement pattern generation option was selected in Section-C (NSRM=0) or 4 lines if the manual input option was selected (NSRN=1).
> Note: If the user input one for the steel reinforcement material number (see Section-C), this section should be read four times before proceeding to Section-A of Unit-3. The four lines of entry correspond to the top transverse and longitudinal reinforcing bar layers and the bottom transverse and longitudinal reinforcing bar layers in the concrete slab.

UNIT 3 - GIRDER PROPERTIES AND MATERIALS

A. NUMBER OF STEEL MATERIALS

1. Number of different steel materials used in the girder including coverplates.

At present there is a maximum of five allowable steel materials permitted in the input. An additional steel type is automatically generated by the program in order to simulate a fictitious steel layer when required.

Variable Name: NSM
FORMAT: I5
Number of lines of entry: 1 (one)
Note: Proceed to Section-B.

B. STEEL TYPE

1. The type of steel material used in the girder or any coverplate.

The user can input one of the three options for this input. The steel type can be defined by the user, the date of the bridge construction, or the American Society of Testing and Materials (ASTM) steel grade. The last two options will automatically generate the material properties listed in the next section (Section-C) in accordance with Reference 1. If the user defined option is selected, the user must input the material properties in Section-C. Allowable ASTM steel grade entries are A7, A8, A36, A94, A242, A440, A441, A514, A517, A529, A572, and A588. Pertinent properties for these steel grades are listed in Table 10. If the steel grade is unknown, but the year of construction is known, the user could input YXXXX where XXXX corresponds to the year of bridge construction. Examples of this input could be Y1888, Y1938, or Y1971. Finally, the user may choose to input his/her own material properties in Section-C by simply inputting a "U" for user defined in this section.

Variable Name: CLASS(I)
FORMAT: 5X, A1, 4I1
Number of lines of entry: NSM (see Section-A)
Note: Section-B will be read NSM times (see Section-A).

If the user selected only non-user defined options, read the next input of Section-B. However, if the user input a "U" in Section-B, proceed to Section-C before reading next input of Section-B.

C. STEEL MATERIAL PROPERTIES

Note: This section is read after each user defined entry in Section-B. **If no user defined option was selected for any of the steel types above, this section is skipped.**

Note: Refer to References 15 and 17 for a technical description of the parameters in this section.

1. Yield stress of the girder steel in ksi.

2. Initial modulus of elasticity for the girder steel in ksi. AASHTO recommends a value of 29,000 ksi (see Ref. 2).

3. Ramberg-Osgood m-parameter for steel girder. The author recommends a value of 0.67.

4. Ramberg-Osgood n-parameter for girder steel. The author recommends a value within the range of 300-400.

5. Initial strain hardening modulus of girder steel. An average value for commonly used structural steels is about 900 ksi.

6. Strain at the initiation of strain hardening. The values obtained from various test results as reported in the literature are 0.014 for A36 and 0.0215 for A441 steels. The user should input one of these values if the true value can not be estimated or approximated by other means.

7. Ultimate strength of the girder steel in ksi.

8. Strain at ultimate stress for the girder steel in inches per inch. The author recommends a value of 0.12 if the true value is unknown.

Variable Names: SBY(I), EB(I), ROM(I), RON(I), ESHB(I), STRAN(I), SBU(I), STBU(I)
FORMAT: 8F10.0
Number of lines of entry: Number of user defined steel type entries from Section-B. There may be as few as zero and as many as NSM (see Section-B) lines of entries. Any line of entry from this section should follow the line of entry from Section-B denoting the user defined option.
Note: If additional steel materials are still to be defined, return to Section-B. Otherwise proceed to Section-D.

D. IDENTICAL OR DIFFERENT GIRDERS

1. Is the girder to be defined identical to the girder just previously defined?
There are two allowable entries for this input. They are "0" (zero) and "1" (one). When defining the first girder on the bridge, the input will always be zero. If the answer to the above question is YES, the user should input "1".

Variable Name: ISAME
FORMAT: I5
Number of lines of entry: NOBM (see Unit-1, Section-B)
Note: Section-D will be read once for each girder in the model. If the user input a zero, a series of lines of entries from Sections-E through -G defining the girder will follow before reading the next value from Section-D. If the

user input a one for Section-D, **skip Sections-E through -G and reread Section-D.** If the input for the last girder in the model is "1", proceed to Section-H.

E. DISTANCE TO NEW GIRDER CROSS-SECTIONS

Note: This section is skipped if ISAME (Section-D) was defined to be "1".

1. The longitudinal or x-direction distance(s) in inches from left most support to the location(s) where new girder cross-sections are to be defined.

Each time Section-E is read the user should always input NBS (Unit-1, Section-F) values of distance. The first value will always be 0.0. The distances should remain the same for all girders of a given bridge even though the cross-section may not change at each distance. For example, a bridge with non-uniform deterioration will probably have new sections where the cross-section does not change.

Variable Name: DNBS(I)
FORMAT: 8F10.0
Number of lines of entry: (NBS)/8 rounded up to the next highest integer when there is a decimal quantity for each girder where ISAME (Section-D) is defined to be zero. This section will be read only once if all girders on a given bridge are identical.
Note: The user is cautioned that the program will internally adjust any input value of this section to match the nearest element length in the discretization. If the adjustment to the input is substantial, the user may want to input his/her own discretization in such a way that the manually inputted finite element lengths (Unit-1, Section-H) will correspond with the input of this section.
Note: Proceed to Section-F.

F. IDENTICAL OR DIFFERENT GIRDER CROSS-SECTIONS

NOTE: This section is skipped if ISAME (Section-D) was defined to be "1".

1. Is the girder cross section to be defined identical to any girder cross-section previously defined on the girder?

There are two permissible entries for this input. They are "0" (zero) or the number of the girder cross-section previously defined which matches the new cross-section. If the answer to the above question is NO, the user should input a "0" (zero).

When defining the first section on each girder of the bridge, the input will always be zero. If the answer to the above question is YES, the user should input the number of girder cross-section previously defined which matches the new cross-section. For example, if the fourth cross-section of girder two is identical to the second cross-section of girder two, the user would input a two for this section. However, if the second cross-section of girder two only matches the second cross-section of girder one, the user would input a "0" (zero) for this input section since the new section does not match any previously defined cross-section on girder two.

> Variable Name: IX
> FORMAT: I5
> Number of lines of entries: NBS (Unit-1, Section-F) for each girder where ISAME (Section-D) is defined to be zero. This section will be read only NBS times if all girders on a given bridge are identical.
> Note: If "IX" is defined to be zero, proceed to Section-G before repeating Section-F. If "IX" is defined greater than zero, skip Section-G and repeat Section-F. If more cross-sections remain to be defined on the girder, return to Section-D. If no more girders remain to be defined, proceed to Section-H.

G. DEFINITION OF GIRDER CROSS-SECTION BY LAYERS

NOTE: This section is skipped if ISAME (Section-D) was defined to be "1" or if "IX" (Section-F) was defined to be greater than zero.

Note: Input for this section should start at the top most layer of the girder (top coverplate or top flange if no coverplate) and proceed through the depth of the girder. Refer to Section 2.3.4 for a more detailed explanation and recommendations on girder layering.

1. Vertical thickness of layer-I at location-J in inches.

2. Horizontal width of layer-I at location-J in inches.

These values are typically the coverplate width, the flange width, and the web thickness; but a deteriorated structure may have different values.

3. The initial stress of layer-I at location-J in ksi.

The user may know the residual stress pattern for the section. If so, input the residual stress here. If no initial stress or residual stress values are known, input 0.0.

4. The girder material type number of layer-I at location-J.

This number corresponds to the order in which the steel type (CLASS(I), Unit-3, Section-B) was entered. For example, input 2.0 for layers made of second steel material inputted. On coverplated girders there may be sections of the girder without any coverplate. If so, input the value equal to (NSM+1) (Unit-3, Section-A) to simulate a fictitious steel layer where no steel layer physically exists.

> Variable Names: T(I,J), B(I,J),SIR(I,J), TY(I,J)
> FORMAT: 4F10.0
> Number of lines of entry: NULAYB (Unit-1, Section-F) for each value of "IX" (Section-F) which was defined to be zero. There will be a minimum of NULAYB lines of entries for a bridge if all girders are identical and only one girder cross section is defined.
> Note: NULAYB(Unit-1, Section-F) lines of entries should be read before proceeding to the next section. Return to Section-F if additional sections remain to be defined on the girder. If no additional sections remain on the girder, return to Section-D. If all girders have been defined, proceed to Section-H.

H. FATIGUE CYCLES

Note: If NFATG (Unit-1, Section-F) was defined to be zero skip this section and proceed to Section-J.

1. The relative number of fatigue cycles a detail might see on the structure under consideration.

The program permits three entries for this input. They are HIG, MED, and LOW. HIG corresponds to a high (2 million) number of fatigue cycles, while MED and LOW correspond to a medium (500,000) and a low (100,00) number of fatigue cycles. Table 8 has been reproduced from Reference 2 in order to aid the user in selecting the appropriate input for this section if it is unknown.

> Variable Name: IFATCYC(I)
> FORMAT: 2X,3A1
> Number of lines of entry: none if NFATG (Unit-1, Section-F) was defined to be zero or one if NFATG was defined to be greater than zero.
> Note: Proceed to Section-I

G. GEOMETRY AND TYPE OF FATIGUE DETAIL

Note: Refer to Reference 2 and Section 2.3.7 for a more detailed explanation of fatigue.

1. The number of girders which contain the detail to be checked for fatigue.

The numbering of girders is explained in Section 2.3.3 and illustrated in Figure 4.

2. The longitudinal or x-direction distance in inches to the fatigue detail location from the left most support of the bridge.

3. The vertical or z-direction distance in inches to the fatigue detail location from the mid-plane of the concrete deck slab.

All distances should be positive for this entry.

4. The type of fatigue detail to be checked.

Allowable entries for this input are A, B, C, D, E, and F. Three tables and one figure have been reproduced from Reference 2 to aid the user in determining the type of detail. They are reprinted as Tables 6, 7, and 8 and Figure 13.

Variable Names: NBEAM(I), LDIST(I), VDIST(I), TDETAIL(I)
FORMAT: I5, 2F10.0, 4X, A1
Number of lines of entry: NFATG (Unit-1, Section-F)
Note: Proceed to Section-J.

J. TYPE OF COMPOSITE ACTION

1. The type of composite action assumed by the model between the steel girders and the concrete slab.

Three entries are permitted. They are FULL for full composite, PART for partial composite, and NONC for non-composite interaction. The program has been thoroughly tested for full composite action option; however, the reliability of the results for the remaining two options is not guaranteed. Therefore the user should use technical judgment in reviewing the results from partial or non-composite structure. **The author highly recommends the use of FULL whenever possible.**

Variable Name: ICOMP(I)
FORMAT: 6X, 4A1
Number of lines of entry: 1 (one)
Note: The input for Unit-3 is now completed. Proceed to Section-A of Unit-4.

UNIT 4 - STRUCTURAL LOADING

This unit will be read for a total of three times following the completion of the input to Units-1, 2, and 3. The program expects to read the dead load on the beam loads, then the dead load on the composite superstructure loads, and finally the live loads. All loads should be entered as area loads and in units of KSI. The user can not enter zeros for any of the loads and expect a completed computer run. If the user does not wish to enter a dead load on the composite superstructure a fictitious small load over a small area far from the point of interest should be entered. For a more detailed explanation of the loading refer to Section 2.2.

A. NUMBER OF AREA LOADS

1. The number of lines of entries for area load to follow in Section-B.

For the dead load on the beam solution, this value should be equal to the number of girders in the model. For example, a bridge with seven girders and a longitudinal axis of symmetry for the bridge and the loading should have four girders in the model. Therefore, enter a value of four here and follow it immediately with four lines of entries for area loads below.

The number of area loads for the remaining two solutions vary depending upon the bridge. Typically two safety parapets are entered as dead loads on the composite superstructure and the overload vehicle as the live load.

Variable Name: NC
FORMAT: I5
Number of lines of entry: 1 (one) for each of the three solutions in the analysis.
Note: The user should proceed to Section-B before reading the next input from Section-A.

B. AREA LOADS

Note: This section will be read NC times before returning to Section-A and redefining NC.

1. The intensity of the area load in KSI.

2. The longitudinal or x-direction distance measured from the left most support to the center of the area load in inches.

3. The transverse or y-direction distance measured from the lower free edge or x-axis (see Fig. 3) to the center of the area load in INCHES.

<u>4.</u> The length of the area load in the longitudinal or x-direction in INCHES.

<u>5.</u> The width of the area load in the transverse or y-direction in inches.

Variable Names: Q, X, Y, XLL, YLL
FORMAT:5F10.0
Number of lines of entry: NC1+NC2+NC3, where NC1, NC2, and NC3 are the values for the three solutions as input in Section-A above. A line of entry with the correct NC value should precede each of the three solution data sets.

END OF INPUT

3.2 Units of Input

A consistent set of units must be used for data input. Automatic assignment of certain variables may take place within the program if desired by the user. Since these variables are in units of <u>inches</u> and <u>kilopounds (kips)</u>, the user must also choose these same basic units for data input. Thus due to the automatic assignment features and due to specific output formats employed, it is suggested that units of inches and kips be used for data input. Any deviation from these recommended values would yield results that have no resemblance to those of the actual problem.

IV. EXAMPLE PROBLEMS

This chapter contains a brief presentation of three example problems solved by program BOVAS. In order to make the presentation as comprehensive as possible, the researchers have attempted to show as many input options as the problems permitted. For each example, a discussion of the geometry, loadings, and the material properties for the bridge superstructure will be presented first. An explanation of the data values for each input illustrates the origin of the input for the example.

4.1 Example Problem - 1

4.1.1 Description of the Problem

The first case study is the AASHO (now known as AASHTO) Bridge 3B which was constructed as part of the AASHO Road Test conducted in the early 1960's (Refs. 8 and 9). Bridge 3B was designed as a simply supported composite reinforced concrete slab and steel girder bridge with a span length of 50 feet centerline-to-centerline of bearing. The concrete deck slab for the bridge had an average measured depth of 6.45 inches and was 15 feet wide. Three W 18 x 60 steel beams were placed 5 feet apart with bottom coverplates (7/16" x 6") extending over 18' - 6" of the middle span. Figures 17 and 18 show the elevational and cross-sectional views of Bridge 3B.

The loads were applied to the superstructure during the test by moving overload vehicles. For testing of Bridge 3B three different overload vehicles were used (vehicles 97, 98, and 99 as shown in Fig. 19). The loading procedure consisted of placing weights on the overload vehicle which would then travel across the bridge usually thirty times. During the loading process the midspan deflections of each beam were monitored and recorded. The load was then increased and another set of runs made. This procedure continued until the bridge collapsed onto the safety crib below the bridge superstructure.

Since the overload vehicle moved over the bridge, an infinite number of static load configurations were applied to the superstructure. The overload vehicle primarily induced longitudinal bending in the superstructure of Bridge 3B. In the general case the slab may be subjected to both longitudinal and transverse bending while the girders are primarily subjected to longitudinal bending. Construction of the static load configuration to simulate the moment envelope and thus to obtain the maximum possible state of stress at every point in both the slab and the girders is very difficult, if not impossible to achieve. Therefore, two different approaches can be analyzed (Ref. 14)

The first option is to simulate the overload vehicle as a line load over each girder in the finite element model. Since this idealized load configuration approximates the moment envelope for the longitudinal direction only, the loading will produce primarily longitudinal bending moments in both the deck slab and the girders. This moment envelope is produced as the vehicle traverses the superstructure and contains the maximum moment values.

The second option is to simulate the overload vehicle as a rectangular area load. The area load should be selected such that the analysis is equivalent to the maximum static moment diagram produced by the moving overload vehicle. In this idealized loading configuration the slab is subjected to both longitudinal and some transverse bending while the girders are primarily subjected to longitudinal bending.

A comparison of the two methods in limited testing shows that the results of both approaches are nearly identical. While the first method may be slightly more accurate, the computational effort is definitely more intensive. Therefore the second option can be used to simulate the overload vehicle. For this example, the load has been entered as one rectangular area load at the midspan of the structure. This is equivalent to the "dolly" type of loading discussed in Section 2.2. The user could also have input the load as a "truck" type of loading which was discussed with the dolly type of loading.

Meanwhile, the dead loads for the dead load on the beam solution should be input as an extremely narrow area load over each girder running the full length of the finite element model. The load intensity for the dead load on the beam solution should include the weight of the steel and the wet concrete. Finally, the dead load on the superstructure only consists of a wooden curb on each free edge.

The structure is definitely symmetric about two axes in its loading and can be assumed symmetric about two axes in its geometry. Therefore only one quarter of the structure need be analyzed. In order to make the geometry symmetric about a longitudinal axis of symmetry, both overhangs were considered to be three feet in width. This increases the bridge width from fifteen to sixteen feet for the full structure.

Figure 2 shows the superstructure discretized into a series of finite elements. It should be noted that because a line of symmetry lies along the axis of the interior girder, only one half of the interior girder cross section is included in the finite element model.

The layered slab and girder models are shown in Fig. 20. A total of six layers of concrete and four layers of steel reinforcement were used in the slab finite element. The direction of action of the reinforcement is indicated by the cross-hatched area and is given along with the thickness, bar size, and spacing in Table 11. The beam finite element consists of a total of twelve layers as indicated in Fig. 20. The two cross-hatched layers, which represents the bottom coverplate, have two sets of material properties. In the region where no coverplate exists in the actual structure (near supports), the material stiffness properties are set to artificially low values to simulate the absence of the coverplate. In the area where there is a coverplate (near midspan), the properties of the steel were used. Table 12 lists the material properties of the girder steel, steel reinforcement, and concrete used in Bridge 3B and the corresponding material properties used in the finite element simulation of the first example.

This example will illustrate the use of the manual discretization, manual reinforcement, user defined steel girder types, and long printout options instead of defaulting to program libraries. The second example repeats the same bridge but illustrates the short printout and the internally defined options. In some cases the values for both examples may be identical.

4.1.2 Data Input Units

This section gives the read statement and associated values for that read statement. Input units correspond to those presented in Chapter-III. The user is reminded that input formats are given in Chapter-III and all units of input should be in kips and inches. The commas in the input data of this section are used to distinguish the separate numerical values. The input units with the actual data cards used for example one are given in Section 4.1.3.

UNIT - 1 INITIAL INPUT PARAMETERS

A. Read Title, (ITITLE)
Line No. 1: DETAILED VERSION - BOVAS EXAMPLE BRIDGE 1-AASHO BRIDGE 3B

(1) This line contains an arbitrary but unique title used for identification purposes.

B. Read Number of Spans, Number of Girders, and the Type of Symmetry, (NSPANS, NOMB, TSYM(I))

Line No. 2: 1, 3, QUAR

(1) AASHO 3B is a simple span bridge, therefore the number of spans equals one (Ref. 9).

(2) There are three girders on the full structure of AASHO 3B (Ref. 9 and Fig. 18).
(3) The loading and bridge geometry are assumed to be symmetric with respect to a longitudinal and transverse axes of symmetry, therefore input quarter symmetry (see Section 4.1.1).

C. Read Superstructure Width, Bridge Overhang, and Span Length, (WIDTH, OVHANG, SPANL(I)).

Line No. 3: 192., 36., 600.

(1) While the actual bridge is only fifteen feet (180. inches) wide, the model assumes the structure is sixteen feet (192. inches) wide in order to use a model with quarter symmetry (see Section 4.1.1 and Fig. 18).
(2) Both overhangs must be of the same width. Since they were not equal, an extra foot of width was added to make both overhangs three feet (36. inches) wide (see Section 4.1.1 and Fig. 2).
(3) AASHO 3B is a simple span bridge with a span length of 50. feet (600. inches) centerline-to-centerline of bearing. Input only one span length (see Ref. 9 and Fig. 17).

D. Read Output Option, (IPRINT)

Line No. 4: L

(1) The long output option is desired for this example, therefore input "L."

E. Read Number of Element Divisions in the Longitudinal or X-Direction, (NELX)

Line No. 5: 6

(1) Six elements in the longitudinal direction should provide an accurate and economical solution. This value agrees with the value the program would generate if the automatic discretization option had been selected (see Section 2.3.2 and Fig. 2).

F. Read Number of Girder Layers, Girder Sections, and Fatigue Checks, (NULAYB, NBS, NFATG).

Line No. 6: 12, 2, 0

(1) This example follows the recommendations presented in Section 2.3.4 (two layers per flange or coverplate and six layers per web). Since there are two flanges and one coverplate, a to-

tal of twelve girder layers was input (see Fig. 20).
(2) The girder is W 18 x 60 section for the entire length. No girder deterioration is considered in this example. A coverplate exists only on the middle portion of the girder. Therefore, three sections exist on the full structure, but only two sections exist on the finite element model because of the transverse axis of symmetry (see Fig. 21).
(3) No fatigue checks are considered in this example. See Example-3 for an illustration of this input.

G. Read Number of Plate Girder Web Panel Checks, (NPNL)

Line No. 7: 0

(1) No plate girder web panel check should be considered here since the girders are rolled sections and because the bridge is a simple span. See Example-3 for an illustration of this input.

H. Read Element Lengths in the Longitudinal or X-Direction, (SIGX(I))

Note: Since a non-zero value was input in Section-E above, input is expected from this statement. Six element divisions were defined in Section-E, therefore, six lengths should be entered here. The lengths should sum to half the total span length (0.5 x 600 = 300) since the transverse axis of symmetry is used in the model.

Line No. 8: 63., 63., 63., 51., 30., 30.

(1) In this example, the coverplate exists between 189. inches and the midspan centerline (300. inches). Therefore, the element lengths were defined such that the sum of the first three element lengths totaled 189. inches. Furthermore, the critical girder sections for the structure and the loading are near the midspan (See Fig. 2).

I. Read Slab Thickness, (DT)

Line No. 9: 6.45

(1) A thickness of 6.45 inches will be assigned to all plate elements (See Ref. 9 and Fig. 20).

J. Read Girder Depth, Top Coverplate Thickness and Bottom Coverplate Thickness, (BDEPTH, TCP, BCP)

Line No. 10: 18.25, 0., 0.4375

(1) The depth of the girder is taken from Ref. 3 for a W18x60 section (See Fig. 20).
(2) No coverplate exists, therefore input 0. (See Figures 20 and 21).
(3) The bottom coverplate thickness is listed as 7/16 inches in Reference 9 (See Fig. 20).

K. Read Flange Width and Thickness and Web Thickness, (BF, TF, TW)

Line No. 11: 7.558, 0.695, 0.416

(1,2,3) All dimensions are taken from Reference 3 for a W18x60 section.

L. Read Geometry of Plate Girder Web Panel Checks, (NBM(I), SDIST(I), PHICO(I), USLEN(I))

Note: This section is skipped since no web panel checks were specified in Section-G above.

UNIT 2 - SLAB PROPERTIES AND MATERIALS

A. Read Concrete Compressive Cylinder Strength, (FC)

Line No. 12: 5.74

(1) The concrete compressive cylinder strength as taken from Reference 8. This corresponds to 28 day test value.

B. Read Steel Reinforcement Yield Strength (SIGMAP)

Line No. 13: 61.2

(1) Reference 8 reports that the yield strength of the reinforcement steel was 61.2 ksi.

C. Read Steel Reinforcement Material Number, (NSRM)

Line No. 14: 1

(1) Since the researchers wish to illustrate the manual reinforcement option with this example, a one should be entered. The automatic generation option is illustrated in Example-2.

D. Read Steel Reinforcement Pattern Geometry, (ISIZE(I), SPACE(I), SZC(I), SPHI(I))

Note: The below data values are identical to the automatic reinforcement option values. Since the actual reinforcement pattern is unknown, these values were used to illustrate the manual input option. They were generated in accordance with Table 1 reproduced from Reference 10.

Four lines should be read from this section corresponding to the top transverse, top longitudinal, bottom longitudinal, and bottom transverse reinforcing layers of the concrete slab. The values are listed in Table 11.

Line No. 15: 5, 6., -0.4125, -90.
Line No. 16: 4, 12., 0.1500, 0.0
Line No. 17: 5, 8.7403, 1.2875, 0.0
Line No. 18: 5, 6., 1.9125, -90.

(1) The bar size for each layer.
(2) The spacing of bars for each layer.
(3) The centroidal location for each layer. Negative values are above the slab mid-plane.
(4) The orientation of the bars for each layer. An input of -90. indicates a transverse layer, while an input of 0.0 indicates a longitudinal layer.

UNIT - 3 GIRDER PROPERTIES AND MATERIALS

A. Read Number of Steel Materials, (NSM)

Line No. 19: 3

(1) Coupons from the flange, web, and coverplate were all tested in order to obtain properties for each region even though the girders are rolled sections. Since the test results are presented in References 8 and 9, they are used here to illustrate the user defined option for the steel girders. The user should be reminded that a fourth steel material (NSM+1) is automatically generated by the program to simulate a fictitious steel layer.

B. Read Steel Type, (CLASS(I))

Note: This section will be read a total of three times (the input value of line 19 above). If the user defined steel type option is selected, Section-C should be read before reading the next value from this section.

Line No. 20: U

(1) The user defined steel type option has been selected. Therefore read the steel material properties for the flange steel from Section-C below before reading the next steel type in Section-B.

C. Read Steel Type Material Properties, (SYB(I), EB(I), ROM(I), RON(I), ESHB(I), STRAN(I), SBU(I), STBU(I))

Note: All properties listed on the next line correspond to steel test results of the girder flange (Steel Material Type - 1)

Line No. 21: 35.1, 30000., 0.67, 400., 900., 0.014, 64.9, 0.12

(1) Yield stress of the flange steel (Ref. 8).
(2) Initial modulus of elasticity for flange steel.
(3) Ramberg-Osgood m-parameter.
(4) Ramberg-Osgood n-parameter.
(5) Initial strain hardening modulus.
(6) Strain at the initiation of strain hardening.
(7) Ultimate strength of flange steel (Ref. 8)
(8) Strain at ultimate stress.

Note: Return to Section-B and read the steel type for the second steel type to be inputted.

B. Read Steel Type, (CLASS(I))

Line No. 22: U

(1) The user defined steel type option has been selected. Therefore, read the steel material properties for the web steel from Section-C below before reading the third and last steel type in Section-B.

C. Read Steel Type Material Properties, (SBY(I), EB(I), ROM(I), RON(I), ESHB(I), STRAN(I), SBU(I), STBU(I))

Note: All properties listed on this line correspond to steel test results of the girder web (steel material type-2). Refer to line 21 above or Chapter-III for a definition of each input value on this line.

Line No. 23: 39.9, 30000., 0.67, 400., 900., 0.014, 66.6, 0.12

Note: Return to Section-B and read the steel type for the third and last steel type to be inputted.

B. Read Steel Type, (CLASS(I))

Line No. 24: U

(1) The user defined steel type option has been selected. Therefore, read the steel material properties for the coverplate from Section-C below. Since no other steel materials remain to be defined, the user should proceed to Section-D after completing Section-C.

C. Read Steel Type Material Properties, (SBY(I), EB(I), ROM(I), RON(I), ESBH(I), STRAN(I), SBU(I), STBU(I))

Note: All properties listed on this line correspond to steel test results of the coverplate (steel material type-3). Refer to line 21 or Chapter-III for a definition of each input value on this line.

Line No. 25: 38.4, 30000., 0.67, 400., 900., 0.014, 60.2, 0.12

Note: All steel types have been defined including the internal definition of a material type-4 corresponding to a fictitious steel material. Therefore proceed to Section-D.

D. Read Identical or Different Girders, (ISAME)

Line No. 26: 0

(1) Since this is the first girder to be defined, the input must be zero.

Note: Since a zero is inputted for this section, proceed to Section-E.

E. Read Distances to New Girder Cross-Sections, (DNBS(I))

Note: Since the number of girder sections (NBS) was defined to be two in Unit-1, Section-F, Entry-2, two values should be entered on the line for this input (see Fig. 21).

Line No. 27: 0., 189.

(1) Whenever Section-E is read, the first entry should always be 0 (zero). This defines the end of the girder at the left support line.
(2) The second entry corresponds to the beginning of the coverplate on the girder. No other new cross-sections exist on the model.

F. Read Identical or Different Cross-Sections, (IX)

Line No. 28: 0

(1) Since this is the first girder cross-section to be defined, the input must be zero.

Note: Since a zero is inputted for this section, proceed to Section-G.

G. Read Definition of Girder Cross-Section, (T(I,J), B(I,J), SIR(I,J), TY(I,J))

Note: Since the number of girder layers (NULAYB) was defined in Unit-1, Section-F, Entry-1 to be twelve, twelve lines should be entered for this section. These twelve lines should define the first girder cross-section which begins at 0.0 inches (the left support) and ends at start of the coverplate (189. inches). The layers should be input consecutively starting with the top most layer (in this case the top flange) and ending with the bottom most layer (in this case the fictitious bottom coverplate). For this example, the first two lines correspond to the top flange, the next six lines define the web, the ninth and tenth lines define the bottom flange, and the last two lines correspond to a fictitious bottom coverplate. The coverplate does not physically exist at this girder section.

Line No. 29: 0.3475, 7.558, 0.0, 1.
Line No. 30: 0.3475, 7.558, 0.0, 1.
Line No. 31: 2.81, 0.416, 0.0, 2.
Line No. 32: 2.81, 0.416, 0.0, 2.
Line No. 33: 2.81, 0.416, 0.0, 2.
Line No. 34: 2.81, 0.416, 0.0, 2.
Line No. 35: 2.81, 0.416, 0.0, 2.
Line No. 36: 2.81, 0.416, 0.0, 2.
Line No. 37: 0.3475, 7.558, 0.0, 1.
Line No. 38: 0.3475, 7.588, 0.0, 1.
Line No. 39: 0.21875, 6., 0.0, 4.
Line No. 40: 0.21875, 6., 0.0, 4.

(1) Vertical thickness of layer. In this example, each flange and coverplate is divided into two layers of equal thickness, while the web is divided into six layers of equal thickness (see Fig. 20).
(2) Horizontal width of layer. In this example, the flange width, web thickness, and coverplate width are inputted for the appropriate layer (see Fig. 20).
(3) Initial stress of layer. No initial or residual stresses were assumed for this example.
(4) Girder steel material type of layer. The numbers 1. and 2. correspond to the values inputted in Section-C for the flange and

web steel material properties. The number 4. corresponds to fictitious steel material properties which were defined by the program.

Note: Since another cross-section remains to be defined on this girder (the coverplated section), proceed to Section-F.

F. Read Identical or Different Cross-Sections, (IX)

Note: Is this new cross-section to be defined at the second location (189.0 inches) identical to any previously defined cross-section on this girder? NO.

Line No. 41: 0

(1) While the first ten layers are identical to the previously defined section, the last two layers (the bottom coverplate) physically exist at this cross-section location. Therefore, the sections are different and a zero should be inputted.

Note: Since a zero is inputted for this section, proceed to Section-G.

G. Read Definition of Girder Cross-Section by Layers, (T(I,J), B(I,J), SIR(I,J), TY(I,J))

Note: Since the number of girder layers (NULAYB) is defined in Unit-1, Section-F, Entry-1 to be twelve, twelve lines should be entered for this section. These twelve lines should define the second girder cross-section which begins at 189.0 inches (the start of the coverplate) and ends at the transverse centerline (300.0 inches). The layers should be input consecutively starting with the top most layer (in this case the top flange) and ending with the bottom most layer (in this case the bottom coverplate). For this example, the first two lines correspond to the top flange, the next six lines define the web, the ninth and the tenth lines correspond to the bottom flange, and the last two lines define the bottom coverplate of the girder. The only difference from the first section, defined in the material type of the bottom coverplate (last entry on last two lines), is the change from fictitious to actual steel properties for the coverplate layers.

Line No. 42: 0.3475, 7.558, 0.0, 1.
Line No. 43: 0.3475, 7.558, 0.0, 1.
Line No. 44: 2.81, 0.416, 0.0, 2.
Line No. 45: 2.81, 0.416, 0.0, 2.
Line No. 46: 2.81, 0.416, 0.0, 2.
Line No. 47: 2.81, 0.416, 0.0, 2.
Line No. 48: 2.81, 0.416, 0.0, 2.

Line No. 49: 2.81, 0.416, 0.0, 2.
Line No. 50: 0.3475, 7.558, 0.0, 1.
Line No. 51: 0.3475, 7.558, 0.0, 1.
Line No. 52: 0.21875, 6., 0.0, 3.
Line No. 53: 0.21875, 6., 0.0, 3.

(1) Vertical thickness of layer. In this example, each flange and coverplate is divided into two layers of equal thickness, while the web is divided into six layers of equal thickness (see Fig. 20).
(2) Horizontal width of layer. In this example, the flange width, web thickness, and coverplate width are inputted for the appropriate layer (see Fig. 20).
(3) Initial stress of layer. No initial or residual stresses were assumed for this example.
(4) Girder steel type of layer. The numbers 1., 2., and 3. correspond to the values inputted in Section-C for the flange, web and coverplate steel material properties. No fictitious layers exist in this cross-section.
Note: Since the first girder has been completely defined for the finite element model (no new cross-section exists on this girder), proceed to Section-D since second girder remains to be defined.

D. Read Identical or Different Girders, (ISAME)

Note: Is the second and last girder of the finite element model identical to the first girder defined? YES

Line No. 54: 1

(1) All girders are assumed to be identical in cross-section, therefore input "one" to indicate the second girder is identical to the first girder. The user is reminded that only one-half of this girder is included in the model because it lies along the longitudinal axis of symmetry. The program internally determines if the girder is a full or half section and adjusts the layer dimensions when necessary.

Note: Since the girders are identical (a one is input), Section-D should be read for the third girder. However, there is no third girder in the finite element model (see Fig. 2). Therefore the user should proceed to Section-H.

H . Read Fatigue Cycles, (IFATCYC(I))

Note: This section is skipped since no fatigue checks (NFATG) were specified in Unit-1, Section-F, Entry-3.

I. Read Geometry and Type of Fatigue Detail, (NBEAM(I), LDIST(I), VDIST(I), TDETAIL(I))
Note: This section is skipped since no fatigue checks (NFATG) were specified in Unit-1, Section-F, Entry-3.

J. Read Type of Composite Action, (ICOMP(I))

Line No. 55: FULL

(1) Reference 9 reports that the bridge was designed to act as a fully composite structure.

UNIT 4 - STRUCTURAL LOADING

Note: Sections-A and -B below will be read first for the dead load on the beam solution. This procedure is then repeated two more times for the dead load on the superstructure and live load solutions.

A. Read Number of Area Loads, (NC)

Line No. 56: 2

(1) The dead load on the beam solution expects the equivalent steel and wet concrete load carried by each girder to be input. Therefore, since two girders exist in the model, two area loads should be input.

B. Read Area Load Lines, (Q, X, Y, XLL, YLL)

Note: The number of lines to be entered for this section should be equal to the value input in Section-A above. Therefore, for this example, two lines should be entered for the dead load on the beam solution. The first line defines the steel and wet concrete load carried by the first or exterior girder and the positioning of that load for this solution. Similarly, the second line defines the load on the second or interior girder and the positioning of that load. All dead load on the beam loads should be input as extremely narrow area loads running the full length of the finite element model in order to simulate a line load on the girders. See Section 2.2 for a further explanation of the loading.

Line No. 57: 4.44080, 150., 36., 300., 0.01
Line No. 58: 4.08512, 150., 96., 300., 0.01

(1) The intensity of the area load. The value is higher for the first line since the effective width of the concrete on the ex-

terior girder is larger in this example (See Section 2.2 in order to determine the load intensities).
(2) The centroidal location of the area load in the longitudinal or x-direction. For this solution, input one-half the girder length of the finite element model (see Fig. 2).
(3) The centroidal location of the area load in the transversal or y-direction. For this solution, input the y-coordinate defining the location of the girder (see Fig. 2).
(4) The length of the area load in the longitudinal or x-direction. For this solution, input the length of the finite element model (see Fig. 2).
(5) The width of the area load in the transversal or y-direction. For this solution, input 0.01 inches to simulate a line load.

Note: The loading for the dead load on the beam solution is now completely defined. Repeat the above process for the dead load on the superstructure solution.

A. Read Number of Area Loads, (NC)

Line No. 59: 1

(1) As explained in Section 4.1.1 of this Chapter, there is only one dead load on the superstructure. Only the dead load due to the wooden curb at the free edge is considered for this example.

B. Read Area Load Lines, (Q, X, Y, XLL, YLL)

Note: The number of lines to be entered for this section should be equal to the value input in Section-A above. For this example, one line should be entered for the dead load on the superstructure solution. See Section 2.2 for a further explanation of the loading.

Line No. 60: 0.000277, 150., 6., 300., 12.

(1) The intensity of the area load. Reference 8 reported that the wooden curb had a unit weight of 40.0 pounds per lineal foot. That value has been converted to an equivalent area load for input.
(2) The centroidal location of the area load in the longitudinal or x-direction. For this solution and example, the loading runs along the entire length of the structure. Therefore input one-half the girder length of the finite element model (See Fig. 2).
(3) The centroidal location of the area load in the transversal or y-direction. For this example, Reference 8 reported the curb was one foot wide. Therefore input one-half of the curb width.
(4) The length of the area load in the longitudinal or x-direction. For this example, input the length of the finite ele-

ment model (See Fig. 2).
(5) The width of the area load in the transversal or y-direction. For this example, Reference 8 reported the curb width was 12.0 inches.

Note: The loading for the dead load on the superstructure solution is now completely defined. Repeat the above process for the live load solution.

A. Read Number of Area Loads, (NC)

Line No. 61: 1

(1) As explained in Section 4.1.1, the live load can be simulated by a rectangular area load at the midspan of the superstructure. Therefore, only one area load should be input.

B. Read Area Load Lines, (Q, X, Y, XLL, YLL)

Note: The number of lines to be entered for this section should be equal to the value input in Section-A above. For this example, one line should be entered for the live load solution. Refer to Section 4.1.1 and Section 2.2 for further explanation of loading.

Line No. 62: 0.00193, 210., 60., 180., 72.

(1) The intensity of the area load. The input intensity is based on calculations made from Reference 7.
(2) The centroidal location of the area load in the longitudinal or x-direction. For this example, input the x-coordinate value for the centroid of the area load on the finite element model.
(3) The centroidal location of the area load in the transversal or y-direction. For this example, input the y-coordinate value of the centroid of the area load on the finite element model.
(4) The length of the area load in the longitudinal or x-direction.
(5) The width of the area load in the transversal or y-direction.

Note: This completes the input necessary to run the detailed version of program BOVAS for Example Problem-1.

4.1.3 Sample Input

See the following listing. Lines 111111111122222222223333333333 etc. are added to indicate the column locations. They are not needed as a part of the input.

```
DETAILED VERSION - BOVAS EXAMPLE BRIDGE 1 - AASHO BRIDGE 3B
11111111112222222222333333333344444444445555555555666666666677777777778888888888
   1    3       OUAR
   192.00      36.00  600.0000
   L
   6
  12    2     0
   0
   63.000     63.000     63.000     51.000     30.000     30.000
 6.450000
 18.25000   0.00000    .43750
 7.558000   .695000   .416000
11111111112222222222333333333344444444445555555555666666666677777777778888888888
    5.740
   61.200
   1
   5     6.0000    -.41250    -90.000
   4    12.0000     .15000      0.000
   5     8.7403    1.28750      0.000
   5     6.0000    1.91250    -90.000
   3
    U0000
  35.1000  30000.00   .670000   400.000   900.000    .01400   64.9000    .12000
11111111112222222222333333333344444444445555555555666666666677777777778888888888
    U0000
  39.9000  30000.00   .670000   400.000   900.000    .01400   66.6000    .12000
    U0000
  38.4000  30000.00   .670000   400.000   900.000    .01400   60.2000    .12000
   0
    0.000   189.000
   0
  .347500   7.55800   0.0000       1.00
  .347500   7.55800   0.0000       1.00
 2.810000    .41600   0.0000       2.00
11111111112222222222333333333344444444445555555555666666666677777777778888888888
 2.810000    .41600   0.0000       2.00
 2.810000    .41600   0.0000       2.00
 2.810000    .41600   0.0000       2.00
 2.810000    .41600   0.0000       2.00
 2.810000    .41600   0.0000       2.00
  .347500   7.55800   0.0000       1.00
  .347500   7.55800   0.0000       1.00
  .218750   6.00000   0.0000       4.00
  .218750   6.00000   0.0000       4.00
   0
11111111112222222222333333333344444444445555555555666666666677777777778888888888
  .347500   7.55800   0.0000       1.00
  .347500   7.55800   0.0000       1.00
 2.810000    .41600   0.0000       2.00
 2.810000    .41600   0.0000       2.00
 2.810000    .41600   0.0000       2.00
 2.810000    .41600   0.0000       2.00
 2.810000    .41600   0.0000       2.00
 2.810000    .41600   0.0000       2.00
  .347500   7.55800   0.0000       1.00
  .347500   7.55800   0.0000       1.00
11111111112222222222333333333344444444445555555555666666666677777777778888888888
  .218750   6.00000   0.0000       3.00
  .218750   6.00000   0.0000       3.00
   1
     FULL
   2
 4.440800   150.000   36.000  300.0000     .0100
 4.085120   150.000   96.000  300.0000     .0100
   1
  .000277   150.000    6.000  300.0000   12.0000
   1
11111111112222222222333333333344444444445555555555666666666677777777778888888888
  .001930   210.000   60.000  180.0000   72.0000
```

4.2 Example Problem - 2

4.2.1 Description of the Problem

This example is the same bridge that was employed in the first example (See Section 4.1.1). Loading configuration is also the same. The major differences between the two examples are that this example illustrates the use of (1) all internally defined options instead of the user defined options, and (2) the use of the short output instead of the long output. The internally defined options used in this example are for the finite element mesh, the refined geometry, and the girder steel material properties. Because of the changes in the definition of the discretization, element lengths in the longitudinal or x-direction are divided differently. The new discretization is shown in Figure 22. The remainder of the input lines are essentially the same.

4.2.2 Data Input Units

This section gives the read statement and the associated values for that read statement. Input units correspond to those presented in Chapter-III. The user is reminded that input formats are given in Chapter-III and all units of input should be in KIPS and INCHES. The commas in the input data of this section are used to delineate the separate data fields. The input units with the actual data lines for Example - 2 are given in Section 4.2.3.

UNIT 1 - INITIAL INPUT PARAMETERS

A. Read Title Line, (ITITLE)

Line No. 1: DETAILED VERSION - BOVAS EXAMPLE BRIDGE 2 - AASHO BRIDGE 3B

(1) This line contains an arbitrary but unique title used for identification purposes.

B. Read Number of Spans, Number of Girders, and Type of Symmetry, (NSPANS, NOMB, TSYM(I))

Line No. 2: 1, 3, QUAR

(1) AASHO 3B is a simple span bridge, therefore the number of spans equals one (Ref. 9).
(2) There are three girders on the full structure of AASHO 3B (Ref. 9 and Fig. 18).
(3) The loading and bridge geometry are assumed to be symmetric with respect to a longitudinal and transverse axes of symmetry, therefore input quarter symmetry (See Section 4.1.1).

C. Read Superstructure Width, Bridge Overhang, and Span Length(s), (WIDTH, OVHANG, SPANL(I))

Line No. 3: 192., 36., 600.

(1) While the actual bridge is only fifteen feet (180.0 inches) wide, the model assumes the structure is 16.0 feet (192. inches) wide in order to use a model with quarter symmetry (See Section 4.1.1 and Fig. 18).
(2) Both overhangs must be of the same width. Since they were not equal, an extra foot of width was added to make both overhangs three feet (36. inches) wide (See Section 4.1.1 and Figure 22).
(3) AASHO 3B is a simple span bridge with a span length of 50.0 feet (600. inches) centerline-to-centerline of bearing. Input only one span length (See Ref. 9 and Figure 17).

D. Read Output Option, (IPRINT)

Line No. 4: S

(1) The short output option is desired for this example, therefore input "S."

E. Read Number of Element Divisions in the Longitudinal or x-Direction, (NELX)

Line No. 5: 0

(1) The use of the internal finite element discretization option is desired for this example. Therefore the user should input a zero in this section. Since the bridge is a simple span, the program will automatically define NELX equal to six (See Section 2.3.2 and Figure 22).

F. Read Number of Girder Layers, Girder Sections, and Fatigue Checks, (NULAYB, NKBS, NKFATG)

Line No. 6: 12, 2, 0

(1) This example follows the recommendations presented in Section 2.3.4 (Two layers per flange or coverplate and six layers per web). Since there are two flanges and one coverplate, a total of twelve girder layers was input (See Figure 20).
(2) The girder is a W 18 x 60 section for the entire length. No girder deterioration is considered in the example. A coverplate exists only on the middle portion of the girder. Therefore, three sections exist on the full structure, but only two sections exist on the finite element model because of the transverse axis

of symmetry (See Figure 21).
(3) No fatigue checks are considered in this example. See Example-3 for an illustration of this input.

G. Read Number of Plate Girder Web Panel Checks, (NPNL)

Line No. 7: 0

(1) No plate girder web panel checks should be considered here since the girders are rolled sections and because the bridge is a simple span. See Example-3 for an illustration of this input.

H. Read Element Lengths in the Longitudinal or X-Direction, (SIGX(I))

Note: Since a zero value was input for NELX in Section-E, this Section is not read. The program will automatically generate the SIGX(I) values based on the number of spans and type of symmetry input. Refer to Fig. 22 for the values generated by the program for this example.

I. Read Slab Thickness, (DT)

Line No. 8: 6.45

(1) A thickness of 6.45 inches will be assigned to all plate elements (See Ref. 9 and Figure 20).

J. Read Girder Depth, Top Coverplate Thickness, and Bottom Coverplate Thickness, (BDEPTH, TCP, BCP)

Line No. 9: 18.25, 0.0, 0.4375

(1) The depth of the girder is taken from Ref. 1 for a W 18 x 60 section (See Fig. 20).
(2) No coverplate exists, therefore input zero (See Figs. 20 and 21).
(3) The bottom coverplate thickness is listed as 7/16 inches in Reference 9 (See Fig. 20).

K. Read Flange Width and Thickness and Web Thickness, (BF, TF, TW)

Line No. 10: 7.558, 0.695, 0.416

(1,2,3) All three dimensions are taken from Ref. 3 for a W18x60 section.

L. Read Geometry of Plate Girder Web Panel Checks, (NBM(I), SDIST(I), PHICO(I), USLEN(I))

Note: This section is skipped since no web panel checks were specified in Section-G above.

M. Read Web Panel Support Conditions, (IBODRY)

Note: This section is skipped since no web panel checks were specified in Section-G above.

UNIT 2 - SLAB PROPERTIES AND MATERIAL

A. Read Concrete Compressive Cylinder Strength, (FC)

Line No. 11: 5.74

(1) The concrete compressive cylinder strength as taken from reference 8. This corresponds to a 28 day test value.

B. Read Steel Reinforcement Yield Strength, (SIGMAP)

Line No. 12: 61.2

(1) Reference 8 reports that the yield strength of the reinforcement steel was 61.2 ksi.

C. Read Steel Reinforcement Material Number, (NSRM)

Line No. 13: 0

(1) Since the researchers wish to illustrate the automatic reinforcement generation option with this example, a zero should be entered. The manual user defined option is illustrated in Example-1.

D. Read Steel Reinforcement Pattern Geometry, (ISIZE(I), SPACE(I), SZC(I), SPHI(I))

Note: Since a zero value was input for NSRM in Section-C, this section is not read. The program will automatically generate the values of this input in accordance with Table-1 reproduced from Reference 10. The generated values for this input are listed in Table 11 of this manual.

UNIT 3 - GIRDER PROPERTIES AND MATERIALS

A. Read Number of Steel Materials, (NSM)

Line No. 14: 2

(1) Coupons from the flange, web, and coverplate were all tested in order to obtain properties for each region even though the girders are all rolled sections. Since the yield stress results of the web and coverplate are nearly identical, they are considered to be the same material for this example (See Refs. 8 and 9). The user should be reminded that a third steel material (NSM+1) is automatically generated by the program to simulate a fictitious steel layer.

B. Read Steel Type, (CLASS(I))

Note: This section will be read a total of two times (the input value of line 14 above). If the user defined steel type option is selected, Section-C should be read before reading the next values from this section.

Line No. 15: A36

(1) Reference 8 reported that the flange steel had a yield strength of 35.1 ksi. Since the researchers wanted to illustrate a non-user defined option with this example, A36 steel was selected because its yield strength (36 KSI) nearly matches the test result value.

C. Read Steel Type Material Properties, (SBY(I), EB(I), ROM(I), RON(I), ESHB(I), STRAN(I), SBU(I), STBU(I))

Note: Since the user defined option was not selected in Section-B above, this section will not be read. The program will automatically generate the material properties based on the input value in Section-B. The generated material properties for this example are listed in Table-12.

Note: Return to Section-B and read the steel type for the second and the last steel type to be inputted.

B. Read Steel Type, (CLASS(I))

Line No. 16: A529

(1) This steel type will define the material properties of both the web and coverplate since the reported yield stress of 39.9 and 38.4 ksi, respectively, are nearly identical. Since the re-

searchers wanted to illustrate a non-user defined option with this example, A529 was selected because its yield strength (42 ksi) "nearly" matches the test result values.

C. Read Steel Type Material Properties, (SBY(I), EB(I), ROM(I), RON(I), ESHB(I), STRAN(I), SBU(I), STBU(I))

Note: Since the user defined option was not selected in Section-B above, this section will not be read. The program will automatically generate the material properties based on the input value of Section-B. The generated material properties for this example are listed in Table-12.

Note: All steel types have been defined including the internal definition of a material type-3 corresponding to a fictitious steel material. Therefore proceed to Section-D.

D. Read Identical or Different Girders, (ISAME)

Line No. 17: 0

(1) Since this is the first girder to be defined, the input must be zero.

Note: Since a zero is inputted for this section, proceed to Section-E.

E. Read Distances to New Girder Cross-Sections, (DNBS(I))

Note: Since the number of girder sections (NBS) was defined to be two in Unit-1, Section-F, Entry-2 two values should be entered on the line for this input (See Fig. 21).

Line No. 18: 0.0, 189.

(1) Whenever Section-E is read, the first entry should always be zero. This defines the end of the girder at the left support line.
(2) The second entry corresponds to the beginning of the coverplate on the girder. The user is cautioned that the program will adjust this input value from 189. to 195. inches in order to match the generated finite element lengths (See Fig. 22). No other new cross-sections exist on the model.

F. Read Identical or Different Cross-Sections, (IX)

Line No. 19: 0

(1) Since this is the first cross-section to be defined, the input must be zero.

Note: Since a zero is inputted for this section, proceed to Section-G.

G. Read Definition of Girder Cross-Sections, (T(I,J), B(I,J), SIR(I,J), TY(I,J))

Note: Since the number of girder layers (NULAYB) was defined in Unit-1, Section-F, Entry-1 to be twelve, twelve lines should be entered for this section. These twelve lines should define the first girder cross-section which begins at 0.0 inches (the left support) and ends at the start of the coverplate (189.0 inches). The layers should be input consecutively starting with the top most layer (in this case the top flange) and ending with the bottom most layer (in this case the "fictitious" bottom coverplate. For this example, the first two lines correspond to the top flange, the next six lines define the web, the ninth and the tenth lines define the bottom flange, and the last two lines correspond to a fictitious bottom coverplate. The coverplate does not physically exist at this girder section.

Line No. 20: 0.3475, 7.558, 0.0, 1.
Line No. 21: 0.3475, 7.558, 0.0, 1.
Line No. 22: 2.81, 0.416, 0.0, 2.
Line No. 23: 2.81, 0.416, 0.0, 2.
Line No. 24: 2.81, 0.416, 0.0, 2.
Line No. 25: 2.81, 0.416, 0.0, 2.
Line No. 26: 2.81, 0.416, 0.0, 2.
Line No. 27: 2.81, 0.416, 0.0, 2.
Line No. 28: 0.3475, 7.558, 0.0, 1.
Line No. 29: 0.3475, 7.558, 0.0, 1.
Line No. 30: 0.21875, 6., 0.0, 3.
Line No. 31: 0.21875, 6., 0.0, 3.

(1) Vertical thickness of layer. In this example, each flange and coverplate is divided into two equal layers of equal thickness, while the web is divided into six layers of equal thickness (See Fig. 20).
(2) Horizontal width of layer. In this example, the flange width, web thickness, and coverplate width are inputted for the appropriate layer (See Fig. 20).
(3) Initial stress of layer. No initial or residual stresses were assumed for this example.
(4) Girder steel material type of layer. The numbers 1. and 2. correspond to the values inputted in Section-B for the flange and web steel material properties. The number 3. corresponds to fictitious steel material properties which are defined by the program.

Note: Since another cross-section remains to be defined on this girder (the coverplated section), proceed to Section-F.

F. Read Identical or Different Cross-Sections, (IX)

Note: Is this new cross-section to be defined at the second location (189. inches) identical to any previously defined section on this girder? NO

Line No. 32: 0

(1) While the first ten layers are identical to the previously defined section, the last two layers (the bottom coverplate) physically exist at this cross-section location. Therefore, the sections are different and a zero should be inputted.

Note: Since a zero is inputted for this section, proceed to Section-G.

G. Read Definition of Girder Cross-Section by Layers, (T(I,J), B(I,J), SIR(I,J), TY(I,J))

Note: Since a zero is inputted for this section, proceed to Section-G.

G. Read Definition of Girder Cross-Section by Layers, (T(I,J), B(I,J), SIR(I,J), TY(I,J))

Note: Since number of girder layers (NULAYB) is defined in Unit-1, Section-F, Entry-2 to be twelve, twelve lines should be entered for this section. These twelve lines should define the second girder cross-section which begins at 189.0 inches (the start of the coverplate) and ends at the transverse centerline (300.0 inches). The layers should be input consecutively starting with the top most layer (in this case the bottom coverplate). For this example, the first two lines correspond to the top flange, the next six lines define the web, the ninth and the tenth lines correspond to the bottom flange, and the last two lines define the bottom coverplate of the girder. The only difference from the first section defined is the material type of the bottom coverplate (last entry on last two lines) changes from fictitious to actual steel properties for the coverplate layers.

Line No. 33: 0.3475, 7.558, 0.0, 1.
Line No. 34: 0.3475, 7.558, 0.0, 1.
Line No. 35: 2.81, 0.416, 0.0, 2.
Line No. 36: 2.81, 0.416, 0.0, 2.
Line No. 37: 2.81, 0.416, 0.0, 2.
Line No. 38: 2.81, 0.416, 0.0, 2.

Line No. 39: 2.81, 0.416, 0.0, 2.
Line No. 40: 2.81, 0.416, 0.0, 2.
Line No. 41: 0.3475, 7.558, 0.0, 1.
Line No. 42: 0.3475, 7.558, 0.0, 1.
Line No. 43: 0.21875, 6., 0.0, 2.
Line No. 44: 0.21875, 6., 0.0, 2.

(1) Vertical thickness of layer. In this example, each flange and coverplate is divided into two layers of equal thickness, while the web is divided into six layers of equal thickness (See Fig. 20).
(2) Horizontal width of layer. In this example, the flange width, web thickness and coverplate width are inputted for the appropriate layer (See Fig. 20).
(3) Initial stress of layer. No initial or residual stresses were assumed for this example.
(4) Girder steel material type of layer. The numbers 1. and 2. correspond to the values inputted in Section-B for the flange and the web and coverplate steel material properties. No fictitious layers exist in this cross-section.

Note: Since the first girder has been completely defined for the finite element model (no new cross-sections exist on this girder), proceed to Section-D since a second girder remains to be defined.

D. Read Identical or Different Girders, (ISAME)

Note: Is the second and last girder of the finite element model identical to the first girder defined? YES

Line No. 45: 1

(1) All girders are assumed to be identical in cross-section, therefore input one to indicate the second girder is identical to the first girder. The user is reminded that only one-half of this girder is included in the model because it lies along the longitudinal axis of symmetry. The program internally determines if the girder is a full or half section and adjusts the layer dimensions when necessary.

Note: Since the girders are identical (a one is input for this section), Section-D should be read for the third girder. However, there is no third girder in the finite element model (See Fig. 22). Therefore, the user should proceed to Section-H.

H. Read Fatigue Cycles, (IFATCYC(I))

Note: This section is skipped since no fatigue checks (NFATG) were specified in Unit-1, Section-F, Entry-3.

I. Read Geometry and Type of Fatigue Detail, (NBEAM(I), LDIST(I), VDIST(I), TDETAIL(I))

Note: This section is skipped since no fatigue checks (NFATG) were specified in Unit-1, Section-F, Entry-3.

J. Read Type of Composite Action, (ICOMP(I))

Line No. 46: FULL

(1) Reference 9 reports that the bridge was designed to act as a fully composite structure.

UNIT - 4 STRUCTURAL LOADING

Note: Sections-A and -B below will be read first for the dead load on the beam solution. This procedure is then repeated two more times for the dead load on the superstructure and live load solutions.

A. Read Number of Area Loads, (NC)

Line No. 47: 2

(1) The dead load on the beam solution expects the equivalent steel and wet concrete load carried by each girder to be input. Therefore, since two girders exist in the model, two area loads should be input.

B. Read Area Load Lines, (Q, X, Y, XLL, YLL)

Note: The number of lines to be entered for this section should be equal to the value input in Section-A above. Therefore, for this example, two lines should be entered for the dead load on the beam solution. The first line defines the steel and wet concrete load carried by the first or exterior girder and the positioning of that load for this solution. Similarly, the second line defines the load on the second or interior girder and the positioning of that load. All dead loads should be input as extremely narrow area loads running the full length of the finite element model in order to simulate a line load on the girders. See Section 2.2 for a further explanation of the loading.

Line No. 48: 4.44080, 150., 36., 300., 0.01
Line No. 49: 4.08512, 150., 96., 300., 0.01

(1) The intensity of the area load. The value is higher for

entry at line No. 48 since the effective width of the concrete on the exterior girder is larger in this example (See Section 2.2 in order to determine load intensities).
(2) The centroidal location of the area load in the longitudinal or x-direction. For this solution, input one-half the girder length of the finite element model (see Fig. 22).
(3) The centroidal location of the area load in the transversal or y-direction. For this solution, input the y-coordinate defining the location of the girder (See Fig. 22).
(4) The length of the area load in the longitudinal or x-direction. For this solution, input the length of the finite element model (See Fig. 22).
(5) The width of the area load in the transversal or y-direction. For this solution, input 0.01 inches to simulate a line load.

Note: The loading for the dead load on the beam solution is now completely defined. Repeat the above process for the dead load on the superstructure solution.

A. Read Number of Area Loads, (NC)

Line No. 50: 1

(1) As explained in Section 4.1.1, there is only one dead load on the superstructure. Only the dead load due to the wooden curb at the free edge is considered for this example.

B. Read Area Load Lines, (Q, X, Y, XLL, YLL)

Note: The number of lines to be entered for this section should be equal to the value input in Section-A above. For this example, one line should be entered for the dead load on the superstructure solution. See Section 2.2 for a further explanation of loading.

Line No. 51: 0.000277, 150., 6., 300., 12.

(1) The intensity of the area load. Reference 8 reported that the wooden curb had a unit weight of 40.0 pounds per lineal foot. That value has been converted to an equivalent area load for input.
(2) The centroidal location of the area load in the longitudinal or x-direction. For this solution and example, the loading runs along the entire length of the structure. Therefore, input one-half the girder length of the finite element model (See Fig. 22).
(3) The centroidal location of the area load in the transversal or y-direction. For this example, Reference 8 reports that the curb was one foot wide. Therefore, input one-half the curb width.

(4) The length of the area load in the longitudinal or x-direction. For this example, input the length of the finite element model (See Fig. 22).
(5) The width of the area load in the transversal or y-direction. For this example, Reference 8 reported the curb width was 12. inches.

Note: The loading for the dead load on the superstructure solution is now completely defined. Repeat the above process for the live load solution.

A. Read Number of Area Loads, (NC)

Line No. 52: 1

(1) As explained in Section 4.1.1, the live load can be simulated by a rectangular area load at the midspan of the superstructure. Therefore, only one area load should be input.

B. Read Area Load Lines, (Q, X, Y, XLL, YLL)

Note: The number of lines to be entered for this section should be equal to the value input in Section-A above. For this example, one line should be entered for the live load solution. Refer to Section 4.1.1 and Section 2.2 for a further explanation of the loading.

Line No. 53: 0.00193, 210., 60., 180., 72.

(1) The intensity of the area load. The input intensity is based on calculations made from Reference 5.
(2) The centroidal location of the area load in the longitudinal or x-direction. For this example, input the x-coordinate value for the centroid of the area load on the finite element model.
(3) The centroidal location of the area load in the transversal or y-direction. For this example, input the y-coordinate value for the centroid of the area load on the finite element model.
(4) The length of the area load in the longitudinal or x-direction.
(5) The width of the area load in the transversal or y-direction.

Note: This completes the input necessary to run the detailed version of Program BOVAS for Example Problem-2.

4.3 Example Problem 3

4.3.1 Description of the Problem

The third example problem is a four span welded girder bridge from the Federal Highway Administration's (FHWA) plans on Typical Continuous Bridges by Load Factor Design (Ref. 19). This bridge superstructure has spans of 100 feet, 140 feet, 140 feet, and 100 feet centerline-to-centerline on bearing with a 44 foot road way width (See Figs. 23 and 24). The reinforced concrete deck averages 9.0 inches thick and the five welded plate girders have web plates 66 inches x 3/8 inches. The variation in the girder flange plates is shown in Fig. 25. The girders are braced laterally at the supports by channel sections and at approximately every 25 feet with steel cross-bracing. The material properties of the concrete, reinforcing steel, and girder steel used in the analysis are outlined in Table 13. The girder web is composed of A36 steel while the girder flanges are composed of either A36 or A441 steel as noted in Fig. 25.

Based upon previous results (Ref. 6), which indicate that the maximum moment envelope of a bridge superstructure can be obtained by a uniformly distributed load pattern, a uniformly distributed load pattern will also be applied in this case using a rectangular area load. While such a loading condition will not necessarily give the worst possible loading condition, the results should effectively exhibit buckling, post-buckling, and any other nonlinear behavior, if any, of conventional bridges.

The live load will be applied as an area load over the entire slab surface between girders one and three (See Fig. 24) for the entire length of the superstructure. Meanwhile, the dead loads for the dead load on the beam solution should be input as an extremely narrow area load over each girder running the full length of the finite element model. The load intensity for the dead load on the beam solution should include the weight of the steel and the wet concrete. Finally, the dead load on the superstructure loads will illustrate the case when no load is desired on the structure. In this case, a minimal load will be placed along the two free edges of the superstructure.

The structure is definitely symmetric about two axes in its geometry, but the bridge is only symmetric about a transverse axis of symmetry in its loading. Therefore, only one-half of the structure need be analyzed. The bridge will be modeled using only the first two spans.

Figure 26 shows the superstructure discretized into a series of finite elements. The node points, element numbering, and element divisions are indicated in the figure. A total of 336 nodes, 200 slab or plate elements, and 100 beam elements were used.

The layered slab and girder elements are shown in figures 27 and 28. A total of six layers of concrete and four layers of steel reinforcement were used in the slab finite element. However, the second steel layer (top longitudinal reinforcement) has two layers contained in it to resist cracking in the negative moment regions. The direction of action of the reinforcement is indicated by the cross-hatched area and is given along with the thickness, bar size, and spacing in Table 14. The beam finite element consists of a total of 15 layers as indicated in Fig. 28. Because of the variation in flange thickness along the length of the girder (See Fig. 25), multiple coverplates exist on both the top and bottom flanges. Therefore, there will be cross-sections with layers where steel does not physically exist. These layers are modeled by specifying a fictitious material with effectively no stiffness.

Finally, this example checks for both buckling and fatigue. A total of six transversely stiffened web plate panels per girder are specified in the analysis. The first four are located over the first interior support, pier-2, while the last two web plate panels are at the center support, pier-3. Based upon the lateral bracing, the unbraced lengths of the web plate panel compression flanges are assumed to be equal to 300., 300., 280., 280., 280., and 280. inches, respectively. As stated earlier, fatigue will also be investigated in this example. A total of 74 locations will be checked against the allowable stress range values. These locations correspond to essentially two types of critical details: (1) the groove weld connecting flanges of differing size when reinforcement is not removed (Stress Category-C) and (2) transverse stiffener to web or flange welds (Stress Category C*, but conservatively modeled as Category C) (See Ref. 2 and Section 2.3.7).

4.3.2 Data Input Units

This section gives the read statement and associated values for that read statement. Input units correspond to those presented in Chapter III. The user is reminded that input formats are given in Chapter III and all units of input should be in kips and inches. The commas in the input data stream are used to identify separate data entries. The input units with the actual data lines for Example - 3 are given in Section 4.3.3.

UNIT 1 - INITIAL INPUT PARAMETERS

A. Read Title Line, (ITITLE)

Line No. 1: DETAILED VERSION - BOVAS EXAMPLE BRIDGE 3 - FHWA FOUR SPAN

(1) This line contains an arbitrary but unique title used for identification purposes.

B. Read Number of Spans, Number of Girders, and Type of Symmetry, (NSPANS, NOMB, TSYM(I))

Line No. 2: 4, 5, TRAN

(1) This is a four span bridge, therefore the number of spans equals four (Ref. 19 and Section 4.3.1).
(2) There are five girders on the full structure of this bridge (See Fig. 24)
(3) The loading and bridge geometry are assumed to be symmetric with respect to a transverse axis of symmetry, therefore input half-traverse symmetry (See Section 4.3.1).

C. Read Superstructure Width, Bridge Overhang, and Span Length(s), (WIDTH, OVHANG, SPANL(I))

Line No. 3: 558., 47., 1200., 1680., 1680., 1200.

(1) The FHWA plans (Ref. 19 or Fig. 24) show the total bridge superstructure width to be 46' - 6" or 558. inches.
(2) The distance between the free edge and the centerline of the exterior girder is shown to be 47. inches in Figure 26.
(3, 4, 5, 6) Since this example is a four span bridge, four span lengths should be entered (See Section 4.3.1 and Fig. 23).

D. Read Output Option, (IPRINT)

Line No. 4: S

(1) The short output option is desired for this example, therefore input "S."

E. Read Number of Element Divisions in the Longitudinal or X-Direction, (NELX)

Line No. 5: 20

(1) The use of automatic mesh generation option would have defined NELX to be 12. However, because of girder cross-section changes at several locations and because a fine mesh is desired at the negative moment regions, the researchers chose to input their own mesh for this example. (See Section 2.3.2 and Fig. 26).

E. Read Number of Girder Layers, Girder Sections, and Fatigue Checks, (NULAYB, NBS, NFATG)

(1) This example provides an illustration of girder layering for a more complex girder. For this bridge, the flange thickness

varies along the length of the girder. The smallest flange thickness on each flange should be considered as the flange thicknesses for the entire girder. Any remaining portion of the flange thickness should be considered as a coverplate layer. In this example, there are two top coverplates and one top flange which correspond to layers one through three. Similarly, there are three bottom coverplates and one bottom flange which correspond to the last four layers. Layers four through eleven are of equal thickness and define the web of the girder. Eight web layers were chosen because the girder is relatively deep (See Fig. 28).
(2) Assuming there is no deterioration on the girders, there are four sections of new cross-section on the girder (See Fig. 25) for the half-transverse symmetry option.
(3) A total of 74 locations will be checked for fatigue (See Section 4.3.1).

G. Read Number of Plate Girder Web Panel Checks, (NPNL)

Line No. 7: 30

(1) As stated in Section 4.3.1, six checks will be made on each girder in the finite element model. Therefore, a total of thirty web panel locations will be investigated for buckling.

H. Read Element Lengths in the Longitudinal or X-Direction, (SIGX(I))

Note: Since a non-zero value was input in Section-E above, input is expected from this statement. Twenty element divisions were defined in Section-E, therefore 20 lengths should be entered here. The lengths should total to the sum of the first two span lengths (2880. inches) since a transverse axis of symmetry is used in the model.

Line No. 8: 200., 200., 200., 204., 204., 92., 50., 50.
Line No. 9: 46.667, 46.667, 98.667, 216., 216., 216., 200., 200.
Line No. 10: 200., 146.667, 46.667, 46.667

(1) In this example the coverplate starts or ends at 1008., 1392., and 2640. inches. Therefore element divisions should occur at those locations. Also, since the program is going to check for buckling, a finer mesh is desirable near the interior supports. Finally, an experienced user would know that the aspect ratio of the elements (length to width ratio) should not exceed four or five to one. The input for this section was based on the above reasoning (See Fig. 26).

I. Read Slab Thickness, (DT)

Line No. 11: 9.

(1) A thickness of 9.0 inches will be assigned to all plate elements (See Ref. 19 and Fig. 27).

J. Read Girder Depth, Top Coverplate Thickness, and Bottom Coverplate Thickness, (EDEPTH, TCP, BCP)

Line No. 12: 67.5, 0.75, 0.625

(1) On a built-up section the depth of the girder is equal to the sum of the top flange thickness (0.625 inches), web depth (66. inches), and bottom flange thickness (0.875 inches) (See Fig. 28).
(2) For this example, the difference between the largest and smallest top flange thickness is considered as the top coverplate thickness (See Ref. 19 and Fig. 25).
(3) For this example, the difference between the largest and smallest bottom flange thickness is considered as the bottom coverplate thickness (Ref. 19 and Fig. 25).

K. Read Flange Width and Thickness and Web Thickness, (BF, TF, TW)

Line No. 13: 16., 0.625, 0.375

(1) Input the largest top flange width on the girder (See Ref. 9 and Fig. 25).
(2) Input the smallest top flange thickness on the girder (See Ref. 9 and Fig. 25).
(3) Input the web thickness of the girder (See Ref. 9 and Fig. 25).

L. Read Geometry of Plate Girder Web Panel Checks, (NBM(I), SDIST(I), PHICO(I), USLEN(I))

Note: Since a non-zero value was input in Section-G above, input is expected from this statement.

Thirty panel checks were specified in Section-G, therefore 30 lines should be entered here.

Line No. 14: 1, 1125., 0.0, 300.
Line No. 15: 1, 1175., 0.0, 300.
Line No. 16: 1, 1225., 180., 280.
Line No. 17: 1, 1275., 180., 280.
Line No. 18: 1, 2810., 0.0, 280.

Line No. 19: 1, 2850., 0.0, 280.
Line No. 20: 2, 1125., 0.0, 300.
Line No. 21: 2, 1175., 0.0, 300.
Line No. 22: 2, 1225., 180., 280.
Line No. 23: 2, 1275., 180., 280.
Line No. 24: 2, 2810., 0.0, 280.
Line No. 25: 2, 2850., 0.0, 280.
Line No. 26: 3, 1125., 0.0, 300.
Line No. 27: 3, 1175., 0.0, 300.
Line No. 28: 3, 1225., 180., 280.
Line No. 29: 3, 1275., 0.0, 280.
Line No. 30: 3, 2810., 0.0, 280.
Line No. 31: 3, 2850., 0.0, 280.
Line No. 32: 4, 1125., 0.0, 300.
Line No. 33: 4, 1175., 0.0, 300.
Line No. 34: 4, 1225., 180., 280.
Line No. 35: 4, 1275., 180., 280.
Line No. 36: 4, 2810., 0.0, 280.
Line No. 37: 4, 2850., 0.0, 280.
Line No. 38: 5, 1125., 0.0, 300.
Line No. 39: 5, 1175., 0.0, 300.
Line No. 40: 5, 1225., 180., 280.
Line No. 41: 5, 1275., 180., 280.
Line No. 42: 5, 2810., 0.0, 280.

(1) As stated in Section 4.3.1, six panel checks should be made on each of the five girders. Therefore input each girder number six times.
(2) Panel checks should be made on two elements preceding the first interior support as well as the first two elements and last two elements on the second span. The researchers recommend inputting the distance to the approximate center of these elements.
(3) Counterclockwise shear deformations are expected on the four elements which precede the first two interior supports, therefore enter 0.0 for those panel checks. Meanwhile, clockwise shear deformations are expected on the first two elements on the second span, therefore enter 180.0 for those panel checks (See Fig. 16).
(4) The second cross frame spacing of the first span is shown to be 25 feet (300. inches) in Ref. 19. Similarly, the cross frame spacing of the second span is shown to be 23' - 4" (280. inches). Input the correct values for each of the two spans.

M. Web Panel Support Conditions, (IBODRY)

Line No. 44: 1

(1) For this example, the flanges are assumed to be as fixed ended beams. Therefore, a one was input for this section.

UNIT 2 - SLAB PROPERTIES AND MATERIALS

A. Read Concrete Compressive Cylinder Strength, (FC)

Line No. 45: 5.5

(1) This is the assumed 28 day test value for the concrete compressive cylinder strength (See Table 13).

B. Read Steel Reinforcement Yield Strength, (SIGMAP)

Line No. 45: 40

(1) Grade 40 or 40 ksi reinforcing steel is the lowest grade used on the superstructure (See Ref. 19). By inputting the lowest yield strength, results may be slightly conservative.

C. Read Steel Reinforcement Material Number, (NSRM)

Line No. 47: 0

(1) Since the researchers wish to illustrate the automatic reinforcement generation option for a continuous span, a zero is entered. The manual user defined option is illustrated in Example-1.

D. Read Steel Reinforcement Pattern Geometry, (ISIZE(I), SPACE(I), SZC(I), SPHI(I))

Note: Since a zero value was input for NSRM in Section-C, this section is not read. The program will automatically generate the values of this input in accordance with Table 1 reproduced from Reference 10. The generated values for this input are listed in Table 14 of this manual.

UNIT 3 - GIRDER PROPERTIES AND MATERIALS

A. Read Number of Steel Materials, (NSM)

Line No. 48: 2

(1) Reference 19 and Figure 25 show that the girder is composed of two steel materials (A36 and A441). Therefore the user should input a two in this Section. The user is also reminded that a third steel material (NSM+1) is automatically generated by the program to simulate a fictitious steel layer.

B. Read Steel Type, (CLASS(I))

Note: This section will be read a total of two times (the input value of Line No. 48 above). If the user defined steel type option is selected, Section-C should be read before reading the next value from this section.

Line No. 49: A36

(1) A36 steel is used on all flange and coverplate layers except those over the intermediate supports. It is also used for all web layers (See Fig. 25).

C. Read Steel Type Material Properties, (SBY(I), EB(I), ROM(I), RON(I), ESHB(I), STRAN(I), SSBU(I), STBU(I))

Note: Since the user defined options were not selected in Section-B above, this section will not be read. The program will automatically generate the material properties based on the input value in Section-B. The generated material properties for this example are listed in Table 13.

Note: Return to Section-B and read the steel type for the second and last steel type to be inputted.

B. Read Steel Type, (CLASS(I))

Line No. 50: A441

(1) A441 steel is used only on the flange and coverplate layers over the intermediate supports (See Fig. 25).

C. Read Steel Type and Material Properties, (SBY(I), EB(I), ROM(I), RON(I), ESHB(I), STRAN(I), SBU(I), STBU(I))

Note: Since the user defined option was not selected in Section-B above, this section will not be read. The program will automatically generate the material properties based on the input value of Section-B. The generated material properties for this example are listed in Table 13.

Note: All steel types have been defined including the internal definition of a material type three corresponding to a fictitious steel material. Therefore proceed to Section-D

D. Read Identical or Different Girders, (ISAME)

Line No. 51: 0

(1) Since this is the first girder to be defined, the input must be zero.

Note: Since a zero is inputted for this section, proceed to Section-E.

E. Read Distances to New Girder Cross-Sections, (DNBS(I))

Note: Since the number of girder sections (NBS) was defined to be four in Unit-1, Section-F, Entry-2, four values should be entered on the line for this input (See Fig. 25).

Line No. 52: 0.0, 1008., 1392., 2640.

(1) Whenever Section-E is read, the first entry should always be zero. This defines the end of the girder at the left support line.
(2) The second entry corresponds to the beginning of the change in flange thickness and material type on the girder on the first span (See Fig. 25).
(3) The third entry corresponds to the end of section two above on the second span of the superstructure (See Fig. 25).
(4) The fourth and last entry corresponds to the beginning of the change in flange thickness and material type on the girder on the second span (See Fig. 25). No other new cross-sections exist on the model.

F. Read Identical or Different Cross-Sections, (IX)

Line No. 53: 0

(1) Since this is the first girder cross-section to be defined, the input must be zero.

Note: Since a zero is inputted for this section, proceed to Section-G.

G. Read Definition of Girder Cross-Section, (T(I,J), B(I,J), SIR(I,J), TY(I,J))

Note: Since the number of girder layers (NULAYB) was defined in Unit-1, Section-F, Entry-1 to be 15, 15 lines should be entered for this section. These 15 lines should define the first girder cross-section which begins at 0.0 inches (the left support) and ends at the start of the second section (108. inches). The layers should be input consecutively starting with the top most layer (in this case the top most "fictitious" coverplate) and ending with the bottom most layer (in this case the bottom most "fictitious" coverplate). For this example, the first two lines define the two top fictitious coverplates, the third line corresponds to the flange, the next eight lines define the web, the twelfth line corresponds to the bottom flange, and the last three lines define the three bottom fictitious coverplates. None of the five coverplate layers physically exist at this girder cross-section.

Line No. 54: 0.125, 12., 0.0, 3.
Line No. 55: 0.625, 12., 0.0, 3.
Line No. 56: 0.625, 12., 0.0, 1.
Line No. 57: 8.25, 0.375, 0.0, 1.
Line No. 58: 8.25, 0.375, 0.0, 1.
Line No. 59: 8.25, 0.375, 0.0, 1.
Line No. 60: 8.25, 0.375, 0.0, 1.
Line No. 61: 8.25, 0.375, 0.0, 1.
Line No. 62: 8.25, 0.375, 0.0, 1.
Line No. 63: 9.25, 0.375, 0.0, 1.
Line No. 64: 8.25, 0.375, 0.0, 1.
Line No. 65: 0.875, 16., 0.0, 1.
Line No. 66: 0.25, 16., 0.0, 3.
Line No. 67: 0.125, 16., 0.0, 3.
Line No. 68: 0.25, 16., 0.0, 3.

(1) Vertical thickness of layer. In this example, each flange and coverplate is considered one layer, while the web is divided into eight layers of equal thickness (See Fig. 28).
(2) Horizontal width of layer. In this example, the flange width, web thickness, and coverplate width are inputted for the appropriate layer (See Fig. 28).
(3) Initial stress of layer. No initial or residual stresses were assumed for this example.
(4) Girder steel material type of layer. The number 1. corresponds to the first steel material type inputted in Section-B. In this case, material type-1. is A36 steel. The number 3. corresponds to fictitious steel material properties which were defined by the program.

Note: Since another cross-section remains to be defined on this girder, proceed to Section-F.

F. Read Identical or Different Cross-Sections, (IX)

Note: Is this new cross-section to be defined at the second location (1008. inches) identical to any previously defined section on this girder? NO.

Line No. 69: 0

(1) While the layer thickness and initial stress are the same for all layers on both sections, the width of the top three layers increases and the material type changes for both flanges

and three of the five coverplate layers. Therefore, the sections are different and a zero should be inputted.

Note: Since a zero is inputted for this section, proceed to Section-G.

G. Read Definition of Girder Cross-Section by Layers, (T(I,J), B(I,J), SIRR(I,J), TY(I,J))

Note: Since the number of layers (NULAYB) is defined in Unit-1, Section-F, Entry-2 to be 15, 15 lines should be entered for this section. These 15 lines should define the second cross-section of the first girder which begins at 1008. inches (the start of a real coverplates section) and ends at the start of the third cross-section (1392. inches). The layers should be input consecutively starting with the top most layer (in this case the top "fictitious" coverplate) and ending with the bottom most layer (in this case the bottom "fictitious" coverplate). For this example, the first two lines define the two top coverplates, the third line corresponds to the top flange, the next eight lines define the web, and the twelfth line corresponds to the bottom flange, and the last three lines define the three bottom coverplates. The top most and bottom most coverplate layers do not physically exist at this girder cross-section. The only difference from the first cross-section defined is that the material type of layers 2, 3, 12, 13, and 14 changes to A441 steel and the top three layers increase to 16. inches in width.

Line No. 70: 0.125, 16., 0.0, 3.
Line No. 71: 0.625, 16., 0.0, 2.
Line No. 72: 0.625, 16., 0.0, 2.
Line No. 73: 8.25, 0.375, 0.0, 1.
Line No. 74: 8.25, 0.375, 0.0, 1.
Line No. 75: 8.25, 0.375, 0.0, 1.
Line No. 76: 8.25, 0.375, 0.0, 1.
Line No. 77: 8.25, 0.375, 0.0, 1.
Line No. 78: 8.25, 0.375, 0.0, 1.
Line No. 79: 8.25, 0.375, 0.0, 1.
Line No. 80: 8.25, 0.375, 0.0, 1.
Line No. 81: 0.875, 16., 0.0, 2.
Line No. 82: 0.25, 16., 0.0, 2.
Line No. 83: 0.125, 16., 0.0, 2.
Line No. 84: 0.25, 16., 0.0, 3.

(1) Vertical thickness of layer. In this example, each flange and coverplate is considered as one layer, while the web is divided into 8 layers of equal thickness (See Fig. 28).
(2) Horizontal width of layer. In this example, the flange width, web thickness, and coverplate width are inputted for the appropriate layer (See Fig. 28).
(3) Initial stress of layer. No initial or residual stresses were assumed for this example.

(4) Girder steel material type of layer. The numbers 1. and 2. correspond to the steel material types inputted in Section-B. In this example, they correspond to A36 and A441 steels, respectively. The number 3. corresponds to fictitious steel material properties which were defined by the program.

Note: Since another cross-section remains to be defined on this girder, proceed to Section-F.

F. Read Identical or Different Cross-Sections, (IX)

Note: Is this new cross-section to be defined at the third location (1392. inches) identical to any previously defined section on this girder? NO

Line No. 85: 0

(1) The third section is nearly identical to the first cross-section. If layer thirteen was a fictitious layer instead of a real steel layer in this section, cross-section three would be identical to the first cross-section and the user could have input a one, skipped Section-G, and read Section-F for the fourth and last cross-section. However, there is a difference in the two sections, therefore the user should input zero.

Note: Since a zero is inputted for this section, proceed to Section-G.

G. Read Definition of Girder Cross-Section by Layers, T(I,J), B(I,J), SIR(I,J), TY(I,J))

Note: Since the number of girder layers (NULAYB) is defined in Unit-1, Section-F, Entry-2 to be 15, 15 lines should be entered for this section. These 15 lines should define the third cross-section of the first girder which begins at 1392. inches (the end of the first coverplated section) and ends at the start of the fourth cross-section (2640. inches). The layers should be input consecutively starting with the top most layer (in this case the top most "fictitious" coverplate) and ending with the bottom most layer (in this case the bottom most "fictitious" coverplate). For this example, the first two lines define the top two "fictitious" coverplates, the third line corresponds to the top flange, the next eight lines define the web, the twelfth line corresponds to the bottom flange, the last three lines define the three bottom coverplates. The two top and two bottom coverplate layers do not physically exist at this girder cross-section.

Line No. 86: 0.125, 12., 0.0, 3.
Line No. 87: 0.625, 12., 0.0, 3.
Line No. 88: 0.625, 12., 0.0, 1.

Line No. 89: 8.25, 0.375, 0.0, 1.
Line No. 90: 8.25, 0.375, 0.0, 1.
Line No. 91: 8.25, 0.375, 0.0, 1.
Line No. 92: 8.25, 0.375, 0.0, 1.
Line No. 93: 8.25, 0.375, 0.0, 1.
Line No. 94: 8.25, 0.375, 0.0, 1.
Line No. 95: 8.25, 0.375, 0.0, 1.
Line No. 96: 8.25, 0.375, 0.0, 1.
Line No. 97: 0.875, 16., 0.0, 1.
Line No. 98: 0.25, 16., 0.0, 1.
Line No. 99: 0.125, 16., 0.0, 3.
Line No. 100: 0.25, 16., 0.0, 3.

(1) Vertical thickness of layer. In this example, each flange and coverplate is considered as one layer, while the web is divided into eight layers of equal thickness (See Fig. 28).
(2) Horizontal width of layer. In this example, the flange width, web thickness, and coverplate width are inputted for the appropriate layer (See Fig. 28).
(3) Initial stress of layer. No initial or residual stress were assumed for this example.
(4) Girder steel material type of layer. The number 1. corresponds to the first steel material type inputted in Section-B. In this example, material type-1 is A36 steel. The number 3. corresponds to fictitious steel material properties which were defined by the program.

Note: Since another cross-section remains to be defined on this girder, proceed to Section-F.

F. Read Identical or Different Cross-Section, (IX)

Note: Is this new cross-section to be defined at the fourth location (2640. inches) identical to any previously defined cross-section on this girder? NO.

Line No. 101: 0

(1) Since the cross-section has no fictitious steel coverplate layers, it is not identical to any of the previously defined cross-sections. Therefore, the user should input zero.

Note: Since a zero is inputted for this section, proceed to Section-G.

G. Read Definition of Girder Cross-Section by Layers, (T(I,J), B(I,J), SIR(I,J), TY(I,J))

Note: Since the number of girder layers (NULAYB) is defined in Unit-1, Section-F, Entry-1 to be 15, 15 lines should be entered for this section. These fifteen lines should define the fourth cross-section of the first girder which begins at 2640. inches and ends at the transverse axis of symmetry (2880. inches). The layers should be input consecutively starting with the top most layer (in this case the top most coverplate) and ending with the bottom most layer (in this case the bottom most coverplate). For this example, the first two lines define the top two coverplates, the third line corresponds to the top flange, the next eight lines define the web, and the twelfth line corresponds to the bottom flange, and the last three lines define the three bottom coverplates. There are no fictitious steel layers at third girder cross-section.

Line No. 102: 0.125, 16i., 0.0, 2.
Line No. 103: 0.625, 16., 0.0, 2.
Line No. 104: 0.625, 16., 0.0, 2.
Line No. 105: 8.25, 0.375, 0.0, 1.
Line No. 106: 8.25, 0.375, 0.0, 1.
Line No. 107: 8.25, 0.375, 0.0, 1.
Line No. 108: 8.25, 0.375, 0.0, 1.
Line No. 109: 8.25, 0.375, 0.0, 1.
Line No. 110: 8.25, 0.375, 0.0, 1.
Line No. 111: 8.25, 0.375, 0.0, 1.
Line No. 112: 8.25, 0.375, 0.0, 1.
Line No. 113: 0.875, 18., 0.0, 2.
Line No. 114: 0.25, 18., 0.0, 2.
Line No. 115: 0.125, 18., 0.0, 2.
Line No. 116: 0.25, 18., 0.0, 2.

(1) Vertical thickness of layer. In this example, each flange and coverplate is considered as one layer, while the web is divided into eight layers of equal thickness (See Fig. 28).
(2) Horizontal width of layer. In this example, the flange width, web thickness, and coverplate width are inputted for the appropriate layer (See Fig. 28).
(3) Initial stress of layer. No initial or residual stress was assumed for this example.
(4) Girder steel material type of layer. The numbers 1. and 2. correspond to the values inputted in Section-B. In this example, they correspond to A36 and A441 steels, respectively. No fictitious layers exist in this cross-section.

Note: Since the first girder has been completely defined for the finite element model (no new cross-section exist on this girder), proceed to Section-D since four girders remain to be defined.

D. Read Identical or Different Girders, (ISAME)

Note: Is the second girder of the finite element model identical to the first girder defined? YES

Line No. 117: 1

(1) All girders are assumed to be identical in cross-section, therefore input one to indicate the second girder is identical to the first girder.

Note: Since the girders are identical (a one is input for this section), Section-D should be read for the third girder. Therefore, skip Sections-E, -F, and -G and return to Section-D.

D. Read Identical or Different Girders, (ISAME)

Note: Is the third girder of the finite element model identical to the second girder defined? YES

Line No. 118: 1

(1) All girders are assumed to be identical in cross-section, therefore input one to indicate the third girder is identical to the second girder.

Note: Since the girders are identical (a one is input for this section), Section-D should be read for the fourth girder. Therefore, skip Sections-E, -F, and -G and return to Section-D.

D. Read Identical or Different Girders, (ISAME)

Note: Is the fourth girder of the finite element model identical to the third girder defined? YES.

Line No. 119: 1

(1) All girders are assumed to be identical in cross-section, therefore input one to indicate the fourth girder is identical to the third girder.

Note: Since the girders are identical (a one is input for this section), Section-D should be read for the fifth and last girder. Therefore, skip Sections-E, -F, and -G and return to Section-D.

D. Read Identical or Different Girders, (ISAME)

Note: Is the fifth girder of the finite element model identical to the fourth girder defined? YES

Line No. 120: 1

(1) All girders are assumed to be identical in cross-section, therefore input one to indicate the fifth girder is identical to

the fourth girder.

Note: Since the girders are identical (a one is input for this section), Section-D should be read for the sixth girder. However, there is no sixth girder in the superstructure (See Fig. 24). Therefore the user should proceed to Section-H.

H. Read Fatigue Cycles, (IFATCYC(I))

Note: Since a non-zero value was read in Unit-1, Section-F, Entry-3 for the number of fatigue checks (NFATG), input is expected from this section.

Line No. 121: HIG

(1) Since this bridge could be constructed as part of a major thoroughfare, a relatively high number of fatigue load cycles could be expected. By inputting HIG for "high," a conservative analysis will probably result (See Table 8).

I. Read Geometry and Type of Fatigue Detail, (NBEAM(I), LDIST(I), VDIST(I), TDETAIL(I))

Note: Since the number of fatigue checks (NFATG) is defined to be 74 in Unit-1, Section-F, Entry-3, 74 lines of input are expected from this section. The fatigue checks can be entered by the user in any order (See Section 4.3.1).

Line No. 122: 2, 900., 5.5, C
Line No. 123: 2, 900., 72.5, C
Line No. 124: 2, 1008., 5.0, C
Line No. 125: 2, 1008., 5.5, C
Line No. 126: 2, 1008., 72.5, C
Line No. 127: 2, 1008., 72.875, C
Line No. 128: 2, 1008., 73.1, C
Line No. 129: 2, 1125., 5.5, C
Line No. 130: 2, 1125., 72.5, C
Line No. 131: 2, 1175., 5.5, C
Line No. 132: 2, 1175., 72.5, C
Line No. 133: 2, 1225., 5.5, C
Line No. 134: 2, 1225., 72.5, C
Line No. 135: 2, 1275., 5.5, C
Line No. 136: 2, 1275., 72.5, C
Line No. 137: 2, 1392., 5.0, C
Line No. 138: 2, 1392., 5.5, C
Line No. 139: 2, 1392., 72.5, C
Line No. 140: 2, 1392., 72.875, C
Line No. 141: 2, 1392., 73.1, C
Line No. 142: 2, 1480., 5.5, C
Line No. 143: 2, 1480., 72.5, C

```
Line No. 144:  2, 1480., 72.875, C
Line No. 145:  2, 2600., 5.5, C
Line No. 146:  2, 2600., 72.5, C
Line No. 147:  2, 2600., 72.875, C
Line No. 148:  2, 2640., 4.6, C
Line No. 149:  2, 2640., 5.0, C
Line No. 150:  2, 2640., 5.5, C
Line No. 151:  2, 2640., 72.5, C
Line No. 152:  2, 2640., 72.875, C
Line No. 153:  2, 2640., 73.1, C
Line No. 154:  2, 2640., 73.2, C
Line No. 155:  2, 2810., 5.5, C
Line No. 156:  2, 2810., 72.5, C
Line No. 157:  2, 2880., 5.5, C
Line No. 158:  2, 2880., 72.5, C
Line No. 159:  4, 900., 5.5, C
Line No. 160:  4. 900., 72.5, C
Line No. 161:  4, 1008., 5.0, C
Line No. 162:  4, 1008., 5.5, C
Line No. 163:  4, 1008., 72.5, C
Line No. 164:  4, 1008., 72.875, C
Line No. 165:  4, 1008., 73.1 C
Line No. 166:  4, 1125., 5.5, C
Line No. 167:  4, 1125., 72.5, C
Line No. 168:  4, 1175., 5.5, C
Line No. 169:  4, 1175., 72.5, C
Line No. 170:  4, 1225., 5.5, C
Line No. 171:  4, 1225., 72.5, C
Line No. 172:  4, 1275., 5.5, C
Line No. 173:  4, 1275., 72.5, C
Line No. 174:  4, 392., 5.0, C
Line No. 175:  4, 1392., 5.5, C
Line No. 176:  4, 1392., 72.5, C
Line No. 177:  4, 1392., 72.875, C
Line No. 178:  4, 1392., 73.1, C
Line No. 179:  4, 1480., 5.5, C
Line No. 180:  4, 1480., 72.5, C
Line No. 181:  4, 1480., 72.875, C
Line No. 182:  4, 2600., 5.5, C
Line No. 183:  4, 2600., 72.5, C
Line No. 184:  4, 2600., 72.875, C
Line No. 185:  4, 2640., 4.6, C
Line No. 186:  4, 2640., 5.0, C
Line No. 187:  4, 2640., 5.5, C
Line No. 188:  4,2640., 72.5, C
Line No. 189:  4, 2640., 72.875, C
Line No. 190:  4, 2640., 73.1, C
Line No. 191:  4, 2640., 73.2, C
Line No. 192:  4,2810., 5.5, C
Line No. 193:  4, 2810., 72.5, C
Line No. 194:  4, 2880., 5.5, C
Line No. 195:  4, 2880., 72.5, C
```

(1) For this example, fatigue checks will be made only on girders two and four. This will check one girder under the overload "vehicle" and one girder without any live load.
(2) The longitudinal distance from the left most support to the fatigue check.
(3) The vertical distance from the mid-plane of the slab to the fatigue check. All distances should be positive.
(4) The type of fatigue detail. The detail type is determined after examining Table 7 and Figure 13 which were reproduced from Reference 2. Refer to Section 4.3.1 for an explanation of the details in this example.

J. Read Type of Composite Action, (ICOMP(I))

Line No. 196: FULL

(1) This structure is assumed to act as a fully composite bridge.

UNIT 4 - STRUCTURAL LOADING

Note: Sections-A and -B below will be read first for the dead load on the beam solution. This procedure is then repeated two more times for the dead load on the superstructure and live load solutions.

A. Read Number of Area Loads, (NC)

Line No. 197: 5

(1) The dead load on the beam solution expects the equivalent steel and wet concrete load carried by each girder to be input. Therefore, since five girders exist in the model, five area loads should be input.

B. Read Area Load Lines, (Q, X, Y, XLL, YLL)

Note: The number of lines to be entered for this section should be equal to the value input in Section-A above. Therefore, for this example, five lines should be entered for the dead load on the beam solution. The first line defines the steel and wet concrete load carried by the first girder (See Fig. 24) and the positioning of that load for this solution. The next four lines similarly define the loads for girders two through five. All dead loads should be input as extremely narrow area loads running the full length of the finite element model in order to simulate a line load on the girders. See Section 2.2 for a further explanation of the loading.

Line No. 198: 9.51422, 1440., 47., 2880., 0.01
Line No. 199: 10.37374, 1440., 163., 2880., 0.01
Line No. 200: 10.37374, 1440., 279., 2880., 0.01
Line No. 201: 10.37374, 1440., 395., 2880., 0.01
Line No. 202: 9.51422, 1440., 511., 2880., 0.01

(1) The intensity of the area load. The values for the interior three girders are higher because the effective width of the concrete on these girders is larger in this example. See Section 2.2 in order to determine the load intensities.
(2) The centroidal location of the area load in the longitudinal or x-direction. For this solution, input one-half the girder length of the finite element model (See Fig. 26).
(3) The centroidal location of the area load in the transversal or y-direction. For this solution, input the y-coordinate defining the location of the girder (See Fig. 26).
(4) The length of the area load in the longitudinal or x-direction. For this solution, input the length of the finite element model (See Fig. 26).
(5) The width of the area load in the transversal or y-direction. For this solution, input 0.01 inches to simulate a line load.

Note: The loading for the dead load on the beam solution is now completely defined. Repeat the above process for the dead load on the superstructure solution.

A. Read Number of Area Loads, (NC)

Line No. 203: 2

(1) As explained in Section 4.3.1, a "fictitious" dead load is to be placed along each of the two free edges of the structure. Therefore input a two for this section.

B. Read Area Load Lines, (Q, X, Y, XLL, YLL)

Note: The number of lines to be entered for this section should be equal to the value input in Section-A above. For this example, two lines should be entered for the dead load on the superstructure solution. See Section 2.2 for further explanation of the loading.

Line No. 204: 0.0000001, 1440., 12., 2880., 24.
Line No. 205: 0.0000001, 1440., 546., 2880., 24.

(1) The intensity of the area load. A "fictitious" load has been entered to simulate the case when the user may not wish to enter any dead load for this solution. This is just one of many ways to accomplish the same goal.

(2) The centroidal location of the area load in the longitudinal or x-direction. For this solution and example, the loading is assumed to run along the entire length of the structure. Therefore input one-half the girder length of the finite element model (See Fig. 26).
(3) The centroidal location of the area load in the transversal or y-direction. For this example, a two foot width is assumed for the loading. Therefore, input y-coordinates which are 12. inches from each free edge (See Fig. 26).
(4) The length of the area load in the longitudinal or x-direction. For this example, input the length of the finite element model (See Fig. 26).
(5) The width of the area load in the transversal or y-direction. For this example, a two foot (24. inches) width is assumed.

Note: The loading for the dead load on the superstructure solution is now completely defined. Repeat the above process for the live load solution.

A. Read Number of Area Loads, (NC)

Line No. 206: 1

(1) As explained in Section 4.3.1, the live load is assumed to be "distributed" load between the first and third girders of the structure. Therefore only one area load is needed to define the live load.

B. Read Area Load Lines, (Q, X, Y, XLL, YLL)

Note: The number of lines to be entered for this section should be equal to the value input in Section-A above. For this example, one line should be entered for the live load solution. Refer to Section 4.3.1 and Section 2.2 for further explanation of the loading.

Line No. 207: 0.00001, 1440., 163., 2880., 232.

(1) The intensity of the area load. The input is based on calculations made from Reference 5.
(2) The centroidal location of the area load in the longitudinal or x-direction. For this example, the loading is applied to the full length of the structure. Therefore, input one-half the girder length of the finite element model (See Fig. 26).
(3) The centroidal location of the area load in the transversal or y-direction. For this example, input the y-coordinate value for the centroid of the area load on the finite element model.
(4) The length of the area load in the longitudinal or x-direction. For this example, input the length of the finite ele-

ment model (See Fig. 26).
(5) The width of the area load in the transversal or y-direction. For this example, the distance between the girders one and three should be entered.

Note: This completes the input necessary to run the Detailed Version of program BOVAS for Example Problem-3.

V. BOVAS OUTPUT

Output of BOVAS can vary from a few pages (10-12 pages) up to hundreds of pages, depending upon the structure and the options requested by the user in the input of the program. For example, if the short printout option is requested by the user, the printout would be rather limited. However, in solving the same bridge for the same loading condition, the printout for the detailed or long output option could be hundreds of pages long. The difference between the two options stems from the fact that in the detailed output all of the stresses, deformations, and forces are printed out at each load level; whereas only key control values are printed for the short printout. If the user is interested in the complete load versus stress and deformation characteristics of the bridge, the detailed output is needed. If this information is not essential, then the long printout should not be used. For all practical purposes the short printout contains all the information that is needed in the rating of the bridge or the overload permit study of the bridge.

THE USE OF THE LONG PRINTOUT OPTION
MUST BE JUSTIFIED BY THE USER.

6.1 Comments on Long Printout

No explanation is sufficient if all the users of program BOVAS expect all the explanation to all the questions on hand and future questions in this user's manual. Through a careful explanation of the output provided by the program as included in this manual the reader/user can find answers to many questions in this manual. To initiate a self-study on the interpretation of the long printout, the rest of this section contains some general comments.

The long printout consists of:

1. A printout of input data.
2. A printout of some key automatically generated data.
3. A printout of displacement and stress solutions to the problem.

Solutions to the problem consist of:

1. Nodal point displacements and associated nodal point forces.
2. A printout of some key automatically generated data.
3. A printout of displacement and stress solutions to the problem.

Solutions to the problem consist of:

1. Nodal point displacements and associated nodal point

forces.

2. Internal moments, and normal and shear forces taken about the reference plane (mid-plane of the slab) for both slab and beam finite elements.
3. Slab stresses, principal stresses and principal angles (for principal stresses).
4. Beam layer stresses, flexural shear stresses, principal stresses, and principal angles (for principal stresses).
5. A summary of cracked, crushed, and yielded layers in the slab which indicates the principal angle and directions of the layer failure.
6. A summary of yielded or strain hardened layers in the girder.
7. A warning message if buckling occurs, if web panel checks were requested.
8. A warning message if the allowable live load stress range is exceeded on any "fatigue detail," if fatigue checks were requested.
9. Printer plots of the slab showing stress levels.
10. Printer plots of the slab showing element and node point numbering, beam locations, and the number of cracked, crushed, and yielded layers in each slab element.
11. A histogram at the end of the job indicating termination checks.
12. A detailed message indicating the important assumptions and limitations that have been made in the analysis scheme and BOVAS. This message is the same in the detailed or the short printout.

Displacement and force fields for only the live load are printed during the overload solution procedure. In order to obtain the total displacements and forces due to the live loads plus the dead load, the dead load solutions must be added to that for the overload solution. The stress fields printed during the overload solution procedure include the contribution from the dead load solutions. Also, the internal forces computed from these stress fields will reflect not only the live load solution but also the dead load solutions.

Letters after the symbol "S" in the titles to the stress field portion of the printout indicate the direction of the stress. The numbers indicate the first (1) or the second (2) principal directions. The principal angles for the slab and girders, designated by THETA1 in the output, are measured clockwise from the x-axis of the element and indicate the direction of stress "S1."

Beam and slab printer plots are generated. The stress codes used in the beam printer plots are interpreted as follows:

1. Numbers indicate compressive stresses. The number "1" indicates 10% of the "yield stress," "2" indicates 20% of

the yield stress, and so on.

2. Letters indicate tensile stresses. The letter "A" indicates 10% of the "yield stress," "B" indicates 20% of the yield stress, and so on.

3. Asterisks in a horizontal row indicate the boundary of elements.

4. Asterisks in a vertical row indicate layers.

5. The stress is measured at the centroid of the layer and is always overstated or at best correct as shown. A 7% compressive stress is indicated by a "1," whereas an 11% compressive stress is indicated by "2." Similarly, a 7% tensile stress is indicated by a "A," whereas an 11% tensile stress is indicated by "B."

6.2 Comments on Short Printout

For the user who has mastered the long printout, the interpretation of the short printout is rather simple. The short printout contains:

1. Echo print of the critical dimensions and values.
2. A printout of some key automatically generated data.
3. The total load on the structure and the cumulative damages to the bridge slab and girders for each load increment.
4. Printer plots of girders and slab indicating incremental stress intensities for various load levels.
5. A histogram at the end of the job indicating termination checks.
6. A detailed message indicating the important assumptions and limitations that have been made in the analysis scheme and BOVAS. This message is the same in the detailed or the short output.

6.3 Example Printouts

6.3.1 Example Problem-1

The first example bridge from Chapter-IV illustrates the long printout option. Because the problem is not that large and because the program terminates at 75% of the yield stress in the girders, the long output is not really that long for the problem. The whole output is 46 pages long.

6.3.2 Example Problem-2

This example problem is nearly identical to the first example. The same bridge and applied loading were analyzed with some slightly different material properties and a different element spacing in the longitudinal direction. Also, the short output was selected. The results of this example compare favorably with the results of the first example.

6.3.3 Example Problem-3

Due to the extensive and repetitious nature of the printout, which would have substantially increased the size of this manual without corresponding benefits, the output is not listed herein.

```
       SUBROUTINE BCHECK      74/855  OPT=0 TRACE STATIC              FTN 4.8+628        85/09/18. 20.09.19        PAGE      1
  CARD NR. SEVERITY  DETAILS    DIAGNOSIS OF PROBLEM
      343      I      5490      THIS IF DEGENERATES INTO A SIMPLE TRANSFER TO THE LABEL INDICATED.

          ************************************************************************************************************

 ********************************DETAILED VERSION - BOVAS EXAMPLE BRIDGE 1 - AASHTO BRIDGE 3B              ********************


 ***************    ALL UNITS OF INPUT SHOULD BE AS FOLLOWS-
                          FORCE- KIPS
                          LENGTH- INCHES
                          ALL OTHER UNITS MUST BE IN COMPLIANCE WITH THESE BASIC UNITS.



      NUMBER OF SPANS, NSPANS                      =       1

      LENGTH OF SPAN   1  (IN), SPANL(I)           =  600.00

      WIDTH OF BRIDGE (IN), WIDTH                  =  192.00

      BRIDGE OVERHANG (IN), OVHANG                 =   36.00

      SPAN OF ENTIRE BRIDGE (IN), TSPAN            =  600.00

      SPAN OF DISCRETIZATION (IN), TSPANH          =  300.00

      WIDTH OF DISCRETIZATION (IN), WIDTHH         =   96.00

      TYPE OF SYMMETRY USED IN DISCRETIZATION,TSYM,=  QUAR

      NUMBER OF ELEMENTS IN X DIRECTION, NELX      =       6
      NUMBER OF ELEMENTS IN Y DIRECTION, NELY      =       3
      NUMBER OF BEAMS IN THE MODEL, NOMB           =       2
      NUMBER OF CONCRETE LAYERS IN SLAB, NULAY     =       6
      NUMBER OF STEEL LAYERS IN SLAB, NSLAYR       =       4
      NUMBER OF DIFFERENT REINFORCEMENT SECTIONS   =       1
      NUMBER OF WEB SHEAR PANELS, NPNL             =       0
      NUMBER OF STEEL LAYERS IN BEAM, NULAYB       =      12
      MAX. NO. OF SECT. WHERE BEAM GEOM. IS DEFINED=       2
      NUMBER OF FATIGUE ELEMENT, LAYER CHECKS      =       0



      LONG  OUTPUT WILL BE PRINTED

      SCALE INITIAL SOLUTION AND PRESCRIBED FORCES =     YES
```

```
IS THERE A DEAD LOAD ON THE STRUCTURE, IDEAD =      YES
SOLUTION MODE IS ITERATIVE, MODES              =      YES

ARE THERE INITIAL START CARDS, ICARDS          =       NO
WILL THERE BE END CARDS, ECARDS                =       NO

MAXIMUM RUN TIME (SECONDS), ETIME              =50000.00

MAXIMUM DISPLACEMENT FOR SIGNIFICANT POINT     = 60.0000 (IN)
SPECIFIED OVERLOAD                             =   1.000 (KIPS)
MAXIMUM RATIO OF APPLIED LOAD TO OVERLOAD      = .10E+21

FORCE RATIO INCREMENT ,CAPA                    =     .400

DISPLACEMENT RATIO INCREMENT FOR PRINTING      =   0.0000
FORCE RATIO INCREMENT FOR PRINTING             =   0.0000

NUMBER OF LOAD CYCLES, LCYCLE                  =      300

IS THERE A DEAD LOAD BEAM SOLUTION, IDEADB     =      YES

COMPUTE ELEMENT STRESS USING                   =  NODE

SKEW ANGLE (DEGREES)                           =  90.000

           ELEMENT LENGTHS IN X DIRECTION
             BEAM ELEMENT       LENGTH
               NUMBER            (IN)

                  1             63.0000
                  2             63.0000
                  3             63.0000
                  4             51.0000
                  5             30.0000
                  6             30.0000

           ELEMENT LENGTHS IN Y DIRECTION
             BEAM ELEMENT       LENGTH
               NUMBER            (IN)

                  1             36.0000
                  2             30.0000
                  3             30.0000

               TOTAL SLAB SIZE
       X-DIRECTION   Y-DIRECTION       THICKNESS
         600.0000      192.0000          6.4500

          BEAM DEPTH AND TOP AND BOTTOM COVERPLATE THICKNESS
```

```
                BEAM DEPTH,                          =    18.25
                TOP COVERPLATE THICKNESS,            =     0.00
                BOTTOM COVERPLATE THICKNESS,         =      .44


            FLANGE WIDTH AND FLANGE AND WEB THICKNESSES

                FLANGE WIDTH,                        =    7.558
                FLANGE THICKNESS                     =     .695
                WEB THICKNESS,                       =     .416


            REFERENCE PLANE LOCATIONS

              ZBAR           ZBARTF

            12.3500         -3.2250


            STARTING NODES FOR BEAMS
        *****     3    6

        EQUATION NUMBERS

        NODE     1    2    3    4    5    6    7    8    9   10   11   12   13   14   15   16   17   18   19   20
           U     1    5    8   10   14   17   19   24   29   31   36   41   43   48   53   55   60   65   67   72
           V     0    0    0    0    0    0   20   25    0   32   37    0   44   49    0   56   61    0   68   73
           W     2    0    0   11    0    0   21   26    0   33   38    0   45   50    0   57   62    0   69   74
          XX     3    6    0   12   15    0   22   27    0   34   39    0   46   51    0   58   63    0   70   75
          YY     4    7    9   13   16   18   23   28   30   35   40   42   47   52   54   59   64   66   71   76
          ZZ     0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0


        NODE    21   22   23   24   25   26   27   28   29   30   31   32   33   34   35   36   37   38   39   40
           U    77   79   84   89   91   96  101  103  108  113  115  120  125  127  132  137    0    0    0    0
           V     0   80   85    0   92   97    0  104  109    0  116  121    0  128  133    0    0    0    0    0
           W     0   81   86    0   93   98    0  105  110    0  117  122    0  129  134    0  139  141    0  143
          XX     0   82   87    0   94   99    0  106  111    0  118  123    0  130  135    0  140  142    0  144
          YY    78   83   88   90   95  100  102  107  112  114  119  124  126  131  136  138    0    0    0    0
          ZZ     0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0


        NODE    41   42
           U     0    0
           V     0    0
           W   145    0
          XX   146    0
          YY     0    0
          ZZ     0    0


             SLAB- LAYER GEOMETRY

     LAYER         THICKNESS          CENTROID

       1           1.250000          -2.600000
       2           1.250000          -1.350000
       3           1.475000            .012500
       4           1.475000           1.487500
       5            .500000           2.475000
       6            .500000           2.975000

             SLAB- CONCRETE MATERIAL PROPERTIES (KSI)

        UNIAXIL CONCRETE COMPRESSIVE STRENGTH, FC      =    5.7400
        DIRECT TENSILE STRENGTH, FT                    =     .4592
        INITIAL MODULUS, EC                            =   4365.39
```

```
UNLOADING MODULUS IN COMPRESSION                    =  1000.00
UNLOADING MODULUS IN TENSION                        =   900.00

                  SLAB- STEEL MATERIAL PROPERTIES

     MAT. TYPE      YOUNGS MODULUS       YIELD STRENGTH        RAMBERG-M  RAMBERG-N
          1         29000.00 KSI               61.20 KSI          .70       300.0

                  SLAB- STEEL LAYER GEOMETRY

                     NUMBER OF DIFFERENT
              REINFORCEMENT PATTERNS LONGITUDINALLY
                               1

        SECTION    ELEMENT
          NO.     START END

           1        1   18
                 LAYER  MAT. TYPE  BAR NO.  SPACING (IN)  THICKNESS (IN)  CENTROID (IN)  ANGLE (DEGREES)
   SECTION    1
                   1        1         5        6.0000         .05167          -.41250        -90.000
                   2        1         4       12.0000         .01667           .15000          0.000
                   3        1         5        8.7403         .03547          1.28750          0.000
                   4        1         5        6.0000         .05167          1.91250        -90.000

     NUMBER OF CARDS TO SPECIFY TERMINATION CHECKS =  2

                  TERMINATION CHECKS FOR THE SLAB LAYERS
                  (STRESS IN KSI. STRAIN IN PERCENT)
    MAT. NO.   MAX STRAIN   MAX TENSILE   MAX COMP   NUMBER OF CRACKED    NUMBER OF
                               STRESS       STRESS    OR YIELDED LAYERS   CRUSHED LAYERS

       0          2.500        4.592        4.592            3                 1
       1           .301       61.200       61.200            1                 0

       TOP SURFACE OF SLAB (IN)
              BAR SPACING                 =    6.000
              CONCRETE COVER              =    2.500
              MAX ALLOWABLE CRACK WIDTH   =    .00400

    BOTTOM SURFACE OF SLAB (IN)
              BAR SPACING                 =    6.000
              CONCRETE COVER              =    1.000
              MAX ALLOWABLE CRACK WIDTH   =    .00400

    NUMBER OF STEEL MATERIALS =     3

                  BEAM MATERIAL PROPERTIES
    MATERIAL     YIELD         YOUNGS          RAMBERG      RAMBERG     STRAIN HARDENING   STRAIN HARDENING    ULTIMATE       ULTIMATE
     NUMBER   STRESS (KSI)  MODULUS (KSI)   OSGOOD-M     OSGOOD-N      MODULUS (KSI)     STRAIN (IN/IN)    STRESS (KSI)  STRAIN (IN/IN)
       1        35.1000       30000.00         .6700      400.000
       2        39.9000       30000.00         .6700      400.000        900.000             .01400
       3        38.4000       30000.00         .6700      400.000        900.000             .01400           64.900          .1200
       4        36.0000           3.00         .6700      400.000        900.000             .01400           66.600          .1200
                                                                            .000         140.00000           69.200          .1200
                                                                                                              58.500       1200.0000
```

```
MATERIAL    SHEAR             ALPHA          BETA           GAMMA          (GSTI-GO)/
 NUMBER  MODULUS (KSI)        (KSI)        (KSI**2)        (KSI**2)       (STRAN-STRY)

    1       11538.4615      28.75583   -122.96317   11911.42115     -413880.58
    2       11538.4615      35.14447   -101.78814    9093.65271     -419107.17
    3       11538.4615      35.55839    -69.09910    5635.90098     -417459.74
    4           1.1538      37.33207    -72.81523        .63131          -.00


     *****THE LAST MATERIAL NUMBER CORRESPONDS TO A FICTITIOUS STEEL MATERIAL     *****


   AVERAGE DISTANCE BETWEEN BEAMS =        60.00000
       IF YDIST = ZERO READ IN KSC VALUES


   NUMBER OF CARDS TO SPECIFY TERMINATION CHECKS =     4


                        TERMINATION CHECKS FOR BEAM LAYERS
                        (STRESS IN KSI, STRAIN IN PERCENT)

     MAT. NO.  MAX STRAIN  MAX TENSILE  MAX COMP  NUMBER OF YIELDED     NUMBER OF
                              STRESS     STRESS         LAYERS        BUCKLED LAYERS

        1          .00        26.33      26.33            0                 0
        2          .00        29.93      29.93            0                 0
        3          .00        28.80      28.80            0                 0
        4    999999.00    999999.00  999999.00         9999              9999

   NUMBER OF DIFFERENT SECTIONS IN BEAM  1 IS   2
       IF ISAME = 1 USE SECTIONS FROM LAST BEAM, ISAME =     0

     X-COORDINATE DISTANCES FROM START OF BEAM (INCHES)

        0.000    189.000


                            SECTION PROPERTIES BY LAYER


         FOR BEAM SECTION NUMBER   1
       THICKNESS           WIDTH      INITIAL STRESS     MATERIAL      SHEAR WIDTH
         (IN)               (IN)          (KIPS)           TYPE           (IN)

          .3475            7.5580        0.0000            1.0           .0010
          .3475            7.5580        0.0000            1.0           .0010
         2.8100             .4160        0.0000            2.0           .4160
         2.8100             .4160        0.0000            2.0           .4160
         2.8100             .4160        0.0000            2.0           .4160
         2.8100             .4160        0.0000            2.0           .4160
         2.8100             .4160        0.0000            2.0           .4160
         2.8100             .4160        0.0000            2.0           .4160
          .3475            7.5580        0.0000            1.0           .0010
          .3475            7.5580        0.0000            1.0           .0010
          .2188            6.0000        0.0000            4.0           .0010
          .2188            6.0000        0.0000            4.0           .0010

         FOR BEAM SECTION NUMBER   2
       THICKNESS           WIDTH      INITIAL STRESS     MATERIAL      SHEAR WIDTH
         (IN)               (IN)          (KIPS)           TYPE           (IN)

          .3475            7.5580        0.0000            1.0           .0010
          .3475            7.5580        0.0000            1.0           .0010
         2.8100             .4160        0.0000            2.0           .4160
```

```
       2.8100              .4160            0.0000
       2.8100              .4160            0.0000           2.0           .4160
       2.8100              .4160            0.0000           2.0           .4160
       2.8100              .4160            0.0000           2.0           .4160
       2.8100              .4160            0.0000           2.0           .4160
        .3475             7.5590            0.0000           2.0           .4160
        .3475             7.5560            0.0000           1.0           .0010
        .2188             6.0000            0.0000           1.0           .0010
        .2188             6.0000            0.0000           3.0           .0010
                                                             3.0           .0010


  ELEMENT     CRITICAL FLANGE   LAYER   LAYER      WEB       FLANGE     FLANGE      WEB
  NUMBER      BUCKLING STRESS    CODE     CODE  THICKNESS  THICKNESS    WIDTH      DEPTH
                   (KSI)          1        2       (IN)       (IN)       (IN)       (IN)
     1            35.4510         9       10      .4160      .6950     7.5580     16.8600
     2            35.4510         9       10      .4160      .6950     7.5580     16.8600
     3            35.4510         9       10      .4160      .6950     7.5580     16.8600
     4            37.1175         9       12      .4160     1.1325     6.9561     16.8600
     5            37.1175         9       12      .4160     1.1325     6.9561     16.8600
     6            37.1175         9       12      .4160     1.1325     6.9561     16.8600
BEAM NO.   1 HAS THE FOLLOWING ELEMENT/LAYER PROPERTIES (LAYERS VERTICAL, ELEMENTS HORIZONTAL).


      INITIAL STRESS (KSI) IN LAYERS

     LAYER       1          2          3          4          5          6
        1     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000
        2     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000
        3     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000
        4     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000
        5     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000
        6     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000
        7     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000
        8     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000
        9     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000
       10     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000
       11     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000
       12     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000


      MATERIAL TYPE FOR LAYERS

     LAYER       1     2     3     4     5     6
        1        1     1     1     1     1     1
        2        1     1     1     1     1     1
        3        2     2     2     2     2     2
        4        2     2     2     2     2     2
        5        2     2     2     2     2     2
        6        2     2     2     2     2     2
        7        2     2     2     2     2     2
        8        2     2     2     2     2     2
        9        1     1     1     1     1     1
       10        1     1     1     1     1     1
       11        4     4     4     3     3     3
       12        4     4     4     3     3     3


      AREAS (SQ.IN) OF LAYERS

     LAYER       1          2          3          4          5          6
        1     2.6264     2.6264     2.6264     2.6264     2.6264     2.6264
        2     2.6264     2.6264     2.6264     2.6264     2.6264     2.6264
```

```
    3       1.1690      1.1690      1.1690      1.1690      1.1690      1.1690
    4       1.1690      1.1690      1.1690      1.1690      1.1690      1.1690
    5       1.1690      1.1690      1.1690      1.1690      1.1690      1.1690
    6       1.1690      1.1690      1.1690      1.1690      1.1690      1.1690
    7       1.1690      1.1690      1.1690      1.1690      1.1690      1.1690
    8       1.1690      1.1690      1.1690      1.1690      1.1690      1.1690
    9       2.6264      2.6264      2.6264      2.6264      2.6264      2.6264
   10       2.6264      2.6264      2.6264      2.6264      2.6264      2.6264
   11       1.3125      1.3125      1.3125      1.3125      1.3125      1.3125
   12       1.3125      1.3125      1.3125      1.3125      1.3125      1.3125



  SHEAR AREAS (SQ.IN) OF LAYERS

 LAYER        1           2           3           4           5           6
    1        .0003       .0003       .0003       .0003       .0003       .0003
    2        .0003       .0003       .0003       .0003       .0003       .0003
    3       1.1690      1.1690      1.1690      1.1690      1.1690      1.1690
    4       1.1690      1.1690      1.1690      1.1690      1.1690      1.1690
    5       1.1690      1.1690      1.1690      1.1690      1.1690      1.1690
    6       1.1690      1.1690      1.1690      1.1690      1.1690      1.1690
    7       1.1690      1.1690      1.1690      1.1690      1.1690      1.1690
    8       1.1690      1.1690      1.1690      1.1690      1.1690      1.1690
    9        .0003       .0003       .0003       .0003       .0003       .0003
   10        .0003       .0003       .0003       .0003       .0003       .0003
   11        .0002       .0002       .0002       .0002       .0002       .0002
   12        .0002       .0002       .0002       .0002       .0002       .0002



  MOMENT OF INERTIA OF LAYERS

 LAYER        1           2           3           4           5           6
    1        .0264       .0264       .0264       .0264       .0264       .0264
    2        .0264       .0264       .0264       .0264       .0264       .0264
    3        .7692       .7692       .7692       .7692       .7692       .7692
    4        .7692       .7692       .7692       .7692       .7692       .7692
    5        .7692       .7692       .7692       .7692       .7692       .7692
    6        .7692       .7692       .7692       .7692       .7692       .7692
    7        .7692       .7692       .7692       .7692       .7692       .7692
    8        .7692       .7692       .7692       .7692       .7692       .7692
    9        .0264       .0264       .0264       .0264       .0264       .0264
   10        .0264       .0264       .0264       .0264       .0264       .0264
   11        .0052       .0052       .0052       .0052       .0052       .0052
   12        .0052       .0052       .0052       .0052       .0052       .0052



  CENTROIDAL DISTANCE (IN) OF LAYERS FROM REFERENCE PLANE

 LAYER        1           2           3           4           5           6
    1      -8.9513     -8.9513     -8.9513     -8.9513     -8.9513     -8.9513
    2      -8.6038     -8.6038     -8.6038     -8.6038     -8.6038     -8.6038
    3      -7.0250     -7.0250     -7.0250     -7.0250     -7.0250     -7.0250
    4      -4.2150     -4.2150     -4.2150     -4.2150     -4.2150     -4.2150
    5      -1.4050     -1.4050     -1.4050     -1.4050     -1.4050     -1.4050
    6       1.4050      1.4050      1.4050      1.4050      1.4050      1.4050
    7       4.2150      4.2150      4.2150      4.2150      4.2150      4.2150
    8       7.0250      7.0250      7.0250      7.0250      7.0250      7.0250
    9       8.6037      8.6037      8.6037      8.6037      8.6037      8.6037
   10       8.9512      8.9512      8.9512      8.9512      8.9512      8.9512
   11       9.2344      9.2344      9.2344      9.2344      9.2344      9.2344
   12       9.4531      9.4531      9.4531      9.4531      9.4531      9.4531
```

```
NUMBER OF DIFFERENT SECTIONS IN BEAM  2 IS   2
   IF ISAME = 1 USE SECTIONS FROM LAST BEAM, ISAME =      1

X-COORDINATE DISTANCES FROM START OF BEAM (INCHES)

    0.000    189.000


                         SECTION PROPERTIES BY LAYER

      FOR BEAM SECTION NUMBER   1
    THICKNESS               WIDTH
      (IN)                  (IN)      INITIAL STRESS    MATERIAL    SHEAR WIDTH
                                         (KIPS)           TYPE         (IN)
       .3475               3.7790
       .3475               3.7790       0.0000            1.0          .0010
      2.8100                .2080       0.0000            1.0          .0010
      2.8100                .2080       0.0000            2.0          .2080
      2.8100                .2080       0.0000            2.0          .2080
      2.8100                .2080       0.0000            2.0          .2080
      2.8100                .2080       0.0000            2.0          .2080
      2.8100                .2080       0.0000            2.0          .2080
       .3475               3.7790       0.0000            2.0          .2080
       .3475               3.7790       0.0000            1.0          .0010
       .2188               3.0000       0.0000            1.0          .0010
       .2188               3.0000       0.0000            4.0          .0010
                                        0.0000            4.0          .0010

      FOR BEAM SECTION NUMBER   2
    THICKNESS               WIDTH
      (IN)                  (IN)      INITIAL STRESS    MATERIAL    SHEAR WIDTH
                                         (KIPS)           TYPE         (IN)
       .3475               3.7790
       .3475               3.7790       0.0000            1.0          .0010
      2.8100                .2080       0.0000            1.0          .0010
      2.8100                .2080       0.0000            2.0          .2080
      2.8100                .2080       0.0000            2.0          .2080
      2.8100                .2080       0.0000            2.0          .2080
      2.8100                .2080       0.0000            2.0          .2080
      2.8100                .2080       0.0000            2.0          .2080
       .3475               3.7790       0.0000            2.0          .2080
       .3475               3.7790       0.0000            1.0          .0010
       .2188               3.0000       0.0000            1.0          .0010
       .2188               3.0000       0.0000            3.0          .0010
                                        0.0000            3.0          .0010


  ELEMENT    CRITICAL FLANGE  LAYER   LAYER     WEB      FLANGE     FLANGE      WEB
  NUMBER     BUCKLING STRESS  CODE    CODE   THICKNESS THICKNESS   WIDTH      DEPTH
                 (KSI)          1       2      (IN)      (IN)      (IN)       (IN)
     7
     8          35.4510         9      10      .4160     .6950     7.5580    16.8600
     9          35.4510         9      10      .4160     .6950     7.5580    16.8600
    10          35.4510         9      10      .4160     .6950     7.5580    16.8600
    11          37.1175         9      12      .4160    1.1325     6.9561    16.8600
    12          37.1175         9      12      .4160    1.1325     6.9551    16.8600
                37.1175         9      12      .4160    1.1325     6.9551    16.8600
BEAM NO.   2 HAS THE FOLLOWING ELEMENT/LAYER PROPERTIES (LAYERS VERTICAL, ELEMENTS HORIZONTAL),


      INITIAL STRESS (KSI) IN LAYERS

     LAYER
       1         1          2          3          4          5          6
       2       0.0000     0.0000     0.0000     0.0000     0.0000     0.0000
       3       0.0000     0.0000     0.0000     0.0000     0.0000     0.0000
       4       0.0000     0.0000     0.0000     0.0000     0.0000     0.0000
       5       0.0000     0.0000     0.0000     0.0000     0.0000     0.0000
       6       0.0000     0.0000     0.0000     0.0000     0.0000     0.0000
       7       0.0000     0.0000     0.0000     0.0000     0.0000     0.0000
       8       0.0000     0.0000     0.0000     0.0000     0.0000     0.0000
       9       0.0000     0.0000     0.0000     0.0000     0.0000     0.0000
               0.0000     0.0000     0.0000     0.0000     0.0000     0.0000
```

```
    10      0.0000     0.0000     0.0000     0.0000     0.0000     0.0000
    11      0.0000     0.0000     0.0000     0.0000     0.0000     0.0000
    12      0.0000     0.0000     0.0000     0.0000     0.0000     0.0000


  MATERIAL TYPE FOR LAYERS

  LAYER      1    2    3    4    5    6
      1      1    1    1    1    1    1
      2      1    1    1    1    1    1
      3      2    2    2    2    2    2
      4      2    2    2    2    2    2
      5      2    2    2    2    2    2
      6      2    2    2    2    2    2
      7      2    2    2    2    2    2
      8      2    2    2    2    2    2
      9      1    1    1    1    1    1
     10      1    1    1    1    1    1
     11      4    4    4    3    3    3
     12      4    4    4    3    3    3


  AREAS (SQ.IN) OF LAYERS

  LAYER        1          2          3          4          5          6
      1     1.3132     1.3132     1.3132     1.3132     1.3132     1.3132
      2     1.3132     1.3132     1.3132     1.3132     1.3132     1.3132
      3      .5845      .5845      .5845      .5845      .5845      .5845
      4      .5845      .5845      .5845      .5845      .5845      .5845
      5      .5845      .5845      .5845      .5845      .5845      .5845
      6      .5845      .5845      .5845      .5845      .5845      .5845
      7      .5845      .5845      .5845      .5845      .5845      .5845
      8      .5845      .5845      .5845      .5845      .5845      .5845
      9     1.3132     1.3132     1.3132     1.3132     1.3132     1.3132
     10     1.3132     1.3132     1.3132     1.3132     1.3132     1.3132
     11      .6563      .6563      .6562      .6563      .6563      .6563
     12      .6563      .6563      .6562      .6563      .6563      .6563


  SHEAR AREAS (SQ.IN) OF LAYERS

  LAYER        1          2          3          4          5          6
      1      .0003      .0003      .0003      .0003      .0003      .0003
      2      .0003      .0003      .0003      .0003      .0003      .0003
      3      .5845      .5845      .5845      .5845      .5845      .5845
      4      .5845      .5845      .5845      .5845      .5845      .5845
      5      .5845      .5845      .5845      .5845      .5845      .5845
      6      .5845      .5845      .5845      .5845      .5845      .5845
      7      .5845      .5845      .5845      .5845      .5845      .5845
      8      .5845      .5845      .5845      .5845      .5845      .5845
      9      .0003      .0003      .0003      .0003      .0003      .0003
     10      .0003      .0003      .0003      .0003      .0003      .0003
     11      .0002      .0002      .0002      .0002      .0002      .0002
     12      .0002      .0002      .0002      .0002      .0002      .0002


  MOMENT OF INERTIA OF LAYERS

  LAYER        1          2          3          4          5          6
      1      .0132      .0132      .0132      .0132      .0132      .0132
      2      .0132      .0132      .0132      .0132      .0132      .0132
```

```
  3      .3846     .3846     .3846     .3846     .3846     .3846
  4      .3846     .3846     .3846     .3846     .3846     .3846
  5      .3846     .3846     .3846     .3846     .3846     .3846
  6      .3846     .3846     .3846     .3846     .3846     .3846
  7      .3846     .3846     .3846     .3846     .3846     .3846
  8      .3846     .3846     .3846     .3846     .3846     .3846
  9      .0132     .3846     .3846     .3846     .3846     .3846
 10      .0132     .0132     .3846     .3846     .3846     .3846
 11      .0026     .0132     .0132     .0132     .3846     .3846
 12      .0026     .0026     .0132     .0132     .0132     .3846
                   .0026     .0026     .0132     .0132     .0132
                             .0026     .0026     .0132     .0132
                                       .0026     .0026     .0026
                                                 .0026     .0026
                                                           .0026


   CENTROIDAL DISTANCE (IN) OF LAYERS FROM REFERENCE PLANE

 LAYER
            1
   1    -8.9513        2
   2    -8.6038   -8.9513        3
   3    -7.0250   -8.6038   -8.9513        4
   4    -4.2150   -7.0250   -8.6038   -8.9513        5
   5    -1.4050   -4.2150   -7.0250   -8.6038   -8.9513        6
   6     1.4050   -1.4050   -4.2150   -7.0250   -8.6038   -8.9513
   7     4.2150    1.4050   -1.4050   -4.2150   -7.0250   -8.6038
   8     7.0250    4.2150    1.4050   -1.4050   -4.2150   -7.0250
   9     8.6037    7.0250    4.2150    1.4050   -1.4050   -4.2150
  10     8.9512    8.6037    7.0250    4.2150    1.4050   -1.4050
  11     9.2344    8.9512    8.6037    7.0250    4.2150    1.4050
  12     9.4531    9.2344    8.9512    8.6037    7.0250    4.2150
                   9.4531    9.2344    8.9512    8.6037    7.0250
                             9.4531    9.2344    8.9512    8.6037
                                       9.4531    9.2344    8.9512
                                                 9.4531    9.2344
                                                           9.4531


               SHEAR CONNECTOR STIFFNES KSC,
 BEAM ELEMENT          KSC
    NUMBER          (KIP/IN)

       1           1010.0116
       2           1010.0116
       3           1010.0116
       4           1711.2948
       5           4945.6420
       6           4945.6420
       7            572.9871
       8            572.9871
       9            572.9871
      10            985.4684
      11           2848.0038
      12           2848.0038


     MODEL ASSUMES FULL COMPOSITE ACTION


  LOADS FOR DEAD LOAD BEAM SOLUTION


  NUMBER OF PATCH LOAD CARDS              =    2
  LOAD CARD    LOAD (KSI)    X OF CENTER(IN)   Y OF C ENTER(IN)  LENGTH(IN)   WIDTH(IN)
      1          4.4408         150.00              36.00          300.00        .01

 THE IMPACT FACTOR APPLIED TO THE ABOVE LOAD  =     1.000

      2          4.0851         150.00              36.00          300.00        .01
```

FEL 435.2

```
THE IMPACT FACTOR APPLIED TO THE ABOVE LOAD  =      1.000


                    FOR DEAD LOAD SOLUTION OF BEAMS


                    NODAL POINT FORCES WITH SPECIFIED UNIFORM AND CONCENTRATED LOADS

         NODE            U            V            W           XX           YY           ZZ

            1      0.00000      0.00000       .00000      -.00000      -.00051      0.00000
            2      0.00000      0.00000      1.39895       .00000    -14.68682      0.00000
            3      0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
            4      0.00000      0.00000       .00000       .00000      -.00117      0.00000
            5      0.00000      0.00000       .64341       .00161     -6.75520      0.00000
            6      0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
            7      0.00000      0.00000       .00000      -.00000      0.00000      0.00000
            8      0.00000      0.00000      2.79770       .00000      0.00000      0.00000
            9      0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
           10      0.00000      0.00000       .00000       .00000      0.00000      0.00000
           11      0.00000      0.00000      1.28681       .00322      0.00000      0.00000
           12      0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
           13      0.00000      0.00000       .00000      -.00000      0.00000      0.00000
           14      0.00000      0.00000      2.79770       .00000      0.00000      0.00000
           15      0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
           16      0.00000      0.00000       .00000       .00000      0.00000      0.00000
           17      0.00000      0.00000      1.28681       .00322      0.00000      0.00000
           18      0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
           19      0.00000      0.00000       .00000      -.00000       .00018      0.00000
           20      0.00000      0.00000      2.53126       .00000      5.06213      0.00000
           21      0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
           22      0.00000      0.00000       .00000       .00000       .00040      0.00000
           23      0.00000      0.00000      1.16426       .00291      2.32832      0.00000
           24      0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
           25      0.00000      0.00000       .00000      -.00000       .00022      0.00000
           26      0.00000      0.00000      1.79852       .00000      6.29435      0.00000
           27      0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
           28      0.00000      0.00000       .00000       .00000       .00050      0.00000
           29      0.00000      0.00000       .82724       .00207      2.89509      0.00000
           30      0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
           31      0.00000      0.00000       .00000      -.00000      0.00000      0.00000
           32      0.00000      0.00000      1.33224       .00000      0.00000      0.00000
           33      0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
           34      0.00000      0.00000       .00000       .00000      0.00000      0.00000
           35      0.00000      0.00000       .61277       .00153      0.00000      0.00000
           36      0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
           37      0.00000      0.00000       .00000      -.00000       .00012      0.00000
           38      0.00000      0.00000       .66612       .00000      3.33035      0.00000
           39      0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
           40      0.00000      0.00000       .00000       .00000       .00027      0.00000
           41      0.00000      0.00000       .30638       .00077      1.53179      0.00000
           42      0.00000      0.00000      0.00000      0.00000      0.00000      0.00000


         TOTAL FORCES ON STRUCTURE

         NODE      U            V            W            XX           YY           ZZ

            1        0.00000      0.00000       .00000      -.00000      -.00051      0.00000
            2        0.00000      0.00000      0.00000       .00000    -14.68682      0.00000
            3        0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
            4        0.00000      0.00000       .00000       .00000      -.00117      0.00000
            5        0.00000      0.00000      0.00000       .00161     -6.75520      0.00000
            6        0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
            7        0.00000      0.00000       .00000      -.00000      0.00000      0.00000
            8        0.00000      0.00000      2.79770       .00000      0.00000      0.00000
            9        0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
           10        0.00000      0.00000       .00000       .00000      0.00000      0.00000
           11        0.00000      0.00000      1.28681       .00322      0.00000      0.00000
           12        0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
           13        0.00000      0.00000       .00000      -.00000      0.00000      0.00000
           14        0.00000      0.00000      2.79770       .00000      0.00000      0.00000
           15        0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
           16        0.00000      0.00000       .00000       .00000      0.00000      0.00000
           17        0.00000      0.00000      1.28681       .00322      0.00000      0.00000
           18        0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
```

```
   19        0.00000        0.00000        .00000        -.00000        .00018        0.00000
   20        0.00000        0.00000       2.53126         .00000       5.06213        0.00000
   21        0.00000        0.00000       0.00000        0.00000       0.00000        0.00000
   22        0.00000        0.00000        .00000         .00000        .00040        0.00000
   23        0.00000        0.00000       1.16426         .00291       2.32832        0.00000
   24        0.00000        0.00000       0.00000        0.00000       0.00000        0.00000
   25        0.00000        0.00000        .00000        -.00000        .00022        0.00000
   26        0.00000        0.00000       1.79852         .00000       6.29435        0.00000
   27        0.00000        0.00000       0.00000        0.00000       0.00000        0.00000
   28        0.00000        0.00000        .00000         .00000        .00050        0.00000
   29        0.00000        0.00000        .82724         .00207       2.89509        0.00000
   30        0.00000        0.00000       0.00000        0.00000       0.00000        0.00000
   31        0.00000        0.00000        .00000        -.00000       0.00000        0.00000
   32        0.00000        0.00000       1.33224         .00000       0.00000        0.00000
   33        0.00000        0.00000       0.00000        0.00000       0.00000        0.00000
   34        0.00000        0.00000        .00000         .00000       0.00000        0.00000
   35        0.00000        0.00000        .61277         .00153       0.00000        0.00000
   36        0.00000        0.00000       0.00000        0.00000       0.00000        0.00000
   37        0.00000        0.00000        .00000        -.00000       0.00000        0.00000
   38        0.00000        0.00000        .66612         .00000       0.00000        0.00000
   39        0.00000        0.00000       0.00000        0.00000       0.00000        0.00000
   40        0.00000        0.00000        .00000         .00000       0.00000        0.00000
   41        0.00000        0.00000        .30638         .00077       0.00000        0.00000
   42        0.00000        0.00000       0.00000        0.00000       0.00000        0.00000

  SUM        0.00000        0.00000      17.40782         .01532      -4.86252        0.00000


      MEMORY REQUIREMENTS FOR OVERLAY CMPLTS
    WITHOUT DATA      070715 OCTAL      29133 DECIMAL
    WITH    DATA      102405 OCTAL      34053 DECIMAL


                         DEAD LOAD BEAM SOLUTION


  NUMBER OF TRIALS      =     0
  NUMBER OF ITERATIONS  =     1
  NUMBER OF TRIALS      =     0
  NUMBER OF ITERATIONS  =     2
  NUMBER OF TRIALS      =     1
  NUMBER OF ITERATIONS  =     1


     APPLIED NODAL POINT FORCES IN KIPS AND IN-KIPS

     NODE          U              V              W              XX             YY             ZZ

        1        0.00000        0.00000        .00000        -.00000        -.00051        0.00000
        2        0.00000        0.00000       1.39885         .00000      -14.68682        0.00000
        3        0.00000        0.00000       0.00000        0.00000        0.00000        0.00000
        4        0.00000        0.00000        .00000         .00000        -.00117        0.00000
        5        0.00000        0.00000        .64341         .00161       -6.75520        0.00000
        6        0.00000        0.00000       0.00000        0.00000        0.00000        0.00000
        7        0.00000        0.00000        .00000        -.00000        0.00000        0.00000
        8        0.00000        0.00000       2.79770         .00000        0.00000        0.00000
        9        0.00000        0.00000       0.00000        0.00000        0.00000        0.00000
       10        0.00000        0.00000        .00000         .00000        0.00000        0.00000
       11        0.00000        0.00000       1.28681         .00322        0.00000        0.00000
       12        0.00000        0.00000       0.00000        0.00000        0.00000        0.00000
       13        0.00000        0.00000        .00000        -.00000        0.00000        0.00000
       14        0.00000        0.00000       2.79770         .00000        0.00000        0.00000
       15        0.00000        0.00000       0.00000        0.00000        0.00000        0.00000
       16        0.00000        0.00000        .00000         .00000        0.00000        0.00000
       17        0.00000        0.00000       1.28681         .00322        0.00000        0.00000
       18        0.00000        0.00000       0.00000        0.00000        0.00000        0.00000
       19        0.00000        0.00000        .00000        -.00000         .00019        0.00000
       20        0.00000        0.00000       2.53126         .00000        5.06213        0.00000
       21        0.00000        0.00000       0.00000        0.00000        0.00000        0.00000
```

```
  22       [illegible]    0.00000      [illegible]  [illegible]  [illegible]  0.00000
  23        0.00000       0.00000       1.15425      .00201     [illegible]  0.00000
  24        0.00000       0.00000       0.00000     0.00000      0.00000     0.00000
  25        0.00000       0.00000        .35000     -.00000       .00022     0.00000
  26        0.00000       0.00000       1.79852   [illegible]    6.29435     0.00000
  27        0.00000       0.00000       0.00000     0.00000      0.00000     0.00000
  28        0.00000       0.00000        .00000      .00000       .00050     0.00000
  29        0.00000       0.00000        .82724      .00207      2.49539     0.00000
  30        0.00000       0.00000       0.00000     0.00000      0.00000     0.00000
  31        0.00000       0.00000        .00000     -.00000      0.00000     0.00000
  32        0.00000       0.00000       1.33224      .00000      0.00000     0.00000
  33        0.00000       0.00000       0.00000     0.00000      0.00000     0.00000
  34        0.00000       0.00000        .00000      .00000      0.00000     0.00000
  35        0.00000       0.00000        .61277      .00153      0.00000     0.00000
  36        0.00000       0.00000       0.00000     0.00000      0.00000     0.00000
  37        0.00000       0.00000        .00000     -.00000       .00012     0.00000
  38        0.00000       0.00000        .66512      .00000      3.33035     0.00000
  39        0.00000       0.00000       0.00000     0.00000      0.00000     0.00000
  40        0.00000       0.00000        .00000      .00000       .00027     0.00000
  41        0.00000       0.00000        .30638      .00077      1.53179     0.00000
  42        0.00000       0.00000       0.00000     0.00000      0.00000     0.00000


 NODAL POINT DISPLACEMENTS IN INCHES AND RADIANS

 NODE          U             V             W           XX           YY           ZZ

   1         .15627       0.00000        .02480      .00084      -.01278     0.00000
   2         .16238       0.00000       0.00000      .00036      -.01263     0.00000
   3         .00723       0.00000       0.00000     0.00000      -.01241     0.00000
   4         .15133       0.00000       -.00200     -.00008      -.01211     0.00000
   5         .14957       0.00000       0.00000     -.00002      -.01163     0.00000
   6         .00671       0.00000       0.00000     0.00000      -.01143     0.00000
   7         .14665       -.00116        .81033      .00113      -.01197     0.00000
   8         .15173       -.00137        .77078      .00106      -.01175     0.00000
   9         .00723       0.00000       0.00000     0.00000      -.01157     0.00000
  10         .14190       -.00151        .74009      .00100      -.01124     0.00000
  11         .13977       -.00149        .70968      .00106      -.01082     0.00000
  12         .00671       0.00000       0.00000     0.00000      -.01065     0.00000
  13         .11965       -.00218       1.50314      .00172      -.00973     0.00000
  14         .12336       -.00253       1.44044      .00179      -.00944     0.00000
  15         .00725       0.00000       0.00000     0.00000      -.00931     0.00000
  16         .11566       -.00275       1.38587      .00190      -.00903     0.00000
  17         .11364       -.00270       1.32630      .00202      -.00869     0.00000
  18         .00672       0.00000       0.00000     0.00000      -.00857     0.00000
  19         .08053       -.00277       2.01457      .00230      -.00640     0.00000
  20         .08197       -.00307       1.93063      .00240      -.00608     0.00000
  21         .00727       0.00000       0.00000     0.00000      -.00600     0.00000
  22         .07796       -.00329       1.85632      .00255      -.00587     0.00000
  23         .07552       -.00329       1.77769      .00270      -.00560     0.00000
  24         .00672       0.00000       0.00000     0.00000      -.00552     0.00000
  25         .04388       -.00215       2.26787      .00262      -.00353     0.00000
  26         .04567       -.00236       2.17238      .00271      -.00339     0.00000
  27         .00406       0.00000       0.00000     0.00000      -.00335     0.00000
  28         .04310       -.00261       2.08874      .00287      -.00323     0.00000
  29         .04208       -.00271       2.00034      .00302      -.00313     0.00000
  30         .00376       0.00000       0.00000     0.00000      -.00309     0.00000
  31         .02174       -.00095       2.34772      .00271      -.00178     0.00000
  32         .02303       -.00130       2.24893      .00281      -.00171     0.00000
  33         .00205       0.00000       0.00000     0.00000      -.00169     0.00000
  34         .02172       -.00158       2.16210      .00297      -.00164     0.00000
  35         .02122       -.00159       2.07085      .00312      -.00158     0.00000
  36         .00190       0.00000       0.00000     0.00000      -.00156     0.00000
  37        0.00000       0.00000       2.37453      .00274      0.00000     0.00000
  38        0.00000       0.00000       2.27458      .00285      0.00000     0.00000
  39        0.00000       0.00000       0.00000     0.00000      0.00000     0.00000
  40        0.00000       0.00000       2.18677      .00300      0.00000     0.00000
  41        0.00000       0.00000       2.09448      .00315      0.00000     0.00000
  42        0.00000       0.00000       0.00000     0.00000      0.00000     0.00000


           DISPLACEMENT/REFERENCE DISPLACEMENT =     2.09448

           FORCE/REFERENCE FORCE               =      .00000

           SUM OF NODAL POINT W-LOADS          =    19.4501

           SUM OF W-LOADS FOR TOTAL STRUCTURE  =    77.8003
```

```
           (SUM OF W-LOADS FOR TOTAL STRUCTURE
                WITHOUT IMPACT FACTOR)              =      77.8003


     FOR THE DEAD LOAD ON THE BEAM SOLUTION (WET CONCRETE),  INTERNAL MOMENTS, NORMAL FORCES, AND TOTAL STRESSES
            IN THE CONCRETE SLAB WILL ALWAYS BE ZERO FOR ALL ELEMENTS AND FOR ALL LAYERS



    INTERNAL MOMENTS (IN-KIPS), NORMAL FORCES (KIPS), AND SHEAR FORCES (KIPS) IN BEAM ELEMENTS
   ELEM            MB                     NB                    VB

     1        387.9015                  .0387              -10.4706
     2       1046.8844                  .1069               -9.0789
     3       1530.6855                  .1574               -6.2348
     4       1921.5637                  .1804               -3.8574
     5       1941.4340                  .1918               -2.1227
     6       1931.1865                  .1960                -.6565
     7        178.5845                  .0049               -4.8173
     8        482.0052                  .0120               -4.1771
     9        704.8008                  .0150               -2.8697
    10        838.7755                  .0118               -1.7749
    11        894.0063                  .0097                -.9768
    12        912.3424                  .0076                -.3027
 TOTAL STRESSES IN BEAM LAYERS (STRESS (KSI), ANG. (DEGRESS), + TEN., - COMP.)


  EL LAYER      SXX           SYY           SXY           S1            S2          THETA1

   1   1     -3.57276       0.00000       -.00014      -3.57276        .00000         .00230
   1   2     -3.43397       0.00000       -.03362      -3.43430        .00033         .56090
   1   3     -2.80346       0.00000      -1.19545      -3.24400        .44054       20.22944
   1   4     -1.68121       0.00000      -1.40787      -2.49034        .79913       29.57981
   1   5      -.55897       0.00000      -1.53526      -1.83998       1.28101       39.84133
   1   6       .56328       0.00000      -1.57761       1.88419      -1.32091      -39.93902
   1   7      1.68552       0.00000      -1.53492       2.59383       -.90830      -30.61532
   1   8      2.80777       0.00000      -1.40720       3.39162       -.58385      -22.53376
   1   9      3.43928       0.00000       -.06574       3.43954       -.00126       -1.09501
   1  10      3.57707       0.00000       -.03352       3.57738       -.00031        -.53690
   1  11       .00037       0.00000       -.00000        .00037       -.00000        -.68383
   1  12       .00038       0.00000       -.00000        .00038       -.00000        -.33797

   2   1     -9.64217       0.00000       -.00012      -9.64217        .00000         .00074
   2   2     -9.26762       0.00000       -.02915      -9.26771        .00009         .18023
   2   3     -7.56596       0.00000      -1.03656      -7.70540        .13944        7.66165
   2   4     -4.53719       0.00000      -1.22075      -4.84479        .30759       14.14250
   2   5     -1.50843       0.00000      -1.33120      -2.28423        .77580       30.23275
   2   6      1.52033       0.00000      -1.36792       2.32511       -.80478      -30.46932
   2   7      4.54910       0.00000      -1.33091       4.90986       -.36077      -15.16659
   2   8      7.57786       0.00000      -1.22016       7.76948       -.19162       -8.92512
   2   9      9.27952       0.00000       -.05700       9.27987       -.00035        -.35195
   2  10      9.65407       0.00000       -.02907       9.65416       -.00009        -.17251
   2  11       .00100       0.00000       -.00000        .00100       -.00000        -.21974
   2  12       .00102       0.00000       -.00000        .00102       -.00000        -.10858

   3   1    -14.09809       0.00000       -.00008     -14.09809        .00000         .00032
   3   2    -13.55044       0.00000       -.01760     -13.55046        .00002         .07440
   3   3    -11.06238       0.00000       -.62964     -11.09811        .03572        3.24716
   3   4     -6.63393       0.00000       -.75084      -6.71785        .08392        6.37737
   3   5     -2.20547       0.00000       -.84221      -2.49030        .28483       18.68534
   3   6      2.22299       0.00000       -.90375       2.54404       -.32105      -19.55721
   3   7      6.65145       0.00000       -.93547       6.78051       -.12906       -7.85518
   3   8     11.07991       0.00000       -.93736      11.15865       -.07874       -4.80173
   3   9     13.56796       0.00000       -.05006      13.56815       -.00018        -.21137
   3  10     14.11561       0.00000       -.04453      14.11575       -.00014        -.18074
   3  11       .00146       0.00000       -.04855        .04929       -.04783      -44.57044
   3  12       .00149       0.00000       -.02460        .02536       -.02387      -44.13241

   4   1    -15.81290       0.00000       -.00005     -15.81290        .00000         .00016
   4   2    -15.27222       0.00000       -.00974     -15.27223        .00001         .03653
   4   3    -12.81582       0.00000       -.35060     -12.82540        .00958        1.56585
   4   4     -8.44369       0.00000       -.42307      -8.46483        .02115        2.86127
   4   5     -4.07156       0.00000       -.48696      -4.12899        .05743        5.72622
   4   6       .30057       0.00000       -.54225        .71298       -.41241      -37.25465
   4   7      4.67270       0.00000       -.58895       4.74579       -.07309       -7.07426
   4   8      9.04483       0.00000       -.62706       9.08810       -.04327       -3.94705
   4   9     11.50124       0.00000       -.03614      11.50135       -.00011        -.18003
   4  10     12.04192       0.00000       -.03919      12.04204       -.00013        -.18647
   4  11     12.48244       0.00000       -.04305      12.48266       -.00023        -.2434
```

```
 4 12     12.42279       0.00000       -.02698      12.42285       -.00006       -.12011

 5  1    -16.85352       0.00000       -.00003     -16.85352        .00000        .00009
 5  2    -16.27726       0.00000       -.00649     -16.27726        .00000        .02285
 5  3    -13.65921       0.00000       -.23133     -13.66312        .00392        .96299
 5  4     -8.99336       0.00000       -.27369      -9.00768        .00832       1.74034
 5  5     -4.33952       0.00000       -.30159      -4.36038        .02086       3.95668
 5  6       .32033       0.00000       -.31505        .51359       -.19326     -31.52622
 5  7      4.98017       0.00000       -.31406       4.99990       -.01973      -3.59419
 5  8      9.64002       0.00000       -.29862       9.64926       -.00924      -1.77256
 5  9     12.25807       0.00000       -.01479      12.25809       -.00002       -.06913
 5 10     12.83433       0.00000       -.01009      12.83434       -.00001       -.04504
 5 11     13.30384       0.00000       -.00651      13.30384       -.00000       -.02804
 5 12     13.66659       0.00000       -.00330      13.66660       -.00000       -.01383

 6  1    -17.19859       0.00000       -.00001     -17.19859        .00000        .00003
 6  2    -16.61053       0.00000       -.00201     -16.61053        .00000        .00693
 6  3    -13.93887       0.00000       -.07155     -13.93924        .00037        .29409
 6  4     -9.18362       0.00000       -.08465      -9.18440        .00078        .52603
 6  5     -4.42836       0.00000       -.09327      -4.43032        .00196       1.20611
 6  6       .32590       0.00000       -.09744        .35374       -.02684     -15.39990
 6  7      5.08216       0.00000       -.09713       5.08401       -.00186      -1.09447
 6  8      9.83742       0.00000       -.09235       9.83828       -.00087       -.53781
 6  9     12.50908       0.00000       -.00457      12.50908       -.00000       -.02095
 6 10     13.09714       0.00000       -.00312      13.09714       -.00000       -.01365
 6 11     13.57626       0.00000       -.00201      13.57626       -.00000       -.00850
 6 12     13.94644       0.00000       -.00102      13.94644       -.00000       -.00419

 7  1     -3.29117       0.00000       -.00003      -3.29117        .00000        .00052
 7  2     -3.16339       0.00000       -.03087      -3.16369        .00030        .55913
 7  3     -2.58283       0.00000      -1.09957      -2.98752        .40470      20.20626
 7  4     -1.54949       0.00000      -1.29530      -2.28407        .73457      29.55776
 7  5      -.51616       0.00000      -1.41273      -1.69419       1.17803      39.82364
 7  6       .51717       0.00000      -1.45186       1.73329      -1.21612     -33.95055
 7  7      1.55051       0.00000      -1.41267       2.38667       -.83616     -30.62132
 7  8      2.58384       0.00000      -1.29517       3.12127       -.53743     -22.53605
 7  9      3.16440       0.00000       -.06051       3.16556       -.00116      -1.09509
 7 10      3.29219       0.00000       -.03086       3.29248       -.00029       -.53694
 7 11       .00034       0.00000       -.00000        .00034       -.00000       -.68388
 7 12       .00035       0.00000       -.00000        .00035       -.00000       -.33799

 8  1     -8.88312       0.00000       -.00002      -8.88312        .00000        .00014
 8  2     -8.53822       0.00000       -.02677      -8.53830        .00008        .17963
 8  3     -6.97127       0.00000       -.95342      -7.09931        .12804       7.64891
 8  4     -4.18227       0.00000      -1.12316      -4.46481        .28254      14.12021
 8  5     -1.39327       0.00000      -1.22499      -2.10586        .71259      30.18686
 8  6      1.39573       0.00000      -1.25392       2.13727       -.74154     -30.49941
 8  7      4.18473       0.00000      -1.22495       4.51692       -.33219     -15.17313
 8  8      6.97373       0.00000      -1.12307       7.15013       -.17640      -8.92649
 8  9      8.54068       0.00000       -.05247       8.54100       -.00032       -.35198
 8 10      8.88558       0.00000       -.02676       8.88566       -.00008       -.17252
 8 11       .00092       0.00000       -.00000        .00092       -.00000       -.21975
 8 12       .00094       0.00000       -.00000        .00094       -.00000       -.10859

 9  1    -12.98942       0.00000        .00000     -12.98942        .00000       -.00000
 9  2    -12.48510       0.00000       -.01615     -12.48512        .00002        .07410
 9  3    -10.19386       0.00000       -.57907     -10.22665        .03279       3.24081
 9  4     -6.11571       0.00000       -.69079      -6.19277        .07706       6.36494
 9  5     -2.03756       0.00000       -.77503      -2.29886        .26129      18.63098
 9  6      2.04059       0.00000       -.83179       2.33668       -.29609     -19.59424
 9  7      6.11874       0.00000       -.86105       6.23760       -.11886      -7.85961
 9  8     10.19688       0.00000       -.86284      10.26938       -.07250      -4.80274
 9  9     12.48812       0.00000       -.04608      12.48829       -.00017       -.21140
 9 10     12.99245       0.00000       -.04099      12.99258       -.00013       -.18075
 9 11       .00134       0.00000       -.04469        .04537       -.04403     -44.57045
 9 12       .00137       0.00000       -.02265        .02334       -.02197     -44.13243

10  1    -14.57132       0.00000        .00001     -14.57132        .00000       -.00006
10  2    -14.07334       0.00000       -.00893     -14.07334        .00001        .03634
10  3    -11.81090       0.00000       -.32238     -11.81969        .00879       1.56232
10  4     -7.78401       0.00000       -.36923      -7.80343        .01941       2.85548
10  5     -3.75713       0.00000       -.44814      -3.80984        .05271       6.70870
10  6       .26976       0.00000       -.49912        .65190       -.38214     -37.43995
10  7      4.29664       0.00000       -.54216       4.36400       -.06736      -7.08186
10  8      8.32353       0.00000       -.57727       8.36337       -.03985      -3.94849
10  9     10.58597       0.00000       -.03327      10.58607       -.00010       -.18006
10 10     11.08395       0.00000       -.03608      11.08407       -.00012       -.18649
10 11     11.48969       0.00000       -.04883      11.48983       -.00021       -.24350
10 12     11.80317       0.00000       -.02474      11.80322       -.00005       -.12011

11  1    -15.53115       0.00000        .00002     -15.53115        .00000       -.00006
11  2    -15.00037       0.00000       -.00595     -15.00037        .00000        .02272
11  3    -12.58995       0.00000       -.21273     -12.59254        .00359        .96780
11  4     -8.29689       0.00000       -.25182      -8.30452        .00764       1.73687
11  5     -4.00482       0.00000       -.27760      -4.02337        .01015       3.74632
```

```
 11  6        .28724        0.00000        -.29005         .46727        -.18004      -31.82872
 11  7       4.57730        0.00000        -.28918        4.59749        -.01819       -3.59968
 11  8       8.87136        0.00000        -.27498        8.87987        -.00852       -1.77370
 11  9      11.28278        0.00000        -.01362       11.28230        -.00002        -.06917
 11 10      11.81356        0.00000        -.00929       11.81357        -.00001        -.04507
 11 11      12.24601        0.00000        -.00600       12.24601        -.00000        -.02805
 11 12      12.58014        0.00000        -.00304       12.58014        -.00000        -.01384

 12  1     -15.84997        0.00000         .00001      -15.84997         .00000        -.00003
 12  2     -15.30830        0.00000        -.00184      -15.30830         .00000         .00688
 12  3     -12.84742        0.00000        -.06579      -12.84775         .00034         .29335
 12  4      -8.46731        0.00000        -.07789       -8.46803         .00072         .52697
 12  5      -4.08721        0.00000        -.08587       -4.08901         .00180        1.20300
 12  6        .29290        0.00000        -.08973         .31820        -.02530      -15.74731
 12  7       4.67300        0.00000        -.08946        4.67472        -.00171       -1.09634
 12  8       9.05311        0.00000        -.08507        9.05391        -.00080        -.53834
 12  9      11.51399        0.00000        -.00421       11.51400        -.00000        -.02097
 12 10      12.05566        0.00000        -.00287       12.05566        -.00000        -.01366
 12 11      12.49699        0.00000        -.00186       12.49699        -.00000        -.00850
 12 12      12.83796        0.00000        -.00094       12.83796        -.00000        -.00420


 LOADS FOR DEAD LOAD STRUCTURE SOLUTION


 NUMBER OF PATCH LOAD CARDS          =     1
 LOAD CARD     LOAD (KSI)    X OF CENTER(IN)  Y OF C ENTER(IN)  LENGTH(IN)    WIDTH(IN)
     1           .0003          150.00               6.00         300.00        12.00


THE IMPACT FACTOR APPLIED TO THE ABOVE LOAD  =      1.000



                     NODAL POINT FORCES WITH SPECIFIED UNIFORM AND CONCENTRATED LOADS

        NODE             U               V               W               XX              YY              ZZ

           1         0.00000         0.00000          .09501         -.38392         -.91618         0.00000
           2         0.00000         0.00000          .00969          .10471         -.18324         0.00000
           3         0.00000         0.00000         0.00000         0.00000         0.00000         0.00000
           4         0.00000         0.00000         0.00000         0.00000         0.00000         0.00000
           5         0.00000         0.00000         0.00000         0.00000         0.00000         0.00000
           6         0.00000         0.00000         0.00000         0.00000         0.00000         0.00000
           7         0.00000         0.00000          .19002         -.76784         0.00000         0.00000
           8         0.00000         0.00000          .01939          .20941         0.00000         0.00000
           9         0.00000         0.00000         0.00000         0.00000         0.00000         0.00000
          10         0.00000         0.00000         0.00000         0.00000         0.00000         0.00000
          11         0.00000         0.00000         0.00000         0.00000         0.00000         0.00000
          12         0.00000         0.00000         0.00000         0.00000         0.00000         0.00000
          13         0.00000         0.00000          .19002         -.76784         0.00000         0.00000
          14         0.00000         0.00000          .01939          .20941         0.00000         0.00000
          15         0.00000         0.00000         0.00000         0.00000         0.00000         0.00000
          16         0.00000         0.00000         0.00000         0.00000         0.00000         0.00000
          17         0.00000         0.00000         0.00000         0.00000         0.00000         0.00000
          18         0.00000         0.00000         0.00000         0.00000         0.00000         0.00000
          19         0.00000         0.00000          .17192         -.69472          .31578         0.00000
          20         0.00000         0.00000          .01754          .18947          .06316         0.00000
          21         0.00000         0.00000         0.00000         0.00000         0.00000         0.00000
          22         0.00000         0.00000         0.00000         0.00000         0.00000         0.00000
          23         0.00000         0.00000         0.00000         0.00000         0.00000         0.00000
          24         0.00000         0.00000         0.00000         0.00000         0.00000         0.00000
          25         0.00000         0.00000          .12216         -.49361          .39265         0.00000
          26         0.00000         0.00000          .01247          .13462          .07853         0.00000
          27         0.00000         0.00000         0.00000         0.00000         0.00000         0.00000
          28         0.00000         0.00000         0.00000         0.00000         0.00000         0.00000
          29         0.00000         0.00000         0.00000         0.00000         0.00000         0.00000
          30         0.00000         0.00000         0.00000         0.00000         0.00000         0.00000
          31         0.00000         0.00000          .09047         -.36564         0.00000         0.00000
          32         0.00000         0.00000          .00923          .09972         0.00000         0.00000
          33         0.00000         0.00000         0.00000         0.00000         0.00000         0.00000
          34         0.00000         0.00000         0.00000         0.00000         0.00000         0.00000
          35         0.00000         0.00000         0.00000         0.00000         0.00000         0.00000
          36         0.00000         0.00000         0.00000         0.00000         0.00000         0.00000
          37         0.00000         0.00000          .04574         -.18292          .20775         0.00000
          38         0.00000         0.00000          .00467          .04985          .04155         0.00000
```

```
    39           0.00000         0.00000          0.00000          0.00000          0.00000          0.00000
    40           0.00000         0.00000          0.00000          0.00000          0.00000          0.00000
    41           0.00000         0.00000          0.00000          0.00000          0.00000          0.00000
    42           0.00000         0.00000          0.00000          0.00000          0.00000          0.00000


  TOTAL FORCES ON STRUCTURE

  NODE        U                 V                 W                 XX                 YY                 ZZ

    1            0.00000         0.00000          .09501          -.38392          -.91618          0.00000
    2            0.00000         0.00000          0.00000          .10471          -.18324          0.00000
    3            0.00000         0.00000          0.00000          0.00000          0.00000          0.00000
    4            0.00000         0.00000          0.00000          0.00000          0.00000          0.00000
    5            0.00000         0.00000          0.00000          0.00000          0.00000          0.00000
    6            0.00000         0.00000          0.00000          0.00000          0.00000          0.00000
    7            0.00000         0.00000          .19002          -.76784          0.00000          0.00000
    8            0.00000         0.00000          .01939          .20941          0.00000          0.00000
    9            0.00000         0.00000          0.00000          0.00000          0.00000          0.00000
   10            0.00000         0.00000          0.00000          0.00000          0.00000          0.00000
   11            0.00000         0.00000          0.00000          0.00000          0.00000          0.00000
   12            0.00000         0.00000          0.00000          0.00000          0.00000          0.00000
   13            0.00000         0.00000          .19002          -.76784          0.00000          0.00000
   14            0.00000         0.00000          .01939          .20941          0.00000          0.00000
   15            0.00000         0.00000          0.00000          0.00000          0.00000          0.00000
   16            0.00000         0.00000          0.00000          0.00000          0.00000          0.00000
   17            0.00000         0.00000          0.00000          0.00000          0.00000          0.00000
   18            0.00000         0.00000          0.00000          0.00000          0.00000          0.00000
   19            0.00000         0.00000          .17192          -.69472          .31578          0.00000
   20            0.00000         0.00000          .01754          .18947          .06316          0.00000
   21            0.00000         0.00000          0.00000          0.00000          0.00000          0.00000
   22            0.00000         0.00000          0.00000          0.00000          0.00000          0.00000
   23            0.00000         0.00000          0.00000          0.00000          0.00000          0.00000
   24            0.00000         0.00000          0.00000          0.00000          0.00000          0.00000
   25            0.00000         0.00000          .12216          -.49361          .39265          0.00000
   26            0.00000         0.00000          .01247          .13462          .07853          0.00000
   27            0.00000         0.00000          0.00000          0.00000          0.00000          0.00000
   28            0.00000         0.00000          0.00000          0.00000          0.00000          0.00000
   29            0.00000         0.00000          0.00000          0.00000          0.00000          0.00000
   30            0.00000         0.00000          0.00000          0.00000          0.00000          0.00000
   31            0.00000         0.00000          .09049          -.36564          0.00000          0.00000
   32            0.00000         0.00000          .00923          .09972          0.00000          0.00000
   33            0.00000         0.00000          0.00000          0.00000          0.00000          0.00000
   34            0.00000         0.00000          0.00000          0.00000          0.00000          0.00000
   35            0.00000         0.00000          0.00000          0.00000          0.00000          0.00000
   36            0.00000         0.00000          0.00000          0.00000          0.00000          0.00000
   37            0.00000         0.00000          .04524          -.18282          0.00000          0.00000
   38            0.00000         0.00000          .00462          .04986          0.00000          0.00000
   39            0.00000         0.00000          0.00000          0.00000          0.00000          0.00000
   40            0.00000         0.00000          0.00000          0.00000          0.00000          0.00000
   41            0.00000         0.00000          0.00000          0.00000          0.00000          0.00000
   42            0.00000         0.00000          0.00000          0.00000          0.00000          0.00000

  SUM            0.00000         0.00000          .98750          -2.65920         -.24930          0.00000



 LOADS FOR LIVE LOAD SOLUTION


 NUMBER OF PATCH LOAD CARDS         =    1

 LOAD CARD     LOAD (KSI)    X OF CENTER(IN)   Y OF C ENTER(IN)   LENGTH(IN)    WIDTH(IN)
     1           .0025           210.00                60.00          180.00        72.00


THE IMPACT FACTOR APPLIED TO THE ABOVE LOAD  =     1.286



                         NODAL POINT FORCES WITH SPECIFIED UNIFORM AND CONCENTRATED LOADS

      NODE          U              V               W              XX              YY              ZZ

        1        0.00000        0.00000         0.00000         0.00000         0.00000         0.00000
```

```
   2          0.00000        0.00000        0.00000        0.00000        0.00000        0.00000
   3          0.00000        0.00000        0.00000        0.00000        0.00000        0.00000
   4          0.00000        0.00000        0.00000        0.00000        0.00000        0.00000
   5          0.00000        0.00000        0.00000        0.00000        0.00000        0.00000
   6          0.00000        0.00000        0.00000        0.00000        0.00000        0.00000
   7          0.00000        0.00000        -.00037        -.00951        -.00527        0.00000
   8          0.00000        0.00000         .00385        -.02198        -.06583        0.00000
   9          0.00000        0.00000        0.00000        0.00000        0.00000        0.00000
  10          0.00000        0.00000         .00386        0.00000        -.07900        0.00000
  11          0.00000        0.00000         .00193         .05317        -.03950        0.00000
  12          0.00000        0.00000        0.00000        0.00000        0.00000        0.00000
  13          0.00000        0.00000         .10377       -1.10814       -1.56307        0.00000
  14          0.00000        0.00000        2.40521       -2.86269      -19.53840        0.00000
  15          0.00000        0.00000        0.00000        0.00000        0.00000        0.00000
  16          0.00000        0.00000        2.78775        -.00000      -23.44608        0.00000
  17          0.00000        0.00000        1.39387        6.92584      -11.72304        0.00000
  18          0.00000        0.00000        0.00000        0.00000        0.00000        0.00000
  19          0.00000        0.00000         .15716       -1.69730         .56577        0.00000
  20          0.00000        0.00000        3.66176       -4.38468        7.07207        0.00000
  21          0.00000        0.00000        0.00000        0.00000        0.00000        0.00000
  22          0.00000        0.00000        4.24324        -.00000        8.48649        0.00000
  23          0.00000        0.00000        2.12162       10.60811        4.24324        0.00000
  24          0.00000        0.00000        0.00000        0.00000        0.00000        0.00000
  25          0.00000        0.00000         .11166       -1.20597         .70348        0.00000
  26          0.00000        0.00000        2.60178       -3.11543        8.79356        0.00000
  27          0.00000        0.00000        0.00000        0.00000        0.00000        0.00000
  28          0.00000        0.00000        3.01494        -.00000       10.55228        0.00000
  29          0.00000        0.00000        1.50747        7.53734        5.27614        0.00000
  30          0.00000        0.00000        0.00000        0.00000        0.00000        0.00000
  31          0.00000        0.00000         .08271        -.89331        0.00000        0.00000
  32          0.00000        0.00000        1.92724       -2.30773        0.00000        0.00000
  33          0.00000        0.00000        0.00000        0.00000        0.00000        0.00000
  34          0.00000        0.00000        2.23329        -.00000        0.00000        0.00000
  35          0.00000        0.00000        1.11664        5.58321        0.00000        0.00000
  36          0.00000        0.00000        0.00000        0.00000        0.00000        0.00000
  37          0.00000        0.00000         .04136        -.44666         .37221        0.00000
  38          0.00000        0.00000         .96362       -1.15386        4.65268        0.00000
  39          0.00000        0.00000        0.00000        0.00000        0.00000        0.00000
  40          0.00000        0.00000        1.11664        0.00000        5.58321        0.00000
  41          0.00000        0.00000         .55832        2.79161        2.79161        0.00000
  42          0.00000        0.00000        0.00000        0.00000        0.00000        0.00000

TOTAL FORCES ON STRUCTURE

NODE      U              V              W              XX             YY             ZZ

   1          0.00000        0.00000        0.00000        0.00000        0.00000        0.00000
   2          0.00000        0.00000        0.00000        0.00000        0.00000        0.00000
   3          0.00000        0.00000        0.00000        0.00000        0.00000        0.00000
   4          0.00000        0.00000        0.00000        0.00000        0.00000        0.00000
   5          0.00000        0.00000        0.00000        0.00000        0.00000        0.00000
   6          0.00000        0.00000        0.00000        0.00000        0.00000        0.00000
   7          0.00000        0.00000        -.00037        -.00951        -.00527        0.00000
   8          0.00000        0.00000         .00385        -.02198        -.06583        0.00000
   9          0.00000        0.00000        0.00000        0.00000        0.00000        0.00000
  10          0.00000        0.00000         .00386        0.00000        -.07900        0.00000
  11          0.00000        0.00000         .00193         .05317        -.03950        0.00000
  12          0.00000        0.00000        0.00000        0.00000        0.00000        0.00000
  13          0.00000        0.00000         .10377       -1.10814       -1.56307        0.00000
  14          0.00000        0.00000        2.40521       -2.86269      -19.53840        0.00000
  15          0.00000        0.00000        0.00000        0.00000        0.00000        0.00000
  16          0.00000        0.00000        2.78775        -.00000      -23.44608        0.00000
  17          0.00000        0.00000        1.39387        6.92584      -11.72304        0.00000
  18          0.00000        0.00000        0.00000        0.00000        0.00000        0.00000
  19          0.00000        0.00000         .15716       -1.69730         .56577        0.00000
  20          0.00000        0.00000        3.66176       -4.38468        7.07207        0.00000
  21          0.00000        0.00000        0.00000        0.00000        0.00000        0.00000
  22          0.00000        0.00000        4.24324        -.00000        8.48649        0.00000
  23          0.00000        0.00000        2.12162       10.60811        4.24324        0.00000
  24          0.00000        0.00000        0.00000        0.00000        0.00000        0.00000
  25          0.00000        0.00000         .11166       -1.20597         .70348        0.00000
  26          0.00000        0.00000        2.60178       -3.11543        8.79356        0.00000
  27          0.00000        0.00000        0.00000        0.00000        0.00000        0.00000
  28          0.00000        0.00000        3.01494        -.00000       10.55228        0.00000
  29          0.00000        0.00000        1.50747        7.53734        5.27614        0.00000
  30          0.00000        0.00000        0.00000        0.00000        0.00000        0.00000
  31          0.00000        0.00000         .08271        -.89331        0.00000        0.00000
  32          0.00000        0.00000        1.92724       -2.30773        0.00000        0.00000
  33          0.00000        0.00000        0.00000        0.00000        0.00000        0.00000
  34          0.00000        0.00000        2.23329        -.00000        0.00000        0.00000
  35          0.00000        0.00000        1.11664        5.58321        0.00000        0.00000
  36          0.00000        0.00000        0.00000        0.00000        0.00000        0.00000
  37          0.00000        0.00000         .04136        -.44666        0.00000        0.00000
```

```
 38        0.00000      0.00000       .96362     -1.15386      0.00000      0.00000
 39        0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
 40        0.00000      0.00000      1.11664      0.00000      0.00000      0.00000
 41        0.00000      0.00000       .55832      2.79161      0.00000      0.00000
 42        0.00000      0.00000      0.00000      0.00000      0.00000      0.00000

SUM        0.00000      0.00000     32.15931     14.29303    -10.76717      0.00000
```

FEL 435.2

FEL 435.2

```
DEAD LOAD SOLUTION
 NUMBER OF TRIALS      =     0
 NUMBER OF ITERATIONS =     1

      SLAB - NEWLY CRACKED, CRUSHED OR YIELDED LAYERS
ELEMENT  LAYER    ANGLE
      NEW BEAM LAYER FAILURES
ELEMENT  LAYER  TYPE OF FAILURE

DEAD LOAD SOLUTION
 NUMBER OF TRIALS      =     0
 NUMBER OF ITERATIONS =     2

      SLAB - NEWLY CRACKED, CRUSHED OR YIELDED LAYERS
ELEMENT  LAYER    ANGLE
      NEW BEAM LAYER FAILURES
ELEMENT  LAYER  TYPE OF FAILURE

DEAD LOAD SOLUTION
 NUMBER OF TRIALS      =     0
 NUMBER OF ITERATIONS =     3

      SLAB - NEWLY CRACKED, CRUSHED OR YIELDED LAYERS
ELEMENT  LAYER    ANGLE
      NEW BEAM LAYER FAILURES
ELEMENT  LAYER  TYPE OF FAILURE

DEAD LOAD SOLUTION
 NUMBER OF TRIALS      =     0
 NUMBER OF ITERATIONS =     4

      SLAB - NEWLY CRACKED, CRUSHED OR YIELDED LAYERS
ELEMENT  LAYER    ANGLE
      NEW BEAM LAYER FAILURES
ELEMENT  LAYER  TYPE OF FAILURE

DEAD LOAD SOLUTION
 NUMBER OF TRIALS      =     1
 NUMBER OF ITERATIONS =     1

      SLAB - NEWLY CRACKED, CRUSHED OR YIELDED LAYERS
ELEMENT  LAYER    ANGLE
      NEW BEAM LAYER FAILURES
ELEMENT  LAYER  TYPE OF FAILURE

DEAD LOAD SOLUTION
 NUMBER OF TRIALS      =     1
 NUMBER OF ITERATIONS =     2

      SLAB - NEWLY CRACKED, CRUSHED OR YIELDED LAYERS
ELEMENT  LAYER    ANGLE
      NEW BEAM LAYER FAILURES
ELEMENT  LAYER  TYPE OF FAILURE

DEAD LOAD SOLUTION
 NUMBER OF TRIALS      =     1
 NUMBER OF ITERATIONS =     3

      SLAB - NEWLY CRACKED, CRUSHED OR YIELDED LAYERS
```

```
ELEMENT  LAYER     ANGLE

         NEW BEAM LAYER FAILURES
ELEMENT  LAYER  TYPE OF FAILURE


DEAD LOAD SOLUTION
 NUMBER OF TRIALS      =     1
 NUMBER OF ITERATIONS  =     4

         SLAB - NEWLY CRACKED, CRUSHED OR YIELDED LAYERS
ELEMENT  LAYER     ANGLE

         NEW BEAM LAYER FAILURES
ELEMENT  LAYER  TYPE OF FAILURE


DEAD LOAD SOLUTION
 NUMBER OF TRIALS      =     1
 NUMBER OF ITERATIONS  =     5

         SLAB - NEWLY CRACKED, CRUSHED OR YIELDED LAYERS
ELEMENT  LAYER     ANGLE

         NEW BEAM LAYER FAILURES
ELEMENT  LAYER  TYPE OF FAILURE


         SOLUTION FOR DEAD LOAD ON THE STRUCTURE




         APPLIED NODAL POINT FORCES IN KIPS AND IN-KIPS

         NODE            U             V             W             XX            YY            ZZ

            1        0.00000       0.00000        .09501       -.38392       -.91618       0.00000
            2        0.00000       0.00000        .00969        .10471       -.18324       0.00000
            3        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
            4        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
            5        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
            6        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
            7        0.00000       0.00000        .19002       -.76784       0.00000       0.00000
            8        0.00000       0.00000        .01939        .20941       0.00000       0.00000
            9        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
           10        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
           11        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
           12        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
           13        0.00000       0.00000        .19002       -.76784       0.00000       0.00000
           14        0.00000       0.00000        .01939        .20941       0.00000       0.00000
           15        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
           16        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
           17        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
           18        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
           19        0.00000       0.00000        .17192       -.69472        .31578       0.00000
           20        0.00000       0.00000        .01754        .18947        .06316       0.00000
           21        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
           22        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
           23        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
           24        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
           25        0.00000       0.00000        .12216       -.49361        .39265       0.00000
           26        0.00000       0.00000        .01247        .13462        .07653       0.00000
           27        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
           28        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
           29        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
           30        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
           31        0.00000       0.00000        .09049       -.36564       0.00000       0.00000
           32        0.00000       0.00000        .00923        .09972       0.00000       0.00000
           33        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
           34        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
           35        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
           36        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
           37        0.00000       0.00000        .04524       -.18282        .20775       0.00000
           38        0.00000       0.00000        .00462        .04986        .04155       0.00000
           39        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
           40        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
           41        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
           42        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
```

FEL 435.2

```
NODAL POINT DISPLACEMENTS IN INCHES AND RADIANS

NODE          U          V          W          XX          YY          ZZ

  1       .00341    0.00000     .02437      .00080     -.00176     0.00000
  2       .00359    0.00000    0.00000      .00041     -.00145     0.00000
  3      -.01353    0.00000    0.00000     0.00000     -.00137     0.00000
  4       .00324    0.00000    -.00423     -.00005     -.00104     0.00000
  5       .00313    0.00000    0.00000     -.00019     -.00053     0.00000
  6      -.00329    0.00000    0.00000     0.00000     -.00052     0.00000
  7       .00315    -.00001     .12885      .00121     -.00160     0.00000
  8       .00328    -.00008     .08684      .00109     -.00131     0.00000
  9      -.01245    0.00000    0.00000     0.00000     -.00126     0.00000
 10       .00303    -.00014     .05756      .00089     -.00092     0.00000
 11       .00295    -.00015     .03242      .00081     -.00051     0.00000
 12      -.00318    0.00000    0.00000     0.00000     -.00049     0.00000
 13       .00250    -.00005     .27432      .00181     -.00134     0.00000
 14       .00262    -.00013     .16042      .00173     -.00103     0.00000
 15      -.00975    0.00000    0.00000     0.00000     -.00100     0.00000
 16       .00248    -.00019     .11016      .00163     -.00073     0.00000
 17       .00248    -.00023     .06207      .00159     -.00043     0.00000
 18      -.00269    0.00000    0.00000     0.00000     -.00041     0.00000
 19       .00165     .00002     .29469      .00230     -.00087     0.00000
 20       .00174    -.00008     .21311      .00222     -.00065     0.00000
 21      -.00601    0.00000    0.00000     0.00000     -.00062     0.00000
 22       .00168    -.00015     .14791      .00214     -.00047     0.00000
 23       .00169    -.00022     .08456      .00210     -.00028     0.00000
 24      -.00169    0.00000    0.00000     0.00000     -.00027     0.00000
 25       .00091     .00008     .32887      .00254     -.00047     0.00000
 26       .00097    -.00002     .23861      .00246     -.00036     0.00000
 27      -.00335    0.00000    0.00000     0.00000     -.00035     0.00000
 28       .00092    -.00011     .16625      .00237     -.00025     0.00000
 29       .00095    -.00019     .09574      .00233     -.00016     0.00000
 30      -.00095    0.00000    0.00000     0.00000     -.00015     0.00000
 31       .00047     .00010     .33959      .00261     -.00024     0.00000
 32       .00047     .00000     .24664      .00254     -.00018     0.00000
 33      -.00169    0.00000    0.00000     0.00000     -.00017     0.00000
 34       .00045    -.00007     .17201      .00245     -.00013     0.00000
 35       .00050    -.00015     .09931      .00241     -.00008     0.00000
 36      -.00048    0.00000    0.00000     0.00000     -.00008     0.00000
 37      0.00000    0.00000     .34318      .00264     0.00000     0.00000
 38      0.00000    0.00000     .24932      .00256     0.00000     0.00000
 39      0.00000    0.00000    0.00000     0.00000     0.00000     0.00000
 40      0.00000    0.00000     .17395      .00247     0.00000     0.00000
 41      0.00000    0.00000     .10052      .00243     0.00000     0.00000
 42      0.00000    0.00000    0.00000     0.00000     0.00000     0.00000


        DISPLACEMENT/REFFRENCE DISPLACEMENT  =     .10052

        FORCE/REFERENCE FORCE                =     .01939

        SUM OF NODAL POINT W-LOADS           =      .9972

        SUM OF W-LOADS FOR TOTAL STRUCTURE   =     3.9888

        (SUM OF W-LOADS FOR TOTAL STRUCTURE
             WITHOUT IMPACT FACTOR)          =     3.9888


   INTERNAL MOMENTS (IN-KIPS/IN) AND NORMAL FORCES (KIPS/IN) IN THE SLAB

 EL         MY          MX          MXY         NX          NY          NXY
  1        -.24       -2.30        -.90        -.14        -.09        -.09
  2        -.26       -2.35        -.85        -.14        -.08         .12
  3        -.03        -.89       -1.22        -.07        -.01         .03
  4         .90         .07        -.66        -.29         .02        -.04
  5         .10        -.47       -1.03        -.22         .02         .03
  6         .08         .00       -1.05        -.20        -.01         .01
  7         .61         .06        -.67        -.39        -.00        -.02
  8         .50        -.26        -.74        -.38        -.01         .06
  9         .19         .00        -.75        -.34        -.01        -.07
 10         .73         .05        -.47        -.42         .01        -.01
 11         .46        -.24        -.45        -.42        -.00         .03
 12         .21         .00        -.46        -.41        -.00         .07
 13         .51        -.24        -.24        -.47        -.01        -.01
```

```
       14                 .50            -.26            -.27            -.47            -.00            .03
       15                 .34            -.13            -.25            -.46            -.01            .01
       16                 .49            -.24            -.13            -.45            -.00           -.00
       17                 .48            -.26            -.13            -.45            -.02            .01
       18                 .36            -.14            -.13            -.45            -.00            .01


         INTERNAL MOMENTS (IN-KIPS), NORMAL FORCES (KIPS), AND SHEAR FORCES (KIPS) IN BEAM ELEMENTS
        ELEM           MB                 NB                 VB

          1        438.5511           9.0526           -13.7338
          2       1170.8807          22.6257           -11.7957
          3       1705.8579          31.4142            -8.1155
          4       2051.3997          35.5717            -5.1258
          5       2188.4631          37.7708            -2.7902
          6       2231.8642          38.6034             -.8511
          7        184.1439            .4404            -5.2674
          8        500.2159           2.0515            -4.6983
          9        739.2201           4.1839            -3.3533
         10        885.2538           5.2382            -2.0735
         11        944.5221           5.7003            -1.1331
         12        965.0758           5.7978             -.3533
 TOTAL STRESSES IN SLAB LAYERS (STRESS (KSI), ANG. (DEGRESS), + TEN., - COMP.)

     EL LAYER        SXX            SYY            SXY            S1             S2           THETA1

      1  1         .00797         .25687         .09722        -.02550         .29034      -18.99770
      1  2        -.00577         .13151         .04498        -.01920         .14484      -16.62769
      1  3        -.02180        -.00558        -.01181        -.02802         .00063       27.76280
      1  4        -.03752        -.15369        -.07377        -.00171        -.18950      -25.89131
      1  5        -.04800        -.25428        -.11608         .00414        -.30642      -24.18841
      1  6        -.05321        -.30626        -.13808         .00755        -.36702      -23.75047
      1  7        -.00000         .27809         .00000         .27809        -.00000      -90.00000
      1  8        -.13306        -.00000        -.00000        -.13306        -.00000        0.00000
      1  9        -.05941        -.00000        -.00000        -.05941        -.00000        0.00000
      1 10        -.00000       -1.28931        -.00000       -1.28931        -.00000      -90.00003

      2  1         .01005         .26303         .12103        -.03853         .31160      -21.86786
      2  2        -.00414         .13490         .07132        -.03422         .16497      -22.86591
      2  3        -.02173        -.00556         .01789        -.03327         .00598      -32.83978
      2  4        -.03831        -.15745        -.04104        -.02554        -.17022      -17.28173
      2  5        -.04937        -.25916        -.08055        -.02201        -.28652      -18.76040
      2  6        -.05496        -.31064        -.10055        -.02015        -.34544      -19.09325
      2  7        -.00000         .28411         .00000         .28411        -.00000      -90.00000
      2  8        -.13306        -.00000         .00000        -.13306        -.00000        0.00000
      2  9        -.05941        -.00000        -.00000        -.05941        -.00000        0.00000
      2 10        -.00000       -1.31721        -.00000       -1.31721        -.00000      -90.00000

      3  1        -.00500         .10638         .15254        -.11170         .21309      -34.97119
      3  2        -.00959         .05395         .08050        -.06436         .10872      -34.23174
      3  3        -.01550        -.00360         .00234        -.01595        -.00316      -10.72361
      3  4        -.01240        -.05613        -.08062         .04922        -.11783      -37.42447
      3  5        -.01075        -.09137        -.13631         .09109        -.19320      -36.76278
      3  6        -.00987        -.10921        -.16451         .11230        -.23139      -36.59962
      3  7        -.00000         .11380         .00000         .11380        -.00000      -90.00000
      3  8        -.09516        -.00000        -.00000        -.09516        -.00000        0.00000
      3  9        -.04239        -.00000        -.00000        -.04239        -.00000        0.00000
      3 10        -.00000        -.52762        -.00000        -.52762        -.00000      -90.00000

      4  1        -.14039        -.00921         .07427        -.17372         .02511      -24.16737
      4  2        -.09536        -.00433         .03528        -.10744         .00775      -19.89172
      4  3        -.04427         .00061        -.00745        -.04547         .00182        9.18046
      4  4         .01164         .00812        -.05153         .06143        -.04169      -44.02152
      4  5         .04785         .01264        -.08165         .11377        -.05328      -38.91576
      4  6         .06624         .01492        -.09689         .14081        -.05965      -37.58312
      4  7        -.00000         .07521         .00000         .07521        -.00000      -90.00000
      4  8        -.27040         .00000        -.00000        -.27040         .00000        0.00000
      4  9         .00847         .00000        -.00000         .00847         .00000        0.00000
      4 10         .00000         .01704        -.00000         .01704         .00000      -90.00000

      5  1        -.04335         .06081         .13944        -.14011         .15758      -34.75993
      5  2        -.03947         .03241         .07877        -.09011         .08305      -32.73681
      5  3        -.03811         .00051         .01368        -.04246         .00487      -17.56124
      5  4        -.02562        -.02622        -.05714         .03122        -.08307      -44.84829
      5  5        -.01805        -.04368        -.10462         .07454        -.13627      -41.50917
      5  6        -.01419        -.05253        -.12866         .09673        -.16244      -40.76210
      5  7        -.00000         .11984         .00000         .11984        -.00000      -90.00000
      5  8        -.25205         .00000         .00000        -.25205         .00000        0.00000
      5  9        -.17653        -.00000        -.00000        -.17653        -.00000        0.00000
      5 10        -.00000        -.23299        -.00000        -.23299        -.00000      -90.00000

      6  1        -.03702         .00122         .12972        -.14902         .11322      -40.60938
```

```
 6  2     -.03452     -.00157      .06821     -.08822      .05213    -38.21091
 6  3     -.03361     -.00507      .00190     -.03373     -.00496     -3.58861
 6  4     -.02226     -.00090     -.07047     -.08286      .05970     40.69142
 6  5     -.01568      .00167     -.11922     -.12654      .11253     42.91909
 6  6     -.01233      .00297     -.14390     -.14878      .13942     43.47886
 6  7     -.00000      .01333      .00000      .01333     -.00000    -90.00000
 6  8     -.21960      .00000     -.00000     -.21960      .00000      0.00000
 6  9     -.18467      .00000     -.00000     -.18467      .00000      0.00000
 6 10     -.00000      .00261     -.00000      .00261     -.00000    -90.00000

 7  1     -.13161     -.00656      .07819     -.16920      .03103    -25.67578
 7  2     -.09960     -.00514      .03963     -.11403      .00929    -19.99810
 7  3     -.05936     -.00247     -.00431     -.05968     -.00215      4.30876
 7  4     -.01438      .00303     -.04919     -.05562      .04428     39.98064
 7  5      .01386      .00621     -.07996      .09009     -.07002    -43.62934
 7  6      .02826      .00780     -.09554      .11412     -.07806    -41.94375
 7  7     -.00000      .07521      .00000      .07521     -.00000    -90.00000
 7  8     -.37782      .00000     -.00000     -.37782      .00000      0.00000
 7  9     -.15971      .00000     -.00000     -.15971      .00000      0.00000
 7 10     -.00000      .01704     -.00000      .01704     -.00000    -90.00000

 8  1     -.11545      .03040      .09956     -.16594      .08089    -26.88789
 8  2     -.08756      .01421      .05614     -.11245      .03910    -23.90568
 8  3     -.06172     -.00449      .00979     -.06335     -.00286     -9.44087
 8  4     -.02140     -.01821     -.04140     -.06124      .02162     43.89542
 8  5      .00414     -.02731     -.07616      .06618     -.08935    -39.16589
 8  6      .01718     -.03195     -.09375      .08953     -.10431    -37.65850
 8  7     -.00000      .10186      .00000      .10186     -.00000    -90.00000
 8  8     -.39171      .00000      .00000     -.39171      .00000      0.00000
 8  9     -.17759     -.00000     -.00000     -.17759     -.00000      0.00000
 8 10     -.00000     -.16018     -.00000     -.16018     -.00000    -90.00000

 9  1     -.07280     -.00009      .09058     -.13405      .06116    -34.06465
 9  2     -.06277     -.00208      .04679     -.08820      .02334    -28.51714
 9  3     -.05542     -.00466     -.00029     -.05542     -.00466       .32690
 9  4     -.03614     -.00136     -.05162     -.07322      .03572     35.69283
 9  5     -.02524      .00052     -.08657     -.09988      .07516     40.76855
 9  6     -.01966      .00146     -.10427     -.11390      .09571     42.10896
 9  7     -.00000      .04925      .00000      .04925     -.00000    -90.00000
 9  8     -.36466      .00000     -.00000     -.36466      .00000      0.00000
 9  9     -.28722      .00000     -.00000     -.28722      .00000      0.00000
 9 10     -.00000      .02109     -.00000      .02109     -.00000    -90.00000

10  1     -.15410     -.00688      .05659     -.17334      .01236    -18.77667
10  2     -.10879     -.00401      .02755     -.11560      .00280    -13.86930
10  3     -.06274     -.00089     -.00268     -.06285     -.00077      2.47200
10  4     -.01117      .00426     -.03394     -.03826      .03135     38.59555
10  5      .02152      .00723     -.05558      .07041     -.04166    -41.33683
10  6      .03923      .00871     -.06653      .09161     -.04469    -39.74545
10  7     -.00000      .09272      .00000      .09272     -.00000    -90.00000
10  8     -.39850      .00000     -.00000     -.39850      .00000      0.00000
10  9     -.14105      .00000     -.00000     -.14105      .00000      0.00000
10 10      .00000      .02360     -.00000      .02360      .00000    -90.00000

11  1     -.11792      .02848      .05985     -.13927      .04983    -17.63455
11  2     -.09087      .01416      .03354     -.10067      .02395    -16.28317
11  3     -.06647     -.00243      .00545     -.06693     -.00197     -4.83162
11  4     -.03151     -.01806     -.02721     -.05281      .00325     38.06132
11  5     -.00495     -.02466     -.04658      .03281     -.06241    -39.02318
11  6      .00714     -.02918     -.05733      .04912     -.07116    -36.21334
11  7     -.00000      .11921      .00000      .11921     -.00000    -90.00000
11  8     -.42854      .00000      .00000     -.42854      .00000      0.00000
11  9     -.22573     -.00000     -.00000     -.22573     -.00000      0.00000
11 10     -.00000     -.12483     -.00000     -.12483     -.00000    -90.00000

12  1     -.08383      .00059      .05543     -.11130      .02805    -26.35595
12  2     -.07958     -.00293      .03091     -.09049      .00799    -19.44504
12  3     -.06405     -.00323     -.00007     -.06405     -.00323       .06587
12  4     -.04401     -.00150     -.03140     -.06067      .01516     27.95400
12  5     -.03332     -.00063     -.05288     -.07232      .03837     36.41133
12  6     -.02779     -.00019     -.06379     -.07926      .05127     38.89708
12  7     -.00000      .07248      .00000      .07248     -.00000    -90.00000
12  8     -.42516      .00000     -.00000     -.42516      .00000      0.00000
12  9     -.34163      .00000     -.00000     -.34163      .00000      0.00000
12 10     -.00000      .03596     -.00000      .03596     -.00000    -90.00000

13  1     -.12762      .02790      .02737     -.13229      .03258     -9.69670
13  2     -.10772      .01251      .01454     -.10945      .01424     -5.79963
13  3     -.07199     -.00247     -.00144     -.07202     -.00244      1.19680
13  4     -.03429     -.01820     -.01857     -.04648     -.00601     33.28305
13  5     -.00715     -.02582     -.02850      .01351     -.04648    -35.93286
13  6      .00554     -.03058     -.03426      .02621     -.05125    -31.10208
13  7     -.00000      .12796      .00000      .12796     -.00000    -90.00000
13  8     -.46468      .00000     -.00000     -.46468      .00000      0.00000
13  9     -.24842     -.00000     -.00000     -.24842     -.00000      0.00000
```

FEL 435.2

```
 13 10        -.00000       -.12383       -.00000       -.12383       -.00000      -90.00000

 14  1        -.12709        .03041        .03566       -.13479        .03811      -12.18151
 14  2        -.10647        .01409        .02156       -.11021        .01783       -9.83922
 14  3        -.07183       -.00172        .00392       -.07205       -.00150       -3.19322
 14  4        -.03433       -.01834       -.01509       -.04341       -.00926       31.04376
 14  5        -.00740       -.02660       -.02634        .01103       -.04504      -34.98876
 14  6         .00527       -.03161       -.03271        .02438       -.05073      -30.29299
 14  7        -.00000        .13453        .00000        .13453       -.00000      -90.00000
 14  8        -.46468        .00000        .00000       -.46468        .00000        0.00000
 14  9        -.24842       -.00000       -.00000       -.24842       -.00000        0.00000
 14 10        -.00000       -.12648       -.00000       -.12648       -.00000      -90.00000

 15  1        -.10975        .01339        .03142       -.11730        .02094      -13.51921
 15  2        -.09142        .00601        .01690       -.09426        .00886       -9.56693
 15  3        -.06819       -.00196        .00050       -.06819       -.00195        -.43676
 15  4        -.04431       -.01032       -.01698       -.05134       -.00329       22.48476
 15  5        -.02837       -.01590       -.02881       -.05161        .00734       38.89645
 15  6        -.01763       -.01622       -.03289       -.04982        .01597       44.38655
 15  7        -.00000        .10622        .00000        .10622       -.00000      -90.00000
 15  8        -.44915        .00000       -.00000       -.44915        .00000        0.00000
 15  9        -.31387        .00000       -.00000       -.31387        .00000        0.00000
 15 10        -.00000       -.03597       -.00000       -.03597       -.00000      -90.00000

 16  1        -.12177        .02788        .01461       -.12318        .02929       -5.52407
 16  2        -.10270        .01308        .00801       -.10325        .01364       -3.93655
 16  3        -.06874       -.00153       -.00026       -.06874       -.00153         .22007
 16  4        -.03286       -.01691       -.00912       -.03699       -.01277       24.40513
 16  5        -.00883       -.02719       -.01503       -.00040       -.03562      -29.29335
 16  6         .00433       -.02963       -.01714        .01148       -.03677      -22.63453
 16  7        -.00000        .12850        .00000        .12850       -.00000      -90.00000
 16  8        -.44491        .00000       -.00000       -.44491        .00000        0.00000
 16  9        -.23864       -.00000       -.00000       -.23864       -.00000        0.00000
 16 10        -.00000       -.11559       -.00000       -.11559       -.00000      -90.00000

 17  1        -.12187        .02727        .01644       -.12366        .02906       -6.21697
 17  2        -.10334        .01142        .00973       -.10415        .01224       -4.81097
 17  3        -.06931       -.00427        .00114       -.06933       -.00425       -1.00295
 17  4        -.03364       -.02081       -.00802       -.03749       -.01696       25.68709
 17  5        -.00977       -.03190       -.01415       -.00288       -.03880      -25.98652
 17  6         .00334       -.03438       -.01634        .00943       -.04047      -20.45435
 17  7        -.00000        .11274        .00000        .11274       -.00000      -90.00000
 17  8        -.44491        .00000        .00000       -.44491        .00000        0.00000
 17  9        -.23864       -.00000       -.00000       -.23864       -.00000        0.00000
 17 10        -.00000       -.14363       -.00000       -.14363       -.00000      -90.00000

 18  1        -.11146        .01498        .01648       -.11355        .01709       -7.30860
 18  2        -.09058        .00723        .00924       -.09144        .00810       -5.34725
 18  3        -.06582       -.00116        .00118       -.06584       -.00114       -1.04933
 18  4        -.04032       -.00999       -.00739       -.04203       -.00828       12.98964
 18  5        -.02321       -.01589       -.01313       -.03318       -.00592       37.20999
 18  6        -.01455       -.01887       -.01602       -.00054       -.03288      -41.15846
 18  7        -.00000        .11001        .00000        .11001       -.00000      -90.00000
 18  8        -.43290        .00000        .00000       -.43290        .00000        0.00000
 18  9        -.28839       -.00000       -.00000       -.28839       -.00000        0.00000
 18 10        -.00000       -.04075       -.00000       -.04075       -.00000      -90.00000
TOTAL STRESSES IN BEAM LAYERS (STRESS (KSI), ANG. (DEGRESS), + TEN., - COMP.)

  EL LAYER      SXX           SYY           SXY           S1            S2           THETA1

   1  1       -3.52504       0.00000       -.02851      -3.52527        .00023         .46329
   1  2       -3.36814       0.00000       -.06146      -3.36926        .00112        1.04505
   1  3       -2.65530       0.00000      -1.68910      -3.47607        .82077       25.91619
   1  4       -1.38652       0.00000      -1.89081      -2.70715       1.32063       34.93232
   1  5        -.11774       0.00000      -1.99801      -2.05775       1.94000       44.15613
   1  6        1.15104       0.00000      -2.01071       2.66697      -1.51593      -37.01374
   1  7        2.41981       0.00000      -1.92890       3.48687      -1.06705      -28.95099
   1  8        3.68959       0.00000      -1.75260       4.38951       -.69992      -21.76985
   1  9        4.40143       0.00000       -.08156       4.40294       -.00151       -1.06122
   1 10        4.55834       0.00000       -.04150       4.55871       -.00038        -.52163
   1 11         .00047       0.00000       -.00001        .00047       -.00000        -.66383
   1 12         .00048       0.00000       -.00000        .00048       -.00000        -.32854

   2  1       -9.49956       0.00000       -.02344      -9.49962        .00006         .14163
   2  2       -9.08065       0.00000       -.05217      -9.08095        .00030         .32918
   2  3       -7.17745       0.00000      -1.44646      -7.45798        .28054       10.97610
   2  4       -3.78395       0.00000      -1.62241      -4.38961        .59965       20.28450
   2  5        -.40246       0.00000      -1.71661      -1.92959       1.52713       41.65696
   2  6        2.98503       0.00000      -1.72903       3.77662       -.79159      -24.59947
   2  7        6.37252       0.00000      -1.65968       6.77886       -.40634      -13.75723
   2  8        9.76001       0.00000      -1.50857       9.98787       -.22786       -8.58965
   2  9       11.66321       0.00000       -.07022      11.66363       -.00042        -.34492
   2 10       12.08213       0.00000       -.03573      12.08223       -.00011        -.16946
```

```
2 11       .00124     0.00000     -.00000       .00124     -.00000     -.21566
2 12       .00127     0.00000     -.00000       .00127     -.00000     -.10671

3  1    -13.92836     0.00000     -.01405    -13.92838      .00001      .05781
3  2    -13.31804     0.00000     -.03160    -13.31812      .00007      .13596
3  3    -10.54526     0.00000     -.88419    -10.61889      .07362     4.75975
3  4     -5.61002     0.00000    -1.00436     -5.78441      .17439     9.85020
3  5      -.67478     0.00000    -1.09286     -1.48114      .80636    36.42164
3  6      4.26046     0.00000    -1.14966      4.55089     -.29043   -14.17765
3  7      9.19570     0.00000    -1.17478      9.34341     -.14771    -7.16642
3  8     14.13094     0.00000    -1.16822     14.22687     -.09593    -4.69423
3  9     16.90372     0.00000     -.06219     16.90395     -.00023     -.21081
3 10     17.51404     0.00000     -.05526     17.51472     -.00017     -.18073
3 11       .00180     0.00000     -.06027       .06118     -.05938   -44.57197
3 12       .00184     0.00000     -.03049       .03143     -.02959   -44.13619

4  1    -15.67826     0.00000     -.00842    -15.67826      .00000      .03076
4  2    -15.08214     0.00000     -.01829    -15.08216      .00002      .06949
4  3    -12.37387     0.00000     -.50939    -12.39481      .02093     2.35338
4  4     -7.55347     0.00000     -.58351     -7.59828      .04481     4.39140
4  5     -2.73306     0.00000     -.64926     -2.87945      .14640    12.70660
4  6      2.08735     0.00000     -.70665      2.30408     -.21673   -17.05060
4  7      6.90776     0.00000     -.75569      6.98946     -.08170    -6.17072
4  8     11.72817     0.00000     -.79636     11.78200     -.05383    -3.86680
4  9     14.43643     0.00000     -.04561     14.43658     -.00014     -.18102
4 10     15.03255     0.00000     -.04903     15.03271     -.00016     -.18686
4 11     15.51924     0.00000     -.06590     15.51852     -.00028     -.24329
4 12     15.89349     0.00000     -.03334     15.89356     -.00007     -.12020

5  1    -16.73649     0.00000     -.00543    -16.73649      .00000      .01858
5  2    -16.10048     0.00000     -.01186    -16.10049      .00001      .04221
5  3    -13.21097     0.00000     -.32795    -13.21911      .00814     1.42113
5  4     -8.06797     0.00000     -.36903     -8.08481      .01684     2.61342
5  5     -2.92497     0.00000     -.39415     -2.97715      .05218     7.54169
5  6      2.21803     0.00000     -.40332      2.28910     -.07106    -9.99256
5  7      7.36103     0.00000     -.39654      7.38233     -.02130    -3.07464
5  8     12.50404     0.00000     -.37379     12.51520     -.01116    -1.71075
5  9     15.39354     0.00000     -.01844     15.39356     -.00002     -.06865
5 10     16.02955     0.00000     -.01255     16.02956     -.00001     -.04486
5 11     16.54774     0.00000     -.00808     16.54775     -.00000     -.02796
5 12     16.94811     0.00000     -.00409     16.94811     -.00000     -.01381

6  1    -17.06337     0.00000     -.00184    -17.06337      .00000      .00617
6  2    -16.41478     0.00000     -.00373    -16.41478      .00000      .01302
6  3    -13.46810     0.00000     -.10093    -13.46886      .00075      .42890
6  4     -8.22335     0.00000     -.11287     -8.22490      .00155      .78621
6  5     -2.97860     0.00000     -.12015     -2.98344      .00484     2.30611
6  6      2.26615     0.00000     -.12266      2.27277     -.00662    -3.08916
6  7      7.51091     0.00000     -.12040      7.51283     -.00193     -.91817
6  8     12.75566     0.00000     -.11339     12.75667     -.00101     -.50925
6  9     15.70233     0.00000     -.00559     15.70233     -.00000     -.02041
6 10     16.35093     0.00000     -.00380     16.35093     -.00000     -.01333
6 11     16.87937     0.00000     -.00245     16.87937     -.00000     -.00831
6 12     17.28766     0.00000     -.00124     17.28766     -.00000     -.00410

7  1     -3.34393     0.00000     -.00677     -3.34395      .00001      .11595
7  2     -3.21217     0.00000     -.03789     -3.21261      .00045      .67569
7  3     -2.61353     0.00000    -1.23110     -3.10211      .48857    21.64613
7  4     -1.54803     0.00000    -1.42684     -2.39727      .84924    30.76073
7  5      -.48253     0.00000    -1.54100     -1.80104     1.31950    40.55086
7  6       .58297     0.00000    -1.57358      1.89184    -1.30887   -39.75286
7  7      1.64847     0.00000    -1.52460      2.55737     -.90890   -30.80163
7  8      2.71397     0.00000    -1.39404      3.30243     -.58846   -22.88583
7  9      3.31260     0.00000     -.06505      3.31388     -.00128    -1.12460
7 10      3.44437     0.00000     -.03315      3.44469     -.00032     -.55140
7 11       .00036     0.00000     -.00000       .00036     -.00000     -.70172
7 12       .00036     0.00000     -.00000       .00036     -.00000     -.34680

8  1     -8.98596     0.00000     -.00786     -8.98597      .00001      .05013
8  2     -8.62803     0.00000     -.03485     -8.62817      .00014      .23142
8  3     -7.00188     0.00000    -1.10362     -7.17171      .16983     8.74838
8  4     -4.10751     0.00000    -1.27284     -4.46996      .36245    15.89460
8  5     -1.21314     0.00000    -1.37057     -2.10536      .89222    33.06368
8  6      1.68123     0.00000    -1.39679      2.47085     -.78962   -29.47981
8  7      4.57560     0.00000    -1.35151      4.94498     -.36938   -15.28618
8  8      7.46397     0.00000    -1.23474      7.66877     -.19880    -9.14660
8  9      9.09612     0.00000     -.05760      9.09649     -.00036     -.36279
8 10      9.45405     0.00000     -.02935      9.45415     -.00009     -.17786
8 11       .00097     0.00000     -.00000       .00097     -.00000     -.22634
8 12       .00100     0.00000     -.00000       .00100     -.00000     -.11186

9  1    -13.12950     0.00000     -.00693    -13.12950      .00000      .03022
9  2    -12.60126     0.00000     -.02329    -12.60130      .00004      .10590
9  3    -10.20138     0.00000     -.71231    -10.25048      .04950     3.97498
9  4     -5.92286     0.00000     -.82448     -6.04236      .11250     7.76998
```

FEL 435.2

```
 9  5     -1.65136      0.00000     -.97721     -2.05632      .33387     23.70561
 9  6      2.71317      0.00000     -.90651      2.52824     -.31506    -13.16074
 9  7      6.88463      0.00000     -.98438      7.02267     -.13798     -7.37727
 9  8     11.15521      0.00000     -.77882     11.24144     -.08523     -4.97636
 9  9     13.55509      0.00000     -.05135     13.55629     -.00020      -.21957
 9 10     14.08433      0.00000     -.04554     14.08447     -.00015      -.19541
 9 11       .00145      0.00000     -.04842       .04955     -.34810    -44.57417
 9 12       .00148      0.00000     -.02473       .02548     -.02399    -44.14013

10  1    -14.74937      0.00000     -.00396    -14.74937      .00000       .01537
10  2    -14.22757      0.00000     -.01307    -14.22758      .00001       .05265
10  3    -11.85693      0.00000     -.40080    -11.87046      .01353      1.93381
10  4     -7.63745      0.00000     -.46869     -7.66611      .02866      3.49862
10  5     -3.41798      0.00000     -.52810     -3.49771      .07973      8.59586
10  6       .80150      0.00000     -.57900      1.10491     -.30341    -27.65572
10  7      5.02098      0.00000     -.62142      5.09674     -.07577     -6.95143
10  8      9.24045      0.00000     -.65533      9.28670     -.04624     -4.03649
10  9     11.61109      0.00000     -.03747     11.61121     -.00012      -.18489
10 10     12.13290      0.00000     -.04002     12.13303     -.00013      -.18900
10 11     12.55803      0.00000     -.05347     12.55826     -.00023      -.24395
10 12     12.88651      0.00000     -.02708     12.88657     -.00006      -.12040

11  1    -15.72343      0.00000     -.00190    -15.72343      .00000       .00691
11  2    -15.16578      0.00000     -.00808    -15.16678      .00000       .03053
11  3    -12.63779      0.00000     -.25522    -12.64294      .00515      1.15646
11  4     -8.13646      0.00000     -.29539     -8.14717      .01071      2.07644
11  5     -3.63514      0.00000     -.32118     -3.66330      .02816      5.01063
11  6       .86619      0.00000     -.33260       .97916     -.11298    -18.76161
11  7      5.36750      0.00000     -.32964      5.39767     -.02017     -3.50126
11  8      9.86992      0.00000     -.31231      9.87870     -.00987     -1.81078
11  9     12.39781      0.00000     -.01544     12.39783     -.00002      -.07138
11 10     12.95447      0.00000     -.01052     12.95448     -.00001      -.04655
11 11     13.40801      0.00000     -.00678     13.40801     -.00000      -.02899
11 12     13.75842      0.00000     -.00344     13.75842     -.00000      -.01431

12  1    -16.07000      0.00000     -.00039    -16.07000      .00000       .00138
12  2    -15.50120      0.00000     -.00239    -15.50120      .00000       .00884
12  3    -12.91706      0.00000     -.07866    -12.91754      .00049       .34891
12  4     -8.31757      0.00000     -.09174     -8.31858      .00101       .63187
12  5     -3.71808      0.00000     -.10023     -3.72078      .00270      1.54299
12  6       .88141      0.00000     -.10411       .89354     -.01213     -6.64576
12  7      5.48090      0.00000     -.10340      5.48285     -.00195     -1.08036
12  8     10.08039      0.00000     -.09809     10.08134     -.00095      -.55744
12  9     12.66453      0.00000     -.00495     12.66453     -.00000      -.02196
12 10     13.23333      0.00000     -.00331     13.23333     -.00000      -.01433
12 11     13.69676      0.00000     -.00213     13.69676     -.00000      -.00892
12 12     14.05481      0.00000     -.00108     14.05481     -.00000      -.00441
```

```
      SOLUTION FOR LIVE LOAD ON THE STRUCTURE


    SCALING PROCEDURE
     NUMBER OF TRIALS      =     0
     NUMBER OF ITERATIONS  =     1


     PCTC OR PCTT LIMITS EXCEEDED IN PSCALE

     ELEMENT     6  LAYER     1   ALLOWABLE STRESS CHANGE OF     .635650576E-02  HAS BEEN EXCEEDED


    FIND THE FORCE INCREMENT

     REFERENCE DISPLACEMENT =    .23632E+01 NODE=   41 W DISP
     REFERENCE FORCE        =    .60332E-02 NODE=    8 W FORCE

      SLAB - NEWLY CRACKED, CRUSHED OR YIELDED LAYERS
    ELEMENT  LAYER    ANGLE

      NEW BEAM LAYER FAILURES
    ELEMENT  LAYER  TYPE OF FAILURE


      APPLIED NODAL POINT FORCES IN KIPS AND IN-KIPS

      NODE           U            V            W            XX           YY           ZZ
         1       0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
         2       0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
         3       0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
         4       0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
         5       0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
         6       0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
         7       0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
         8       0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
         9       0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
        10       0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
        11       0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
        12       0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
        13       0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
        14       0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
        15       0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
        16       0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
        17       0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
        18       0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
        19       0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
        20       0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
        21       0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
        22       0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
        23       0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
        24       0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
        25       0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
        26       0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
        27       0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
        28       0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
        29       0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
        30       0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
        31       0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
        32       0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
        33       0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
        34       0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
        35       0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
        36       0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
        37       0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
        38       0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
        39       0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
```

```
    40         0.00000         0.00000         0.00000         0.00000         0.00000         0.00000
    41         0.00000         0.00000         0.00000         0.00000         0.00000         0.00000
    42         0.00000         0.00000         0.00000         0.00000         0.00000         0.00000


      NODAL POINT DISPLACEMENTS IN INCHES AND RADIANS

      NODE          U               V               W               XX              YY              ZZ

         1         0.00000         0.00000         0.00000         0.00000         0.00000         0.00000
         2         0.00000         0.00000         0.00000         0.00000         0.00000         0.00000
         3         0.00000         0.00000         0.00000         0.00000         0.00000         0.00000
         4         0.00000         0.00000         0.00000         0.00000         0.00000         0.00000
         5         0.00000         0.00000         0.00000         0.00000         0.00000         0.00000
         6         0.00000         0.00000         0.00000         0.00000         0.00000         0.00000
         7         0.00000         0.00000         0.00000         0.00000         0.00000         0.00000
         8         0.00000         0.00000         0.00000         0.00000         0.00000         0.00000
         9         0.00000         0.00000         0.00000         0.00000         0.00000         0.00000
        10         0.00000         0.00000         0.00000         0.00000         0.00000         0.00000
        11         0.00000         0.00000         0.00000         0.00000         0.00000         0.00000
        12         0.00000         0.00000         0.00000         0.00000         0.00000         0.00000
        13         0.00000         0.00000         0.00000         0.00000         0.00000         0.00000
        14         0.00000         0.00000         0.00000         0.00000         0.00000         0.00000
        15         0.00000         0.00000         0.00000         0.00000         0.00000         0.00000
        16         0.00000         0.00000         0.00000         0.00000         0.00000         0.00000
        17         0.00000         0.00000         0.00000         0.00000         0.00000         0.00000
        18         0.00000         0.00000         0.00000         0.00000         0.00000         0.00000
        19         0.00000         0.00000         0.00000         0.00000         0.00000         0.00000
        20         0.00000         0.00000         0.00000         0.00000         0.00000         0.00000
        21         0.00000         0.00000         0.00000         0.00000         0.00000         0.00000
        22         0.00000         0.00000         0.00000         0.00000         0.00000         0.00000
        23         0.00000         0.00000         0.00000         0.00000         0.00000         0.00000
        24         0.00000         0.00000         0.00000         0.00000         0.00000         0.00000
        25         0.00000         0.00000         0.00000         0.00000         0.00000         0.00000
        26         0.00000         0.00000         0.00000         0.00000         0.00000         0.00000
        27         0.00000         0.00000         0.00000         0.00000         0.00000         0.00000
        28         0.00000         0.00000         0.00000         0.00000         0.00000         0.00000
        29         0.00000         0.00000         0.00000         0.00000         0.00000         0.00000
        30         0.00000         0.00000         0.00000         0.00000         0.00000         0.00000
        31         0.00000         0.00000         0.00000         0.00000         0.00000         0.00000
        32         0.00000         0.00000         0.00000         0.00000         0.00000         0.00000
        33         0.00000         0.00000         0.00000         0.00000         0.00000         0.00000
        34         0.00000         0.00000         0.00000         0.00000         0.00000         0.00000
        35         0.00000         0.00000         0.00000         0.00000         0.00000         0.00000
        36         0.00000         0.00000         0.00000         0.00000         0.00000         0.00000
        37         0.00000         0.00000         0.00000         0.00000         0.00000         0.00000
        38         0.00000         0.00000         0.00000         0.00000         0.00000         0.00000
        39         0.00000         0.00000         0.00000         0.00000         0.00000         0.00000
        40         0.00000         0.00000         0.00000         0.00000         0.00000         0.00000
        41         0.00000         0.00000         0.00000         0.00000         0.00000         0.00000
        42         0.00000         0.00000         0.00000         0.00000         0.00000         0.00000


               DISPLACEMENT/REFERENCE DISPLACEMENT =    0.00000

               FORCE/REFERENCE FORCE               =    0.00000

               SUM OF NODAL POINT W-LOADS          =     0.0000

               SUM OF W-LOADS FOR TOTAL STRUCTURE  =     0.0000

               (SUM OF W-LOADS FOR TOTAL STRUCTURE
                    WITHOUT IMPACT FACTOR)         =     0.0000


     INTERNAL MOMENTS (IN-KIPS/IN) AND NORMAL FORCES (KIPS/IN) IN THE SLAB

   EL              MY               MX               MXY              NX               NY               NXY
    1             -.24            -2.30             -.90             -.14             -.09             -.03
    2             -.26            -2.35             -.85             -.14             -.08              .12
    3             -.03             -.82            -1.22             -.07             -.01              .03
    4              .80              .03             -.66             -.29              .02             -.04
    5              .10             -.47            -1.03             -.22              .02              .03
    6              .08              .00            -1.05             -.20             -.01              .01
    7              .61              .06             -.67             -.39             -.00             -.02
    8              .50             -.25             -.74             -.38             -.01              .06
    9              .19              .01             -.75             -.34             -.01             -.00
```

```
          10              .73            .06           -.47           -.42           .31           -.01
          11              .46           -.24           -.45           -.45          -.00            .03
          12              .21            .00           -.46           -.41          -.00            .00
          13              .51           -.24           -.24           -.47          -.01           -.01
          14              .50           -.26           -.27           -.47          -.00            .03
          15              .34           -.13           -.25           -.46          -.01            .01
          16              .48           -.24           -.13           -.42          -.00           -.00
          17              .48           -.26           -.13           -.45          -.02            .01
          18              .36           -.14           -.13           -.45          -.00            .01


       INTERNAL MOMENTS (IN-KIPS), NORMAL FORCES (KIPS), AND SHEAR FORCES (KIPS) IN BEAM ELEMENTS
      ELEM          MB                 NB                VB

          1      438.5511            9.0526          -13.7338
          2     1170.8807           22.6257          -11.7957
          3     1705.8579           31.4142           -8.1155
          4     2051.3997           35.5717           -5.1258
          5     2188.4631           37.7708           -2.7902
          6     2231.8642           38.6034            -.8511
          7      184.1439             .4404           -5.2674
          8      500.2159            2.0515           -4.6883
          9      739.2201            4.1839           -3.3533
         10      885.2538            5.2382           -2.0785
         11      944.5221            5.7003           -1.1331
         12      965.0758            5.7878            -.3533
TOTAL STRESSES IN SLAB LAYERS (STRESS (KSI), ANG. (DEGRESS), + TEN., - COMP.)

   EL LAYER       SXX           SYY           SXY           S1            S2          THETA1

    1  1        .00797        .25687        .09722      -.02550        .29034      -18.99770
    1  2       -.00577        .13141        .04498      -.01920        .14484      -16.62769
    1  3       -.02180       -.00558       -.01181      -.02802        .00063       27.76280
    1  4       -.03752       -.15369       -.07377      -.00171       -.18950      -25.89131
    1  5       -.04800       -.25428       -.11608       .00414       -.30642      -24.18841
    1  6       -.05321       -.30626       -.13808       .00755       -.36702      -23.75047
    1  7       -.00000        .27809        .00000       .27809       -.00000      -90.00000
    1  8       -.13306       -.00000       -.00000      -.13306       -.00000        0.00000
    1  9       -.05941       -.00000       -.00000      -.05941       -.00000        0.00000
    1 10       -.00000      -1.28931       -.00000     -1.28931       -.00000      -90.00000

    2  1        .01005        .26303        .12103      -.03853        .31160      -21.86786
    2  2       -.00414        .13490        .07132      -.03422        .16497      -22.86591
    2  3       -.02173       -.00556        .01789      -.03327        .00598      -32.83978
    2  4       -.03831       -.15745       -.04104      -.02554       -.17022      -17.28173
    2  5       -.04937       -.25916       -.08055      -.02201       -.28652      -18.76040
    2  6       -.05496       -.31064       -.10055      -.02015       -.34544      -19.09325
    2  7       -.00000        .28411        .00000       .28411       -.00000      -90.00000
    2  8       -.13306       -.00000        .00000      -.13306       -.00000        0.00000
    2  9       -.05941       -.00000       -.00000      -.05941       -.00000        0.00000
    2 10       -.00000      -1.31721       -.00000     -1.31721       -.00000      -90.00000

    3  1       -.00500        .10638        .15254      -.11170        .21308      -34.97118
    3  2       -.00959        .05395        .08050      -.06436        .10872      -34.23174
    3  3       -.01550       -.00360        .00234      -.01595       -.00316      -10.72361
    3  4       -.01248       -.05613       -.08062       .04922       -.11783      -37.42447
    3  5       -.01075       -.09137       -.13631       .09109       -.19320      -36.76278
    3  6       -.00987       -.10921       -.16451       .11230       -.23139      -36.59962
    3  7       -.00000        .11380        .00000       .11380       -.00000      -90.00000
    3  8       -.09516       -.00000       -.00000      -.09515       -.00000        0.00000
    3  9       -.04239       -.00000       -.00000      -.04239       -.00000        0.00000
    3 10       -.00000       -.52762       -.00000      -.52762       -.00000      -90.00000

    4  1       -.14039       -.00821        .07427      -.17372        .02511      -24.16737
    4  2       -.09536       -.00433        .03528      -.10744        .00775      -18.89172
    4  3       -.04427        .00061       -.00745      -.04547        .00182        9.18046
    4  4        .01164        .00912       -.05153       .06143       -.04168      -44.07152
    4  5        .04785        .01264       -.08165       .11377       -.05328      -38.91576
    4  6        .06624        .01492       -.09689       .14081       -.05965      -37.58312
    4  7       -.00000        .07521        .00000       .07521       -.00000      -90.00000
    4  8       -.27040        .00000       -.00000      -.27040        .00000        0.00000
    4  9        .00847        .00000       -.00000       .00847        .00000        0.00000
    4 10        .00000        .01704       -.00000       .01704        .00000      -90.00000

    5  1       -.04335        .06081        .13944      -.14011        .15758      -34.75993
    5  2       -.03947        .03241        .07877      -.09011        .09305      -32.73681
    5  3       -.03811        .00051        .01368      -.04246        .00487      -17.66124
    5  4       -.02562       -.02622       -.05714       .03122       -.08307      -44.84829
    5  5       -.01805       -.04368       -.10462       .07454       -.13627      -41.50819
    5  6       -.01419       -.05253       -.12866       .09673       -.16344      -40.76210
    5  7       -.00000        .11984        .00000       .11984       -.00000      -90.00000
    5  8       -.25205        .00000        .00000      -.25205        .00000        0.00000
```

```
 5  9     -.17653     -.00000     -.00000     -.17653     -.00000      0.00000
 5 10     -.00000     -.23299     -.00000     -.23299     -.00000    -90.00000

 6  1     -.03702      .00122      .12472     -.14902      .11322    -40.80838
 6  2     -.03452     -.00157      .06821     -.08922      .05213    -33.21091
 6  3     -.03361     -.00507      .00150     -.03373     -.00496     -3.58961
 6  4     -.02226     -.00090     -.07047     -.08286      .05970     40.69142
 6  5     -.01568      .00167     -.11922     -.12654      .11253     42.91909
 6  6     -.01233      .00297     -.14390     -.14878      .13942     43.47886
 6  7     -.00000      .01333      .00000      .01333     -.00000    -90.00000
 6  8     -.21960      .00000     -.00000     -.21960      .00000      0.00000
 6  9     -.18467      .00000     -.00000     -.18467      .00000      0.00000
 6 10     -.00000      .00261     -.00000      .00261     -.00000    -90.00000

 7  1     -.13161     -.00656      .07819     -.16920      .03103    -25.67578
 7  2     -.09960     -.00514      .03963     -.11403      .00929    -19.99810
 7  3     -.05936     -.00247     -.00431     -.05969     -.00215      4.30826
 7  4     -.01438      .00303     -.04919     -.05562      .04428     39.98064
 7  5      .01386      .00621     -.07996      .09009     -.07002    -43.62934
 7  6      .02826      .00780     -.09554      .11412     -.07806    -41.94375
 7  7     -.00000      .07521      .00000      .07521     -.00000    -90.00000
 7  8     -.37782      .00000     -.00000     -.37782      .00000      0.00000
 7  9     -.15971      .00000     -.00000     -.15971      .00000      0.00000
 7 10     -.00000      .01704     -.00000      .01704     -.00000    -90.00000

 8  1     -.11545      .03040      .09956     -.16594      .08088    -26.88788
 8  2     -.08756      .01421      .05614     -.11245      .03910    -23.90568
 8  3     -.06172     -.00449      .00979     -.06335     -.00286     -9.44087
 8  4     -.02140     -.01821     -.04140     -.06124      .02162     43.89542
 8  5      .00414     -.02731     -.07616      .06618     -.08935    -39.16589
 8  6      .01718     -.03195     -.09375      .08953     -.10431    -37.65850
 8  7     -.00000      .10186      .00000      .10186     -.00000    -90.00000
 8  8     -.39171      .00000      .00000     -.39171      .00000      0.00000
 8  9     -.17759     -.00000     -.00000     -.17759     -.00000      0.00000
 8 10     -.00000     -.16018     -.00000     -.16018     -.00000    -90.00000

 9  1     -.07280     -.00009      .09058     -.13405      .06116    -34.06465
 9  2     -.06277     -.00208      .04679     -.08820      .02334    -28.51714
 9  3     -.05542     -.00466     -.00029     -.05542     -.00466       .32690
 9  4     -.03614     -.00136     -.05162     -.07322      .03572     35.69283
 9  5     -.02524      .00052     -.08657     -.09988      .07516     40.76855
 9  6     -.01966      .00146     -.10427     -.11390      .09571     42.10896
 9  7     -.00000      .04925      .00000      .04925     -.00000    -90.00000
 9  8     -.36466      .00000     -.00000     -.36466      .00000      0.00000
 9  9     -.28722      .00000     -.00000     -.28722      .00000      0.00000
 9 10     -.00000      .02109     -.00000      .02109     -.00000    -90.00000

10  1     -.15410     -.00688      .05659     -.17334      .01236    -18.77667
10  2     -.10879     -.00401      .02755     -.11560      .00280    -13.86930
10  3     -.06274     -.00089     -.00268     -.06285     -.00077      2.47200
10  4     -.01117      .00426     -.03394     -.03826      .03135     38.59555
10  5      .02152      .00723     -.05558      .07041     -.04166    -41.33683
10  6      .03823      .00871     -.06653      .09161     -.04468    -39.74545
10  7     -.00000      .09272      .00000      .09272     -.00000    -90.00000
10  8     -.39850      .00000     -.00000     -.39850      .00000      0.00000
10  9     -.14105      .00000     -.00000     -.14105      .00000      0.00000
10 10      .00000      .02360     -.00000      .02360      .00000    -90.00000

11  1     -.11792      .02848      .05985     -.13927      .04983    -19.63455
11  2     -.09087      .01416      .03354     -.10067      .02395    -16.28317
11  3     -.06647     -.00243      .00545     -.06693     -.00197     -4.83162
11  4     -.03151     -.01806     -.02721     -.05281      .00325     38.06132
11  5     -.00494     -.02466     -.04658      .03281     -.06241    -39.02318
11  6      .00714     -.02918     -.05733      .04912     -.07116    -36.21334
11  7     -.00000      .11921      .00000      .11921     -.00000    -90.00000
11  8     -.42854      .00000      .00000     -.42854      .00000      0.00000
11  9     -.22573     -.00000     -.00000     -.22573     -.00000      0.00000
11 10     -.00000     -.12483     -.00000     -.12483     -.00000    -90.00000

12  1     -.08383      .00359      .05543     -.11130      .02805    -26.35595
12  2     -.07958     -.00293      .03091     -.09049      .00799    -19.44504
12  3     -.06405     -.00323     -.00007     -.06405     -.00323       .06587
12  4     -.04401     -.00150     -.03140     -.06067      .01516     27.95400
12  5     -.03332     -.00063     -.05288     -.07232      .03837     35.41133
12  6     -.02779     -.00019     -.06379     -.07926      .05127     38.89708
12  7     -.00000      .07248      .00000      .07248     -.00000    -90.00000
12  8     -.42516      .00000     -.00000     -.42516      .00000      0.00000
12  9     -.34163      .00000     -.00000     -.34163      .00000      0.00000
12 10     -.00000      .03596     -.00000      .03596     -.00000    -90.00000

13  1     -.12762      .02790      .02737     -.13229      .03258     -9.69670
13  2     -.10772      .01251      .01454     -.10945      .01424     -5.79963
13  3     -.07199     -.00247     -.00144     -.07202     -.00244      1.18680
13  4     -.03429     -.01820     -.01857     -.04649     -.00601     33.28305
13  5     -.00715     -.02582     -.02250      .01351     -.04649    -39.93286
```

```
 13  6      .00544      -.03058      -.03426      .02621      -.05125     -31.16208
 13  7     -.00000       .12796       .00000      .12796      -.00000     -90.00000
 13  8     -.46468       .00000      -.00000     -.46468       .00000       0.00000
 13  9     -.24842      -.00000      -.00000     -.24842      -.00000       0.00000
 13 10     -.00000      -.12383      -.00000     -.12383      -.00000     -90.00000

 14  1     -.12709       .03041       .03566     -.13479       .03811     -12.18151
 14  2     -.10647       .01409       .02156     -.11021       .01783      -9.83922
 14  3     -.07183      -.00172       .00392     -.07205      -.00150      -3.19322
 14  4     -.03433      -.01834      -.01509     -.04341      -.00926      31.04376
 14  5     -.00740      -.02660      -.02634      .01103      -.04504     -34.98876
 14  6      .00527      -.03161      -.03271      .02438      -.05073     -30.29299
 14  7     -.00000       .13453       .00000      .13453      -.00000     -90.00000
 14  8     -.46468       .00000       .00000     -.46468       .00000       0.00000
 14  9     -.24842      -.00000      -.00000     -.24842      -.00000       0.00000
 14 10     -.00000      -.12648      -.00000     -.12648      -.00000     -90.00000

 15  1     -.10975       .01339       .03142     -.11730       .02094     -13.51921
 15  2     -.09142       .00601       .01690     -.09426       .00886      -9.56693
 15  3     -.06819      -.00196       .00050     -.06819      -.00195       -.43676
 15  4     -.04431      -.01032      -.01698     -.05134      -.00329      22.48476
 15  5     -.02837      -.01590      -.02881     -.05161       .00734      39.89645
 15  6     -.01763      -.01622      -.03289     -.04982       .01597      44.38655
 15  7     -.00000       .10622       .00000      .10622      -.00000     -90.00000
 15  8     -.44915       .00000      -.00000     -.44915       .00000       0.00000
 15  9     -.31387       .00000      -.00000     -.31387       .00000       0.00000
 15 10     -.00000      -.03597      -.00000     -.03597      -.00000     -90.00000

 16  1     -.12177       .02788       .01461     -.12318       .02929      -5.52407
 16  2     -.10270       .01308       .00801     -.10325       .01364      -3.93655
 16  3     -.06874      -.00153      -.00026     -.06874      -.00153        .22007
 16  4     -.03286      -.01691      -.00912     -.03699      -.01277      24.40513
 16  5     -.00883      -.02719      -.01503     -.00040      -.03562     -29.29335
 16  6      .00433      -.02963      -.01714      .01148      -.03677     -22.63453
 16  7     -.00000       .12850       .00000      .12850      -.00000     -90.00000
 16  8     -.44491       .00000      -.00000     -.44491       .00000       0.00000
 16  9     -.23864      -.00000      -.00000     -.23864      -.00000       0.00000
 16 10     -.00000      -.11559      -.00000     -.11559      -.00000     -90.00000

 17  1     -.12187       .02727       .01644     -.12366       .02906      -6.21697
 17  2     -.10334       .01142       .00973     -.10415       .01224      -4.81097
 17  3     -.06731      -.00427       .00114     -.06933      -.00425      -1.00295
 17  4     -.03364      -.02081      -.00802     -.03749      -.01696      25.68709
 17  5     -.00977      -.03190      -.01415     -.00288      -.03880     -25.98652
 17  6      .00334      -.03438      -.01634      .00943      -.04047     -20.45435
 17  7     -.00000       .11274       .00000      .11274      -.00000     -90.00000
 17  8     -.44491       .00000       .00000     -.44491       .00000       0.00000
 17  9     -.23864      -.00000      -.00000     -.23864      -.00000       0.00000
 17 10     -.00000      -.14363      -.00000     -.14363      -.00000     -90.00000

 18  1     -.11144       .01498       .01648     -.11355       .01709      -7.30860
 18  2     -.09058       .00723       .00924     -.09144       .00810      -5.34725
 18  3     -.06582      -.00116       .00118     -.06584      -.00114      -1.04933
 18  4     -.04032      -.00999      -.00739     -.04203      -.00828      12.98964
 18  5     -.02321      -.01589      -.01313     -.03318      -.00592      37.20999
 18  6     -.01455      -.01887      -.01602     -.00054      -.03288     -41.15846
 18  7     -.00000       .11001       .00000      .11001      -.00000     -90.00000
 18  8     -.43290       .00000       .00000     -.43290       .00000       0.00000
 18  9     -.28839      -.00000      -.00000     -.28839      -.00000       0.00000
 18 10     -.00000      -.04075      -.00000     -.04075      -.00000     -90.00000
TOTAL STRESSES IN BEAM LAYERS (STRESS (KSI), ANG. (DEGRESS), + TEN., - COMP.)

 EL LAYER     SXX          SYY          SXY          S1           S2          THETA1

  1  1     -3.52504      0.00000      -.02851    -3.52527       .00023        .46329
  1  2     -3.36814      0.00000      -.06146    -3.36926       .00112       1.04505
  1  3     -2.65530      0.00000     -1.66910    -3.47607       .82077      25.91619
  1  4     -1.38652      0.00000     -1.89081    -2.70715      1.32063      34.93232
  1  5      -.11774      0.00000     -1.99801    -2.05775      1.94000      44.15613
  1  6      1.15104      0.00000     -2.01071     2.66697     -1.51593     -37.01374
  1  7      2.41981      0.00000     -1.92890     3.48687     -1.06705     -28.95099
  1  8      3.68859      0.00000     -1.75260     4.38851      -.69992     -21.76985
  1  9      4.40143      0.00000      -.08156     4.40294      -.00151      -1.06122
  1 10      4.55834      0.00000      -.04150     4.55871      -.00038       -.52163
  1 11       .00047      0.00000      -.00001      .00047      -.00000       -.66383
  1 12       .00048      0.00000      -.00000      .00048      -.00000       -.32854

  2  1     -9.49956      0.00000      -.02348    -9.49962       .00006        .14163
  2  2     -9.08065      0.00000      -.05217    -9.08095       .00030        .32918
  2  3     -7.17745      0.00000     -1.44646    -7.45798       .28054      10.97610
  2  4     -3.78996      0.00000     -1.62241    -4.38961       .59965      20.28450
  2  5      -.40246      0.00000     -1.71661    -1.92959      1.52713      41.65695
  2  6      2.98503      0.00000     -1.72903     3.77662      -.79159     -24.59947
```

FEL 435.2

```
  2  7      6.37252      0.00000     -1.65968      6.77886      -.40634    -13.75723
  2  8      9.76001      0.00000     -1.50857      9.98786      -.22786     -8.58905
  2  9     11.66321      0.00000      -.07022     11.66363      -.00042      -.34492
  2 10     12.08213      0.00000      -.03573     12.08223      -.00011      -.16946
  2 11       .00124      0.00000      -.00000       .00124      -.00000      -.21566
  2 12       .00127      0.00000      -.00000       .00127      -.00000      -.10671

  3  1    -13.92836      0.00000      -.01405    -13.92838       .00001       .05781
  3  2    -13.31804      0.00000      -.03160    -13.31812       .00007       .13596
  3  3    -10.54526      0.00000      -.88418    -10.61889       .07362      4.75975
  3  4     -5.61002      0.00000     -1.00436     -5.78441       .17439      9.85020
  3  5      -.67478      0.00000     -1.09286     -1.48114       .80636     36.42164
  3  6      4.26046      0.00000     -1.14966      4.55089      -.29043    -14.17765
  3  7      9.19570      0.00000     -1.17478      9.34341      -.14771     -7.16642
  3  8     14.13094      0.00000     -1.16822     14.22687      -.09593     -4.69423
  3  9     16.90372      0.00000      -.06219     16.90395      -.00023      -.21081
  3 10     17.51404      0.00000      -.05526     17.51422      -.00017      -.18078
  3 11       .00180      0.00000      -.06027       .06118      -.05938    -44.57197
  3 12       .00184      0.00000      -.03049       .03143      -.02959    -44.13619

  4  1    -15.67826      0.00000      -.00842    -15.67826       .00000       .03076
  4  2    -15.08214      0.00000      -.01829    -15.08216       .00002       .06949
  4  3    -12.37387      0.00000      -.50939    -12.39481       .02093      2.35339
  4  4     -7.55347      0.00000      -.58351     -7.59828       .04481      4.39140
  4  5     -2.73306      0.00000      -.64926     -2.87945       .14640     12.70660
  4  6      2.08735      0.00000      -.70665      2.30408      -.21673    -17.05060
  4  7      6.90776      0.00000      -.75569      6.98946      -.08170     -6.17072
  4  8     11.72817      0.00000      -.79636     11.78200      -.05383     -3.86680
  4  9     14.43643      0.00000      -.04561     14.43658      -.00014      -.18102
  4 10     15.03255      0.00000      -.04903     15.03271      -.00016      -.18686
  4 11     15.51824      0.00000      -.06590     15.51852      -.00028      -.24329
  4 12     15.89349      0.00000      -.03334     15.89356      -.00007      -.12020

  5  1    -16.73649      0.00000      -.00543    -16.73649       .00000       .01858
  5  2    -16.10048      0.00000      -.01186    -16.10049       .00001       .04221
  5  3    -13.21097      0.00000      -.32795    -13.21911       .00814      1.42113
  5  4     -8.06797      0.00000      -.36903     -8.08481       .01684      2.61342
  5  5     -2.92497      0.00000      -.39415     -2.97715       .05218      7.54169
  5  6      2.21803      0.00000      -.40332      2.28910      -.07106     -9.99256
  5  7      7.36103      0.00000      -.39654      7.38233      -.02130     -3.07464
  5  8     12.50404      0.00000      -.37379     12.51520      -.01116     -1.71075
  5  9     15.39354      0.00000      -.01844     15.39356      -.00002      -.06865
  5 10     16.02955      0.00000      -.01255     16.02956      -.00001      -.04486
  5 11     16.54774      0.00000      -.00808     16.54775      -.00000      -.02796
  5 12     16.94811      0.00000      -.00409     16.94811      -.00000      -.01381

  6  1    -17.06337      0.00000      -.00184    -17.06337       .00000       .00617
  6  2    -16.41478      0.00000      -.00373    -16.41478       .00000       .01302
  6  3    -13.46810      0.00000      -.10083    -13.46886       .00075       .42890
  6  4     -8.22335      0.00000      -.11287     -8.22490       .00155       .78621
  6  5     -2.97860      0.00000      -.12015     -2.98344       .00484      2.30611
  6  6      2.26615      0.00000      -.12266      2.27277      -.00662     -3.08916
  6  7      7.51091      0.00000      -.12040      7.51283      -.00193      -.91817
  6  8     12.75566      0.00000      -.11339     12.75667      -.00101      -.50925
  6  9     15.70233      0.00000      -.00559     15.70233      -.00000      -.02041
  6 10     16.35093      0.00000      -.00380     16.35093      -.00000      -.01333
  6 11     16.87937      0.00000      -.00245     16.87937      -.00000      -.00831
  6 12     17.28766      0.00000      -.00124     17.28766      -.00000      -.00410

  7  1     -3.34393      0.00000      -.00677     -3.34395       .00001       .11595
  7  2     -3.21217      0.00000      -.03789     -3.21261       .00045       .67569
  7  3     -2.61353      0.00000     -1.23110     -3.10211       .48857     21.64613
  7  4     -1.54803      0.00000     -1.42684     -2.39727       .84924     30.76073
  7  5      -.48253      0.00000     -1.54100     -1.80104      1.31850     40.55086
  7  6       .58297      0.00000     -1.57358      1.89184     -1.30887    -39.75286
  7  7      1.64847      0.00000     -1.52460      2.55737      -.90890    -30.80163
  7  8      2.71397      0.00000     -1.39404      3.30243      -.58846    -22.88583
  7  9      3.31260      0.00000      -.06505      3.31388      -.00128     -1.12460
  7 10      3.44437      0.00000      -.03315      3.44469      -.00032      -.55140
  7 11       .00036      0.00000      -.00000       .00036      -.00000      -.70172
  7 12       .00036      0.00000      -.00000       .00036      -.00000      -.34680

  8  1     -8.98596      0.00000      -.00786     -8.98597       .00001       .05013
  8  2     -8.62803      0.00000      -.03485     -8.62817       .00014       .23142
  8  3     -7.00188      0.00000     -1.10362     -7.17171       .16983      8.74838
  8  4     -4.10751      0.00000     -1.27284     -4.46996       .36245     15.89460
  8  5     -1.21314      0.00000     -1.37057     -2.10536       .89222     33.06368
  8  6      1.68123      0.00000     -1.39679      2.47085      -.78962    -29.47981
  8  7      4.57560      0.00000     -1.35151      4.94498      -.36939    -15.28618
  8  8      7.46997      0.00000     -1.23474      7.66877      -.19880     -9.14660
  8  9      9.09612      0.00000      -.05760      9.09649      -.00036      -.36279
  8 10      9.45405      0.00000      -.02935      9.45415      -.00009      -.17786
  8 11       .00097      0.00000      -.00000       .00097      -.00000      -.22634
  8 12       .00100      0.00000      -.00000       .00100      -.00000      -.11186
```

```
  9  1    -13.12950    0.00000    -.00673   -13.12950    .00000     .03022
  9  2    -12.60126    0.00000    -.02329   -12.60130    .00004     .10590
  9  3    -10.20138    0.00000    -.71231   -10.25088    .04950    3.97498
  9  4     -5.92986    0.00000    -.82448    -6.04236    .11250    7.76998
  9  5     -1.65834    0.00000    -.90721    -2.05822    .39987   23.78661
  9  6      2.61317    0.00000    -.96051     2.97824   -.31506  -18.16034
  9  7      6.88469    0.00000    -.96438     7.02267   -.13798   -7.97927
  9  8     11.15621    0.00000    -.97882    11.24144   -.08523   -4.97636
  9  9     13.55609    0.00000    -.05195    13.55629   -.00020    -.21957
  9 10     14.08433    0.00000    -.04558    14.08447   -.00015    -.18541
  9 11       .00145    0.00000    -.04882      .04955   -.04810  -44.57417
  9 12       .00148    0.00000    -.02473      .02548   -.02399  -44.14013

 10  1    -14.74937    0.00000    -.00396   -14.74937    .00000     .01537
 10  2    -14.22757    0.00000    -.01307   -14.22758    .00001     .05265
 10  3    -11.85693    0.00000    -.40080   -11.87046    .01353    1.93381
 10  4     -7.63745    0.00000    -.46869    -7.66611    .02866    3.49862
 10  5     -3.41798    0.00000    -.52810    -3.49771    .07973    8.58586
 10  6       .80150    0.00000    -.57900     1.10491   -.30341  -27.65572
 10  7      5.02098    0.00000    -.62142     5.09674   -.07577   -6.95143
 10  8      9.24045    0.00000    -.65533     9.28670   -.04624   -4.03649
 10  9     11.61109    0.00000    -.03747    11.61121   -.00012    -.18489
 10 10     12.13290    0.00000    -.04002    12.13303   -.00013    -.18900
 10 11     12.55803    0.00000    -.05347    12.55826   -.00023    -.24395
 10 12     12.88651    0.00000    -.02708    12.88657   -.00006    -.12040

 11  1    -15.72343    0.00000    -.00190   -15.72343    .00000     .00691
 11  2    -15.16678    0.00000    -.00808   -15.16678    .00000     .03053
 11  3    -12.63779    0.00000    -.25522   -12.64294    .00515    1.15646
 11  4     -8.13646    0.00000    -.29539    -8.14717    .01071    2.07644
 11  5     -3.63514    0.00000    -.32118    -3.66330    .02816    5.01063
 11  6       .86618    0.00000    -.33260      .97916   -.11298  -18.76161
 11  7      5.36750    0.00000    -.32964     5.38767   -.02017   -3.50126
 11  8      9.86882    0.00000    -.31231     9.87870   -.00987   -1.81078
 11  9     12.39781    0.00000    -.01544    12.39783   -.00002    -.07138
 11 10     12.95447    0.00000    -.01052    12.95448   -.00001    -.04655
 11 11     13.40801    0.00000    -.00678    13.40801   -.00000    -.02899
 11 12     13.75842    0.00000    -.00344    13.75842   -.00000    -.01431

 12  1    -16.07000    0.00000    -.00039   -16.07000    .00000     .00138
 12  2    -15.50120    0.00000    -.00239   -15.50120    .00000     .00884
 12  3    -12.91706    0.00000    -.07866   -12.91754    .00048     .34891
 12  4     -8.31757    0.00000    -.09174    -8.31858    .00101     .63182
 12  5     -3.71808    0.00000    -.10023    -3.72078    .00270    1.54298
 12  6       .88141    0.00000    -.10411      .89354   -.01213   -6.64576
 12  7      5.48090    0.00000    -.10340     5.48285   -.00195   -1.08036
 12  8     10.08039    0.00000    -.09809    10.08134   -.00095    -.55744
 12  9     12.66453    0.00000    -.00485    12.66453   -.00000    -.02196
 12 10     13.23333    0.00000    -.00331    13.23333   -.00000    -.01433
 12 11     13.69676    0.00000    -.00213    13.69676   -.00000    -.00892
 12 12     14.05481    0.00000    -.00108    14.05481   -.00000    -.00441

     DIRECTION OF PRINCIPAL AXIS (DEG.) 1ST AND 2ND CRACK (ANG. = 999.0 IF NO CRACK)
   ELEMENT LAYER   PRINCIPAL        FIRST                   SECOND

     BEAM LAYER FAILURES
     ELEMENT  LAYER  TYPE OF FAILURE



PLOT SHOWING CRACK-CRUSH AREAS, STRESSES, NODE AND LAYER MARKERS FOR REFERENCE
(SEE USERS MANUAL FOR DETAILS)


BEAM NUMBER   1

  *                   **                   **                   **                **        **         *

* 222222222222222222222333333333333333333333444444444444444444444555555555555555555555555555555555555555 *
* 111111111111111111111333333333333333333333444444444444444444444555555555555555555555555555555555555555 *
* 111111111111111111111222222222222222222222333333333333333333333444444444444444444444444444444444444444 *
* 111111111111111111111111111111111111111111222222222222222222222222222222222222222333333333333333333333 *
* 111111111111111111111111111111111111111111111111111111111111111111111111111111111111111111111111111111 *
* AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAABBBBBBBBBBBBBBBBBBBBBAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA *
* AAAAAAAAAAAAAAAAAAAAABBBBBBBBBBBBBBBBBBBBBCCCCCCCCCCCCCCCCCCCCCBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBB *
* AAAAAAAAAAAAAAAAAAAAACCCCCCCCCCCCCCCCCCCCCDDDDDDDDDDDDDDDDDDDDDCCCCCCCCCCCCCCCCCCDDDDDDDDDDDDDDDDDDDDD *
* BBBBBBBBBBBBBBBBBBBBBDDDDDDDDDDDDDDDDDDDDDEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEE *
* BBBBBBBBBBBBBBBBBBBBBDDDDDDDDDDDDDDDDDDDDDFFEEEEEFFEFFEEEFFFFFFFFFFFFFEFFFFFEFFFEEEFFFFFFFFFFFFFEFEEEE *
* AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAFFFFFFFFFFFFFFFFFFFFEFEFFFFFEFFFFFEFEEE *
```

FEL 435.2

```
* AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEE *

  *                   **                   **                   **               **         **        *


BEAM NUMBER  2

  *                   **                   **                   **               **         **        *

* 11111111111111111111133333333333333333333344444444444444444444455555555555555555555555555555555555555 *
* 11111111111111111111133333333333333333333344444444444444444444455555555555555555555555555555555555555 *
* 111111111111111111111222222222222222222222333333333333333333333333333333333333333444444444444444444444 *
* 111111111111111111111222222222222222222222222222222222222222222222222222222222222333333333333333333333 *
* 11111111111111111111111111111111111111111111111111111111111111111111111111111111111111111111111111111 *
* AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA *
* AAAAAAAAAAAAAAAAAAAAABBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBB *
* AAAAAAAAAAAAAAAAAAAAABBBBBBBBBBBBBBBBBBBBBCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC *
* AAAAAAAAAAAAAAAAAAAAACCCCCCCCCCCCCCCCCCCCCDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDD *
* AAAAAAAAAAAAAAAAAAAAACCCCCCCCCCCCCCCCCCCCCEEEEEEEEEEEEEEEEEEEEEDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDD *
* AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAADDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDD *
* AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAADDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDD *


  *                   **                   **                   **               **         **        *



     SLAB PLOT

          NODE J                                                               NODE L

                 ELEMENT NUMBER                   Y = NUMBER OF YIELDED LAYERS

                 C = NUMBER OF CRUSHED LAYERS     T = NUMBER OF CRACKED LAYERS

          NODE I                                                               NODE K






5BBBBBBBBBBBBBBBBBB11BBBBBBBBBBBBBBBBB17BBBBBBBBBBBBBBBBB23BBBBBBBBBBBBB29BBBBBBBBBB35BBBBBBBBB41
*                  *                  *                  *              *           *           *
*                  *                  *                  *              *           *           *
*     3            *     6            *     9            *   12         *  15       *  18       *
*                  *                  *                  *              *           *           *
*                  *                  *                  *              *           *           *
*                  *                  *                  *              *           *           *
*                  *                  *                  *              *           *           *
*                  *                  *                  *              *           *           *
*                  *                  *                  *              *           *           *
4******************10*****************16*****************22*************28**********34*********40
*                  *                  *                  *              *           *           *
*                  *                  *                  *              *           *           *
*     2            *     5            *     8            *   11         *  14       *  17       *
*                  *                  *                  *              *           *           *
*                  *                  *                  *              *           *           *
*                  *                  *                  *              *           *           *
*                  *                  *                  *              *           *           *
*                  *                  *                  *              *           *           *
*                  *                  *                  *              *           *           *
2BBBBBBBBBBBBBBBBBB8BBBBBBBBBBBBBBBBBB14BBBBBBBBBBBBBBBBB20BBBBBBBBBBBBB26BBBBBBBBBB32BBBBBBBBB38
*                  *                  *                  *              *           *           *
*                  *                  *                  *              *           *           *
*                  *                  *                  *              *           *           *
*     1            *     4            *     7            *   10         *  13       *  16       *
*                  *                  *                  *              *           *           *
*                  *                  *                  *              *           *           *
*                  *                  *                  *              *           *           *
*                  *                  *                  *              *           *           *
*                  *                  *                  *              *           *           *
*                  *                  *                  *              *           *           *
*                  *                  *                  *              *           *           *
*                  *                  *                  *              *           *           *
1******************7******************13*****************19*************25**********31*********37


     LOAD CYCLE =        1

     ----LOAD RATIO AT START OF CYCLE     =   .400000000E+00
     ----PRESCAN FACTOR AT START OF CYCLE =   .100000000E+01
```

```
 NUMBER OF CASES      =     1
 NUMBER OF ITERATIONS =     1
 NUMBER OF TRIALS     =     1
 NUMBER OF ITERATIONS =     2
 NUMBER OF TRIALS     =     1
 NUMBER OF ITERATIONS =     3

        SLAB - NEWLY CRACKED, CRUSHED OR YIELDED LAYERS
 ELEMENT  LAYER    ANGLE

        NEW BEAM LAYER FAILURES.
 ELEMENT  LAYER  TYPE OF FAILURE


        APPLIED NODAL POINT FORCES IN KIPS AND IN-KIPS

        NODE           U            V            W            XX           YY           ZZ

          1         0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
          2         0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
          3         0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
          4         0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
          5         0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
          6         0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
          7         0.00000      0.00000      -.00073      -.00534      -.00331      0.00000
          8         0.00000      0.00000       .00241      -.01379      -.04131      0.00000
          9         0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
         10         0.00000      0.00000       .00242      0.00000      -.04958      0.00000
         11         0.00000      0.00000       .00121       .03337      -.02479      0.00000
         12         0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
         13         0.00000      0.00000       .06512      -.69542      -.98092      0.00000
         14         0.00000      0.00000      1.50941     -1.79650    -12.26150      0.00000
         15         0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
         16         0.00000      0.00000      1.74948      -.00000    -14.71380      0.00000
         17         0.00000      0.00000       .87474      4.34638     -7.35690      0.00000
         18         0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
         19         0.00000      0.00000       .09863     -1.06515       .35505      0.00000
         20         0.00000      0.00000      2.29797     -2.75165      4.43814      0.00000
         21         0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
         22         0.00000      0.00000      2.66288      -.00000      5.32577      0.00000
         23         0.00000      0.00000      1.33144      6.65721      2.66288      0.00000
         24         0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
         25         0.00000      0.00000       .07008      -.75682       .44148      0.00000
         26         0.00000      0.00000      1.63277     -1.95512      5.51848      0.00000
         27         0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
         28         0.00000      0.00000      1.89205      -.00000      6.62217      0.00000
         29         0.00000      0.00000       .94602      4.73012      3.31109      0.00000
         30         0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
         31         0.00000      0.00000       .05191      -.56061      0.00000      0.00000
         32         0.00000      0.00000      1.20946     -1.44824      0.00000      0.00000
         33         0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
         34         0.00000      0.00000      1.40152      -.00000      0.00000      0.00000
         35         0.00000      0.00000       .70076      3.50380      0.00000      0.00000
         36         0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
         37         0.00000      0.00000       .02595      -.28030       .23359      0.00000
         38         0.00000      0.00000       .60473      -.72412      2.91983      0.00000
         39         0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
         40         0.00000      0.00000       .70076      0.00000      3.50380      0.00000
         41         0.00000      0.00000       .35038      1.75190      1.75190      0.00000
         42         0.00000      0.00000      0.00000      0.00000      0.00000      0.00000


        NODAL POINT DISPLACEMENTS IN INCHES AND RADIANS

        NODE           U            V            W            XX           YY           ZZ

          1          .01323      0.00000      -.00354      -.00011      -.00463      0.00000
          2          .01416      0.00000      0.00000      -.00007      -.00479      0.00000
          3         -.04341      0.00000      0.00000      0.00000      -.00463      0.00000
          4          .01403      0.00000       .00086       .00001      -.00488      0.00000
          5          .01470      0.00000      0.00000       .00003      -.00513      0.00000
          6         -.04704      0.00000      0.00000      0.00000      -.00496      0.00000
          7          .01252       .00069       .28238      -.00027      -.00433      0.00000
          8          .01342       .00055       .29298      -.00031      -.00452      0.00000
          9         -.04085      0.00000      0.00000      0.00000      -.00436      0.00000
         10          .01324       .00042       .30277      -.00034      -.00461      0.00000
         11          .01397       .00028       .31371      -.00039      -.00484      0.00000
         12         -.04422      0.00000      0.00000      0.00000      -.00467      0.00000
```

FEL 435.2

```
     13          .01056        .00122        .53311       -.00047       -.00353       0.00000
     14          .01123        .00092        .55229       -.00060       -.00371       0.00000
     15         -.03316       0.00000       0.00000       0.00000       -.00356       0.00000
     16          .01095        .00066        .57123       -.00064       -.00382       0.00000
     17          .01145        .00040        .59096       -.00069       -.00397       0.00000
     18         -.03602       0.00000       0.00000       0.00000       -.00381       0.00000
     19          .00745        .00131        .71839       -.00064       -.00231       0.00000
     20          .00767        .00089        .74445       -.00082       -.00239       0.00000
     21         -.02085       0.00000       0.00000       0.00000       -.00227       0.00000
     22          .00747        .00055        .77017       -.00085       -.00245       0.00000
     23          .00763        .00021        .79584       -.00088       -.00254       0.00000
     24         -.02272       0.00000       0.00000       0.00000       -.00241       0.00000
     25          .00427        .00105        .80939       -.00074       -.00124       0.00000
     26          .00428        .00060        .83892       -.00091       -.00133       0.00000
     27         -.01171       0.00000       0.00000       0.00000       -.00128       0.00000
     28          .00413        .00022        .86751       -.00096       -.00134       0.00000
     29          .00419       -.00014        .89675       -.00099       -.00142       0.00000
     30         -.01279       0.00000       0.00000       0.00000       -.00136       0.00000
     31          .00230        .00077        .83805       -.00078       -.00065       0.00000
     32          .00214        .00033        .86885       -.00094       -.00067       0.00000
     33         -.00594       0.00000       0.00000       0.00000       -.00065       0.00000
     34          .00205        .00004        .89826       -.00099       -.00070       0.00000
     35          .00212       -.00032        .92804       -.00102       -.00071       0.00000
     36         -.00647       0.00000       0.00000       0.00000       -.00069       0.00000
     37         0.00000       0.00000        .84791       -.00079       0.00000       0.00000
     38         0.00000       0.00000        .87890       -.00095       0.00000       0.00000
     39         0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
     40         0.00000       0.00000        .90870       -.00100       0.00000       0.00000
     41         0.00000       0.00000        .93872       -.00103       0.00000       0.00000
     42         0.00000       0.00000       0.00000       0.00000       0.00000       0.00000


              DISPLACEMENT/REFFRENCE DISPLACEMENT =      .39722

              FORCE/REFERENCE FORCE               =      .40000

              SUM OF NODAL POINT W-LOADS          =    20.1819

              SUM OF W-LOADS FOR TOTAL STRUCTURE  =    80.7275

              (SUM OF W-LOADS FOR TOTAL STRUCTURE
                   WITHOUT IMPACT FACTOR)         =    62.7880


         INTERNAL MOMENTS (IN-KIPS/IN) AND NORMAL FORCES (KIPS/IN) IN THE SLAB
       EL              MY            MX              MXY             NX              NY              NXY
        1              .20         -1.94             -.50            -.48            -.14            -.27
        2              .18         -1.99             -.67            -.48            -.14             .27
        3             -.04          -.64             -.63            -.46            -.08            -.15
        4             2.40           .10             -.32           -1.19             .10            -.16
        5              .80          -.44             -.78           -1.30            -.05             .20
        6             1.41           .11             -.46           -1.34            -.08            -.21
        7             2.23           .08             -.31           -1.85            -.03            -.22
        8             2.51          -.21             -.45           -2.09            -.07             .16
        9             2.34           .15             -.37           -2.16            -.09            -.23
       10             2.53           .06             -.29           -2.26             .01            -.14
       11             2.66          -.35             -.27           -2.48            -.02             .04
       12             2.40           .12             -.22           -2.41            -.04            -.14
       13             2.85          -.41             -.04           -2.69            -.02            -.13
       14             2.86          -.34             -.24           -2.68            -.01            -.02
       15             2.30           .51             -.06           -2.52            -.01            -.09
       16             2.69          -.35             -.06           -2.62            -.02            -.08
       17             2.60          -.30             -.08           -2.60            -.14            -.09
       18             2.63           .52             -.07           -2.47            -.01            -.04


         INTERNAL MOMENTS (IN-KIPS), NORMAL FORCES (KIPS), AND SHEAR FORCES (KIPS) IN BEAM ELEMENTS
       ELEM          MB                     NB                  VB

        1         562.1019              30.3855            -24.2755
        2        1539.1032              86.7971            -21.8963
        3        2305.5974             134.0895            -16.5251
        4        2880.3243             158.1349            -10.7148
        5        3090.4473             169.6244             -5.7281
        6        3154.6379             174.0700             -1.7800
        7         251.2023              11.9243            -10.9340
        8         699.0676              36.5348            -10.1351
        9        1060.4051              59.6606             -7.8949
       10        1328.8200              71.6762             -5.1063
```

```
      11      1424.7041            77.5841              -2.7125
      12      1457.4026            79.4060              -.8349

OTAL STRESSES IN SLAB LAYERS (STRESS (KSI), ANG. (DEGRESS), + TEN., - COMP.)

   EL LAYER       SXX            SYY            SXY            S1             S2           THETA1

    1   1       -.09612         .20529         .01854        -.09725         .20642       -3.50595
    1   2       -.08303         .10043        -.01007        -.08358         .10098        3.13374
    1   3       -.07653        -.01626        -.04382        -.09957         .00679       27.73934
    1   4       -.05757        -.14020        -.07664        -.01182        -.19595      -30.83605
    1   5       -.04556        -.22479        -.09997        -.00092        -.26943      -24.06416
    1   6       -.03924        -.26812        -.11188         .00636        -.31372      -22.17537
    1   7       -.00000         .24495        -.00000         .24495        -.00000      -90.00000
    1   8       -.46639        -.00000        -.00000        -.46639        -.00000        0.00000
    1   9       -.24111        -.00000        -.00000        -.24111        -.00000        0.00000
    1  10       -.00000       -1.13570        -.00000       -1.13570        -.00000      -90.00000

    2   1       -.09432         .21228         .12216        -.13704         .25500      -19.27489
    2   2       -.08202         .10419         .08268        -.11343         .13560      -20.80296
    2   3       -.07548        -.01628         .04263        -.09857         .00581      -27.38556
    2   4       -.05824        -.14395        -.00483        -.05797        -.14423       -3.21790
    2   5       -.04688        -.22944        -.03596        -.04005        -.23627      -10.75110
    2   6       -.04102        -.27283        -.05188        -.02994        -.28391      -12.05662
    2   7       -.00000         .25101         .00000         .25101        -.00000      -90.00000
    2   8       -.46639        -.00000         .00000        -.46639        -.00000        0.00000
    2   9       -.24111        -.00000         .00000        -.24111        -.00000        0.00000
    2  10       -.00000       -1.16378        -.00000       -1.16378        -.00000      -90.00000

    3   1       -.06303         .06530         .05299        -.08208         .08435      -19.77617
    3   2       -.06413         .02809         .01546        -.06665         .03061       -9.27069
    3   3       -.07232        -.01485        -.02631        -.08255        -.00462       21.23858
    3   4       -.06987        -.05142        -.06719        -.12847         .00717       41.09149
    3   5       -.06751        -.07627        -.09520         .02242        -.16620      -43.66779
    3   6       -.06553        -.08964        -.10907         .03215        -.18732      -41.84629
    3   7       -.00000         .08407        -.00000         .08407        -.00000      -90.00000
    3   8       -.47038        -.00000        -.00000        -.47038        -.00000        0.00000
    3   9       -.42666        -.00000        -.00000        -.42666        -.00000        0.00000
    3  10       -.00000        -.38977        -.00000        -.38977        -.00000      -90.00000

    4   1       -.47004         .00063         .01446        -.47049         .00107       -1.75782
    4   2       -.33399         .00614        -.00541        -.33407         .00622         .91071
    4   3       -.18331         .01214        -.02653        -.18684         .01567        7.59392
    4   4       -.00980         .01903        -.04633        -.04391         .05314       36.35967
    4   5        .09738         .02281        -.06237         .13276        -.01257      -29.56539
    4   6        .15280         .02515        -.07031         .18393        -.00598      -23.88244
    4   7       -.00000         .37012        -.00000         .37012        -.00000      -90.00000
    4   8      -1.12531         .00000        -.00000       -1.12531         .00000        0.00000
    4   9       -.26287         .00000        -.00000        -.26287         .00000        0.00000
    4  10        .00000         .08321        -.00000         .08321         .00000      -90.00000

    5   1       -.28277         .04554         .12566        -.32535         .08811      -18.71638
    5   2       -.25625         .01684         .08042        -.27817         .03877      -15.24848
    5   3       -.19973        -.01321         .03166        -.20496        -.00798       -9.37420
    5   4       -.13293        -.03708        -.02236        -.13789        -.03211       12.50781
    5   5       -.08830        -.05256        -.05884        -.13193        -.00894       36.55399
    5   6       -.06847        -.06113        -.07485        -.13974         .01014       43.59797
    5   7       -.00000         .26332         .00000         .26332        -.00000      -90.00000
    5   8      -1.30469         .00000         .00000       -1.30469         .00000        0.00000
    5   9       -.94382        -.00000        -.00000        -.94382        -.00000        0.00000
    5  10       -.00000        -.17670        -.00000        -.17670        -.00000      -90.00000

    6   1       -.37202        -.02521         .02255        -.37348        -.02375       -3.70429
    6   2       -.29089        -.02173        -.00423        -.29096        -.02166         .90010
    6   3       -.20402        -.01831        -.03275        -.20963        -.01270        9.71350
    6   4       -.09523        -.00590        -.06321        -.12796         .02683       27.37687
    6   5       -.03256        -.00062        -.08629        -.10433         .07115       37.75675
    6   6       -.00012         .00215        -.09808        -.09708         .09910       44.66766
    6   7       -.00000         .17823        -.00000         .17823        -.00000      -90.00000
    6   8      -1.30832         .00000        -.00000       -1.30832         .00000        0.00000
    6   9       -.79422         .00000        -.00000        -.79422         .00000        0.00000
    6  10       -.00000         .04765        -.00000         .04765        -.00000      -90.00000

    7   1       -.55089        -.01600         .00310        -.55090        -.01598        -.33179
    7   2       -.42232        -.01317        -.01446        -.42283        -.01266        2.02157
    7   3       -.27636        -.00893        -.03542        -.28097        -.00432        7.41859
    7   4       -.11890        -.00152        -.05528        -.14083         .02041       21.64169
    7   5       -.01237         .00225        -.06950        -.07494         .06462       41.79646
    7   6        .03849         .00374        -.07756         .10060        -.05837      -38.68722
    7   7       -.00000         .37012        -.00000         .37012        -.00000      -90.00000
    7   8      -1.78178         .00000        -.00000       -1.78178         .00000        0.00000
    7   9       -.96491         .00000        -.00000        -.96491         .00000        0.00000
    7  10       -.00000         .08321        -.00000         .08321        -.00000      -90.00000
```

FEL 435.2

```
  8  1      -.62971     .01319     .07856    -.63917     .02265   -6.86667
  8  2      -.46560    -.00236     .05456    -.47194     .00398   -5.62638
  8  3      -.31160    -.01699     .02635    -.31393    -.01465   -5.07156
  8  4      -.13461    -.02565    -.00546    -.13488    -.02539    2.86323
  8  5      -.01777    -.03150    -.02652     .00276    -.05203  -37.73256
  8  6       .03961    -.03603    -.04048     .05719    -.05361  -23.47305
  8  7      -.00000     .40262     .00000     .40262    -.00000  -90.00000
  8  8     -1.99440     .00000     .00000   -1.99440     .00000    0.00000
  8  9     -1.06543     .00000    -.00000   -1.06543     .00000    0.00000
  8 10      -.00000    -.10004    -.00000    -.10004    -.00000  -90.00000

  9  1      -.61073    -.03317     .00908    -.61087    -.03303    -.90088
  9  2      -.47202    -.02675    -.01289    -.47239    -.02638    1.65698
  9  3      -.32400    -.02015    -.03608    -.32823    -.01593    6.68059
  9  4      -.15918    -.00690    -.06179    -.18020     .01512   19.62261
  9  5      -.04060     .00112    -.07923    -.10167     .06218   37.62477
  9  6       .01336     .00437    -.08933     .09831    -.08058  -43.55987
  9  7      -.00000     .35172    -.00000     .35172    -.00000  -90.00000
  9  8     -2.08181     .00000    -.00000   -2.08181     .00000    0.00000
  9  9     -1.21798     .00000    -.00000   -1.21798     .00000    0.00000
  9 10      -.00000     .10203    -.00000     .10203    -.00000  -90.00000

 10  1      -.65340    -.00991     .01450    -.65372    -.00958   -1.29033
 10  2      -.50022    -.00733    -.00421    -.50026    -.00730     .48955
 10  3      -.33582    -.00453    -.02311    -.33743    -.00293    3.97108
 10  4      -.16289     .00037    -.04235    -.17321     .01070   13.70986
 10  5      -.03463     .00360    -.05460    -.07336     .04233   35.35245
 10  6       .02249     .00434    -.06213     .07621    -.04938  -40.84527
 10  7      -.00000     .49321    -.00000     .49321    -.00000  -90.00000
 10  8     -2.18115     .00000    -.00000   -2.18115     .00000    0.00000
 10  9     -1.24810     .00000    -.00000   -1.24810     .00000    0.00000
 10 10      -.00000     .14334    -.00000     .14334    -.00000  -90.00000

 11  1      -.72093     .03755     .03730    -.72276     .03938   -2.80879
 11  2      -.52424     .01234     .02402    -.52531     .01341   -2.55805
 11  3      -.35868    -.01142     .00716    -.35883    -.01127   -1.17990
 11  4      -.18493    -.03179    -.01418    -.18624    -.03048    5.24677
 11  5      -.06446    -.04132    -.02595    -.08130    -.02448   32.98470
 11  6      -.00549    -.04760    -.03266     .01231    -.06540  -28.59420
 11  7      -.00000     .52210     .00000     .52210    -.00000  -90.00000
 11  8     -2.32344     .00000     .00000   -2.32344     .00000    0.00000
 11  9     -1.38181     .00000    -.00000   -1.38181     .00000    0.00000
 11 10      -.00000    -.07270    -.00000    -.07270    -.00000  -90.00000

 12  1      -.65439    -.02389     .00430    -.65442    -.02386    -.39084
 12  2      -.51987    -.02059    -.00633    -.51995    -.02051     .72666
 12  3      -.36148    -.01340    -.02210    -.36288    -.01200    3.61913
 12  4      -.18828    -.00341    -.03691    -.19537     .00368   10.88449
 12  5      -.07104     .00271    -.04714    -.09402     .02569   25.98256
 12  6      -.01707     .00477    -.05338    -.06064     .04834   39.22132
 12  7      -.00000     .45541    -.00000     .45541    -.00000  -90.00000
 12  8     -2.34619     .00000    -.00000   -2.34619     .00000    0.00000
 12  9     -1.45961     .00000    -.00000   -1.45961     .00000    0.00000
 12 10      -.00000     .17208    -.00000     .17208    -.00000  -90.00000

 13  1      -.77416     .04560    -.01861    -.77458     .04602    1.29979
 13  2      -.57306     .01395    -.01563    -.57347     .01436    1.52450
 13  3      -.38574    -.01147    -.01868    -.38667    -.01054    2.85006
 13  4      -.20053    -.03474    -.02342    -.20377    -.03150    7.88980
 13  5      -.07334    -.04710    -.02498    -.08844    -.03201   31.14921
 13  6      -.01053    -.05440    -.02648     .00192    -.06685  -25.18030
 13  7      -.00000     .56927    -.00000     .56927    -.00000  -90.00000
 13  8     -2.50151     .00000    -.00000   -2.50151     .00000    0.00000
 13  9     -1.49622     .00000    -.00000   -1.49622     .00000    0.00000
 13 10      -.00000    -.08239    -.00000    -.08239    -.00000  -90.00000

 14  1      -.77424     .03955     .02371    -.77493     .04024   -1.66733
 14  2      -.56867     .01194     .01263    -.56895     .01222   -1.24600
 14  3      -.38524    -.00318    -.00326    -.38527    -.00915     .49606
 14  4      -.19919    -.02885    -.02035    -.20172    -.02631    6.90831
 14  5      -.07188    -.03891    -.03124    -.09071    -.02008   31.08998
 14  6      -.00868    -.04487    -.03707     .01448    -.06803  -31.99301
 14  7      -.00000     .57744    -.00000     .57744    -.00000  -90.00000
 14  8     -2.50151     .00000    -.00000   -2.50151     .00000    0.00000
 14  9     -1.49622     .00000    -.00000   -1.49622     .00000    0.00000
 14 10      -.00000    -.03701    -.00000    -.03701    -.00000  -90.00000

 15  1      -.66390    -.06668    -.00641    -.66397    -.06661     .61468
 15  2      -.52556    -.03917    -.00970    -.52576    -.03897    1.14204
 15  3      -.37247    -.00930    -.01386    -.37300    -.00877    2.18159
 15  4      -.21572     .02579    -.01811    -.21707     .02714    4.26479
 15  5      -.09686     .04490    -.02143    -.10003     .04807    3.40936
 15  6      -.04344     .05722    -.02155    -.04786     .06164   11.59022
 15  7      -.00000     .44752    -.00000     .44752    -.00000  -90.00000
 15  8     -2.43676     .00000    -.00000   -2.43676     .00000    0.00000
```

```
 15  9      -1.61434         .00000        -.00000       -1.61434         .00000        0.00000
 15 10      -.00000          .44372        -.00000         .44372        -.00000      -90.00000

 16  1      -.73046          .03936        -.00653        -.73052         .03941         .49318
 16  2      -.56585          .01031        -.00840        -.56597         .01043         .83533
 16  3      -.38245         -.01075        -.01230        -.38286        -.01034        1.89255
 16  4      -.19983         -.03001        -.01722        -.20156        -.02828        5.73182
 16  5      -.07644         -.04262        -.02044        -.08606        -.03300       25.20050
 16  6      -.01343         -.04635        -.02117        -.00308        -.05670      -26.06561
 16  7      -.00000          .56075        -.00000         .56075        -.00000      -90.00000
 16  8     -2.48293          .00000        -.00000       -2.48293         .00000        0.00000
 16  9     -1.49579          .00000        -.00000       -1.49579         .00000        0.00000
 16 10      -.00000         -.04203        -.00000        -.04203        -.00000      -90.00000

 17  1      -.71226          .01126        -.00472        -.71229         .01129         .37393
 17  2      -.55559         -.00852        -.00781        -.55570        -.00841         .81793
 17  3      -.38656         -.02598        -.01334        -.38715        -.02548        2.11461
 17  4      -.20310         -.04403        -.01915        -.20537        -.04176        6.76731
 17  5      -.07913         -.05604        -.02295        -.09327        -.04190       31.65090
 17  6      -.01603         -.05908        -.02394        -.00536        -.06976      -24.02090
 17  7      -.00000          .46038        -.00000         .46038        -.00000      -90.00000
 17  8     -2.48293          .00000        -.00000       -2.48293         .00000        0.00000
 17  9     -1.49579          .00000        -.00000       -1.49579         .00000        0.00000
 17 10      -.00000         -.13266        -.00000        -.13266        -.00000      -90.00000

 18  1      -.69705         -.06659         .00277        -.69706        -.06658        -.25133
 18  2      -.53887         -.03837        -.00115        -.53888        -.03836         .13200
 18  3      -.36542         -.00777        -.00555        -.36550        -.00764         .88942
 18  4      -.18239          .02724        -.01021        -.18289         .02773        2.78063
 18  5      -.05614          .04722        -.01343        -.05786         .04893        7.28123
 18  6       .00168          .05714        -.01562        -.00242         .06124       14.69803
 18  7      -.00000          .45547        -.00000         .45547        -.00000      -90.00000
 18  8     -2.37741          .00000        -.00000       -2.37741         .00000        0.00000
 18  9     -1.44362          .00000        -.00000       -1.44362         .00000        0.00000
 18 10      -.00000          .41254        -.00000         .41254        -.00000      -90.00000
TOTAL STRESSES IN BEAM LAYERS (STRESS (KSI), ANG. (DEGRESS), + TEN., - COMP.)

  EL LAYER     SXX            SYY            SXY            S1             S2           THETA1

  1  1     -3.44603        0.00000        -.11847       -3.45009         .00407        1.96672
  1  2     -3.24492        0.00000        -.15038       -3.25187         .00695        2.64768
  1  3     -2.33126        0.00000       -3.27675       -4.64353        2.31227       35.20908
  1  4      -.70504        0.00000       -3.44832       -3.81881        3.11377       42.08148
  1  5       .92118        0.00000       -3.49382        3.98464       -3.06346      -41.24502
  1  6      2.54739        0.00000       -3.41325        4.91685       -2.36945      -34.76814
  1  7      4.17361        0.00000       -3.20660        5.91264       -1.73903      -28.47226
  1  8      5.79983        0.00000       -2.87387        6.98264       -1.18281      -22.37080
  1  9      6.71349        0.00000        -.13293        6.71612        -.00263       -1.13388
  1 10      6.91460        0.00000        -.06743        6.91525        -.00066        -.55868
  1 11       .00071        0.00000        -.00001         .00071        -.00000        -.70916
  1 12       .00072        0.00000        -.00000         .00072        -.00000        -.35144

  2  1     -9.23026        0.00000        -.10890       -9.23155         .00128         .67584
  2  2     -8.67961        0.00000        -.13689       -8.68177         .00216         .90332
  2  3     -6.17789        0.00000       -2.96429       -7.37014        1.19224       21.91012
  2  4     -1.72512        0.00000       -3.11351       -4.09334        2.36823       37.25765
  2  5      2.72766        0.00000       -3.15025        4.79663       -2.06896      -33.29542
  2  6      7.18044        0.00000       -3.07449        8.31697       -1.13653      -20.28756
  2  7     11.63322        0.00000       -2.88624       12.30993        -.67672      -13.19545
  2  8     16.08599        0.00000       -2.58550       16.49134        -.40535       -8.91024
  2  9     18.58771        0.00000        -.11956       18.59848        -.00077        -.36853
  2 10     19.13836        0.00000        -.06065       19.13856        -.00019        -.18155
  2 11       .00196        0.00000        -.00001         .00196        -.00000        -.23047
  2 12       .00199        0.00000        -.00000         .00199        -.00000        -.11421

  3  1    -13.59495        0.00000        -.07757      -13.59540         .00044         .32690
  3  2    -12.77007        0.00000        -.09541      -12.77078         .00071         .42804
  3  3     -9.02246        0.00000       -2.04528       -9.46445         .44199       12.19417
  3  4     -2.35214        0.00000       -2.15932       -3.63490        1.28275       30.71259
  3  5      4.31818        0.00000       -2.22930        5.26254        -.94437      -22.95830
  3  6     10.98849        0.00000       -2.25520       11.43333        -.44483      -11.15822
  3  7     17.65881        0.00000       -2.23702       17.93779        -.27898       -7.10966
  3  8     24.32913        0.00000       -2.17478       24.52201        -.19287       -5.06811
  3  9     28.07674        0.00000        -.11385       28.07720        -.00046        -.23233
  3 10     28.90162        0.00000        -.09764       28.90195        -.00033        -.19356
  3 11       .00296        0.00000        -.10172         .10321        -.10026      -44.58360
  3 12       .00301        0.00000        -.05134         .05247        -.04966      -44.16071

  4  1    -15.49847        0.00000        -.04668      -15.49861         .00014         .17255
  4  2    -14.70057        0.00000        -.05734      -14.70080         .00022         .22348
  4  3    -11.07562        0.00000       -1.23249      -11.21112         .13549        6.27360
  4  4     -4.62361        0.00000       -1.31122       -4.96958         .34597       14.78064
  4  5      1.92840        0.00000       -1.37900        2.56671        -.74031      -28.22853
```

FEL 435.2

```
 4  6      9.26342      0.00000     -1.43583      8.52232     -.24191     -9.56332
 4  7     14.73243      0.00000     -1.46171     14.87997     -.14754     -5.68661
 4  8     21.18444      0.00000     -1.51663     21.29247     -.10803     -4.07421
 4  9     24.80939      0.00000      -.08480     24.80968     -.00029      -.19583
 4 10     25.60723      0.00000      -.08700     25.60758     -.00030      -.19466
 4 11     26.25737      0.00000      -.11216     26.25784     -.00049      -.24473
 4 12     26.75963      0.00000      -.05661     26.75975     -.00012      -.12121

 5  1    -16.63191      0.00000      -.02857    -16.63196      .00005       .09842
 5  2    -15.77579      0.00000      -.03511    -15.77587      .00008       .12752
 5  3    -11.88632      0.00000      -.75041    -11.93351      .04719      3.59817
 5  4     -4.96349      0.00000      -.78758     -5.08546      .12197      8.90342
 5  5      1.95934      0.00000      -.80181      2.24563     -.28629    -19.64931
 5  6      8.88217      0.00000      -.79310      8.95244     -.07026     -5.06265
 5  7     15.80500      0.00000      -.76145     15.84160     -.03660     -2.75189
 5  8     22.72784      0.00000      -.70686     22.74980     -.02196     -1.77966
 5  9     26.61731      0.00000      -.03464     26.61735     -.00005      -.07456
 5 10     27.47342      0.00000      -.02346     27.47344     -.00002      -.04892
 5 11     28.17094      0.00000      -.01502     28.17095     -.00001      -.03055
 5 12     28.70986      0.00000      -.00758     28.70987     -.00000      -.01513

 6  1    -16.92182      0.00000      -.00980    -16.92183      .00001       .03319
 6  2    -16.04826      0.00000      -.01148    -16.04826      .00001       .04099
 6  3    -12.07951      0.00000      -.23728    -12.08417      .00466      1.12491
 6  4     -5.01558      0.00000      -.24633     -5.02765      .01207      2.80498
 6  5      2.04834      0.00000      -.24877      2.07812     -.02978     -6.82637
 6  6      9.11227      0.00000      -.24460      9.11883     -.00656     -1.53653
 6  7     16.17620      0.00000      -.23383     16.17958     -.00338      -.82798
 6  8     23.24012      0.00000      -.21644     23.24214     -.00202      -.53355
 6  9     27.20887      0.00000      -.01059     27.20887     -.00000      -.02231
 6 10     28.08243      0.00000      -.00717     28.08244     -.00000      -.01462
 6 11     28.79417      0.00000      -.00458     28.79417     -.00000      -.00912
 6 12     29.34407      0.00000      -.00231     29.34407     -.00000      -.00451

 7  1     -3.26897      0.00000      -.10337     -3.27224      .00327      1.80941
 7  2     -3.08922      0.00000      -.13341     -3.09497      .00575      2.46823
 7  3     -2.27259      0.00000     -2.93744     -4.28586     2.01326     34.42597
 7  4      -.81908      0.00000     -3.10110     -3.53757     2.71848     41.23843
 7  5       .63442      0.00000     -3.14917      3.48232    -2.84790    -42.12404
 7  6      2.08793      0.00000     -3.08166      4.29766    -2.20972    -35.64265
 7  7      3.54144      0.00000     -2.89856      5.16735    -1.62591    -29.28971
 7  8      4.99495      0.00000     -2.59988      6.10257    -1.10762    -23.07544
 7  9      5.81158      0.00000      -.12030      5.81407     -.00249     -1.18533
 7 10      5.99132      0.00000      -.06104      5.99195     -.00062      -.58361
 7 11       .00061      0.00000      -.00001       .00061     -.00000      -.74056
 7 12       .00063      0.00000      -.00000       .00063     -.00000      -.36685

 8  1     -8.71464      0.00000      -.10025     -8.71579      .00115       .65902
 8  2     -8.21442      0.00000      -.12638     -8.21636      .00194       .88123
 8  3     -5.94184      0.00000     -2.74177     -7.01365     1.07181     21.35149
 8  4     -1.89689      0.00000     -2.88142     -3.98195     2.08506     35.89029
 8  5      2.14805      0.00000     -2.91660      4.18210    -2.03405    -34.89200
 8  6      6.19300      0.00000     -2.84731      7.30310    -1.11010    -21.29968
 8  7     10.23794      0.00000     -2.67355     10.89407     -.65613    -13.78865
 8  8     14.28289      0.00000     -2.39532     14.67389     -.39100     -9.27100
 8  9     16.55547      0.00000      -.11078     16.55621     -.00074      -.38336
 8 10     17.05569      0.00000      -.05619     17.05588     -.00019      -.18876
 8 11       .00175      0.00000      -.00001       .00175     -.00000      -.23953
 8 12       .00178      0.00000      -.00000       .00178     -.00000      -.11866

 9  1    -12.74227      0.00000      -.07646    -12.74273      .00046       .34378
 9  2    -11.98321      0.00000      -.09279    -11.98393      .00072       .44360
 9  3     -8.53467      0.00000     -1.97061     -8.96770      .43303     12.39351
 9  4     -2.39664      0.00000     -2.07363     -3.59330     1.19666     29.98853
 9  5      3.74139      0.00000     -2.13434      4.70881     -.96742    -24.38315
 9  6      9.87942      0.00000     -2.15275     10.32813     -.44871    -11.77389
 9  7     16.01745      0.00000     -2.12884     16.29556     -.27811     -7.44294
 9  8     22.15548      0.00000     -2.06263     22.34587     -.19039     -5.27374
 9  9     25.60402      0.00000      -.10756     25.60447     -.00045      -.24068
 9 10     26.36308      0.00000      -.09120     26.36340     -.00032      -.19820
 9 11       .00270      0.00000      -.09346       .09481     -.09212    -44.58658
 9 12       .00275      0.00000      -.04717       .04857     -.04582    -44.16644

10  1    -14.45421      0.00000      -.04719    -14.45436      .00015       .18706
10  2    -13.71708      0.00000      -.05650    -13.71731      .00023       .23601
10  3    -10.36818      0.00000     -1.19289    -10.50366      .13548      6.47926
10  4     -4.40752      0.00000     -1.26107     -4.74282      .33530     14.88983
10  5      1.55315      0.00000     -1.31884      2.30707     -.75392    -23.75456
10  6      7.51382      0.00000     -1.36622      7.75452     -.24071     -3.93202
10  7     13.47448      0.00000     -1.40319     13.61905     -.14457     -5.88253
10  8     19.43515      0.00000     -1.42977     19.53977     -.10462     -4.18501
10  9     22.78404      0.00000      -.07959     22.78432     -.00028      -.20014
10 10     23.52117      0.00000      -.08086     23.52145     -.00028      -.19598
10 11     24.12175      0.00000      -.10327     24.12219     -.00044      -.24529
10 12     24.58577      0.00000      -.05213     24.58588     -.00011      -.12146
```

```
 11  1    -15.40855      0.00000      -.02734    -15.40860      .00005      .10165
 11  2    -14.61377      0.00000      -.03345    -14.61934      .00008      .13110
 11  3    -11.03064      0.00000      -.71279    -11.07651      .04567     3.68197
 11  4     -4.64417      0.00000      -.74740     -4.76149      .11732     8.92079
 11  5      1.74230      0.00000      -.76039      2.02748     -.23518   -20.55809
 11  6      8.12877      0.00000      -.75175      8.19771     -.06894    -5.23951
 11  7     14.51524      0.00000      -.72149     14.55102     -.03577    -2.83859
 11  8     20.90171      0.00000      -.66960     20.92314     -.02143    -1.83300
 11  9     24.48984      0.00000      -.03281     24.48988     -.00004     -.07676
 11 10     25.27963      0.00000      -.02222     25.27964     -.00002     -.05035
 11 11     25.92310      0.00000      -.01422     25.92311     -.00001     -.03144
 11 12     26.42027      0.00000      -.00718     26.42027     -.00000     -.01557

 12  1    -15.75722      0.00000      -.00804    -15.75723      .00000      .02922
 12  2    -14.94934      0.00000      -.01005    -14.94935      .00001      .03854
 12  3    -11.27300      0.00000      -.21746    -11.28319      .00419     1.10412
 12  4     -4.74619      0.00000      -.22909     -4.75722      .01103     2.75704
 12  5      1.78661      0.00000      -.23387      1.81672     -.03011    -7.33545
 12  6      8.31942      0.00000      -.23179      8.32587     -.00645    -1.59472
 12  7     14.85222      0.00000      -.22287     14.85557     -.00334     -.85950
 12  8     21.38503      0.00000      -.20708     21.38703     -.00201     -.55476
 12  9     25.05537      0.00000      -.01015     25.05538     -.00000     -.02322
 12 10     25.86325      0.00000      -.00688     25.86326     -.00000     -.01523
 12 11     26.52147      0.00000      -.00440     26.52148     -.00000     -.00952
 12 12     27.03003      0.00000      -.00222     27.03003     -.00000     -.00471
    DIRECTION OF PRINCIPAL AXIS (DEG.) 1ST AND 2ND CRACK (ANG. = 999.0 IF NO CRACK)
  ELEMENT LAYER    PRINCIPAL          FIRST                  SECOND

    BEAM LAYER FAILURES
    ELEMENT  LAYER  TYPE OF FAILURE



PLOT SHOWING CRACK-CRUSH AREAS, STRESSES, NODE AND LAYER MARKERS FOR REFERENCE
(SEE USERS MANUAL FOR DETAILS)

BEAM NUMBER   1

  *                   **                   **                   **               **        **         *

* 11111111111111111111133333333333333333333344444444444444444444455555555555555555555555555555555555555 *
* 11111111111111111111133333333333333333333344444444444444444444455555555555555555555555555555555555555 *
* 11111111111111111111122222222222222222222233333333333333333333333333333333333333333333333344444444444 *
* 11111111111111111111111111111111111111111111111111111111111111122222222222222222222222222222222222222 *
* AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAABBBBBBBBBBBBBBBBBBBBBAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA *
* AAAAAAAAAAAAAAAAAAAAABBBBBBBBBBBBBBBBBBBBBCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC *
* BBBBBBBBBBBBBBBBBBBBBCCCCCCCCCCCCCCCCCCCCCEEEEEEEEEEEEEEEEEEEEEDDDDDDDDDDDDDDDDDDDDDDDDDDDEEEEEEEEEEE *
* BBBBBBBBBBBBBBBBBBBBBEEEEEEEEEEEEEEEEEEEEEGGGGGGGGGGGGGGGGGGGGGFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFF *
* BBBBBBBBBBBBBBBBBBBBBFFFFFFFFFFFFFFFFFFFFFHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHH *
* BBBBBBBBBBBBBBBBBBBBBFFFFFFFFFFFFFFFFFFFFFIIIIIIIIIIIIIIIIIIIIIHHHHHHHHHHHHHHHHHHHHHHHHHHHIIIIIIIIIII *
* AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAGGGGGGGGGGGGGGGGGHHHHHHHHHHHHHHHHHHHHH *
* AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAGGGGGGGGGGGGGGGGGHHHHHHHHHHHHHHHHHHHHH *

  *                   **                   **                   **               **        **         *


BEAM NUMBER   2

  *                   **                   **                   **               **        **         *

* 11111111111111111111133333333333333333333344444444444444444444455555555555555555555555555555555555555 *
* 11111111111111111111133333333333333333333344444444444444444444444444444444444444444455555555555555555 *
* 11111111111111111111122222222222222222222233333333333333333333333333333333333333333333333333333333333 *
* 11111111111111111111111111111111111111111111111111111111111111122222222222222222222222222222222222222 *
* AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA *
* AAAAAAAAAAAAAAAAAAAAABBBBBBBBBBBBBBBBBBBBBCCCCCCCCCCCCCCCCCCCCCBBBBBBBBBBBBBBBBBCCCCCCCCCCCCCCCCCCCCC *
* AAAAAAAAAAAAAAAAAAAAACCCCCCCCCCCCCCCCCCCCCEEEEEEEEEEEEEEEEEEEEEDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDD *
* BBBBBBBBBBBBBBBBBBBBBDDDDDDDDDDDDDDDDDDDDDFFFFFFFFFFFFFFFFFFFFFEEEEEEEEEEEEEEEEEFFFFFFFFFFFFFFFFFFFFF *
* BBBBBBBBBBBBBBBBBBBBBEEEEEEEEEEEEEEEEEEEEEHHHHHHHHHHHHHHHHHHHHHGGGGGGGGGGGGGGGGGGGGGGGGGGGHHHHHHHHHHH *
* BBBBBBBBBBBBBBBBBBBBBEEEEEEEEEEEEEEEEEEEEEHHHHHHHHHHHHHHHHHHHHHGGGGGGGGGGGGGGGGGHHHHHHHHHHHHHHHHHHHHH *
* AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGG *
* AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAGGGGGGGGGGGGGGGGGGGGGGGGGGGHHHHHHHHHHH *
```

```
SLAB PLOT
     NODE J                                                                 NODE L
            ELEMENT NUMBER                      Y = NUMBER OF YIELDED LAYERS
            C = NUMBER OF CRUSHED LAYERS        T = NUMBER OF CRACKED LAYERS
     NODE I                                                                 NODE K



5BBBBBBBBBBBBBBBBBBB11BBBBBBBBBBBBBBBBBB17BBBBBBBBBBBBBBBBBB23BBBBBBBBBBBBB29BBBBBBBBBBB35BBBBBBBBBB41
*                   *                   *                   *              *            *           *
*                   *                   *                   *              *            *           *
*     3             *     6             *     9             *   12         *  15        * 18        *
*                   *                   *                   *              *            *           *
*                   *                   *                   *              *            *           *
*                   *                   *                   *              *            *           *
*                   *                   *                   *              *            *           *
*                   *                   *                   *              *            *           *
*                   *                   *                   *              *            *           *
4*******************10******************16******************22*************28***********34**********40
*                   *                   *                   *              *            *           *
*                   *                   *                   *              *            *           *
*     2             *     5             *     8             *   11         *  14        * 17        *
*                   *                   *                   *              *            *           *
*                   *                   *                   *              *            *           *
*                   *                   *                   *              *            *           *
*                   *                   *                   *              *            *           *
*                   *                   *                   *              *            *           *
*                   *                   *                   *              *            *           *
2BBBBBBBBBBBBBBBBBBB8BBBBBBBBBBBBBBBBBBB14BBBBBBBBBBBBBBBBBB20BBBBBBBBBBBBB26BBBBBBBBBBB32BBBBBBBBBB38
*                   *                   *                   *              *            *           *
*                   *                   *                   *              *            *           *
*                   *                   *                   *              *            *           *
*     1             *     4             *     7             *   10         *  13        * 16        *
*                   *                   *                   *              *            *           *
*                   *                   *                   *              *            *           *
*                   *                   *                   *              *            *           *
*                   *                   *                   *              *            *           *
*                   *                   *                   *              *            *           *
*                   *                   *                   *              *            *           *
*                   *                   *                   *              *            *           *
*                   *                   *                   *              *            *           *
1*******************7*******************13******************19*************25***********31**********37

     LOAD CYCLE =        2

     ----LOAD RATIO AT START OF CYCLE      =    .400000000E+00
     ----PRESCAN FACTOR AT START OF CYCLE  =    .100000000E+01


     A TERMINATION CHECK HAS BEEN EXCEEDED IN THE PREVIOUS LOAD CYCLE.


          YES- INDICATES THAT A TERMINATION CHECK HAS BEEN EXCEEDED
          NO - INDICATES THAT THE TERMINATION CHECK HAS NOT BEEN EXCEEDED


          SLAB  -FIRST CRACK LOAD =    -999.0000 KIPS
          SLAB  -FIRST CRUSH LOAD =    -999.0000 KIPS
          SLAB  -FIRST YIELD LOAD =    -999.0000 KIPS
```

```
BEAM  -FIRST CRACK LOAD =    -999.0000 KIPS

BEAM  -FIRST CRUSH LOAD =    -999.0000 KIPS

BEAM  -FIRST YIELD LOAD =    -999.0000 KIPS



MAXIMUM DISPLACEMENT HAS BEEN EXCEEDED (NODE)  =       NO ( 41)

SPECIFIED OVERLOAD RATIO OF   .100E+21 EXCEEDED=       NO

RATIO OF TOTAL LOAD TO THE SPECIFIED OVERLOAD  =  20.182



MAX SHEAR HAS BEEN EXCEEDED(BEAM ELEMENT,LAYER)=       NO(  0, 0)



MAXIMUM SLAB CRACK WIDTH HAS BEEN EXCEEDED =       NO
     CRACK WIDTH         =  0.00000 (IN)
     ELEMENT NUMBER      =        0
     CRACK ANGLE         =    0.000 (DEGREES)
     CRACK LOCATION      =     NONE



BEAM TERMINATION CHECKS  /  MATERIAL TYPE =      1          2          3          4
FOR EXCEEDING LIMITS ON

     STRAIN                               =     YES         NO        YES         NO
          ELEMENT LAYER                         9 10       0  0       6 12       0  0

     TENSILE STRESS                       =     YES         NO        YES         NO
          ELEMENT LAYER                         9 10       0  0       6 12       0  0

     COMPRESSIVE STRESS                   =      NO         NO         NO         NO
          ELEMENT LAYER                        0  0       0  0       0  0       0  0

     CRACKED OR YIELDED LAYERS            =      NO         NO         NO         NO
          ELEMENT LAYER                        0  0       0  0       0  0       0  0

     CRUSHED LAYERS                       =      NO         NO         NO         NO
          ELEMENT LAYER                        0  0       0  0       0  0       0  0


SLAB TERMINATION CHECKS  /  MATERIAL TYPE = CONCRETE/STEEL-1
FOR EXCEEDING LIMITS ON

     STRAIN                               =      NO         NO
          ELEMENT LAYER                        0  0       0  0

     TENSILE STRESS                       =      NO         NO
          ELEMENT LAYER                        0  0       0  0

     COMPRESSIVE STRESS                   =      NO         NO
          ELEMENT LAYER                        0  0       0  0

     CRACKED OR YIELDED LAYERS            =      NO         NO
          ELEMENT LAYER                        0  0       0  0

     CRUSHED LAYERS                       =      NO         NO
          ELEMENT LAYER                        0  0       0  0
```

BOTH THE SOPHISTICATED AND SIMPLIFIED VERSIONS OF THE PROGRAM EMPLOY SUBSTANTIAL DEFAULT VALUES. THE USER IS CAUTIONED TO CHECK THE DEFAULT VALUES AGAINST THE ACTUAL STRUCTURE IN ORDER TO ASSURE THE PROGRAM IS CORRECTLY MODELING THE STRUCTURE. IF SUBSTANTIAL DIFFERENCES ARE NOTED BETWEEN THE STRUCTURE AND THE MODEL, THEN THE PREDICTED BEHAVIOR MAY NOT BE REPRESENTATIVE OF THE ACTUAL BRIDGE BEHAVIOR.

IF THE USER DESIRES TO ANALYZE AN UNUSUAL OR COMPLICATED STRUCTURE, THE SOPHISTICATED VERSION OF THE PROGRAM SHOULD BE USED IN ORDER TO MORE ACCURATELY PREDICT THE BRIDGE BEHAVIOR. EXAMPLES OF STRUCTURES WHERE THE SOPHISTICATED VERSION SHOULD DEFINITELY BE USED INCLUDE BRIDGES OF UNUSUAL HYBRID CONSTRUCTION OR HAUNCHED GIRDER BRIDGES OR BRIDGES UNDER VARYING DEGREES OF DETERIORATION. THE SOPHISTICATED VERSION CAN MORE REALISTICALLY MODEL THESE TYPES OF STRUCTURES AND THEREBY AVOID GROSS SIMPLIFICATIONS AND INACCURATE RESULTS.

THIS ANALYTICAL MODEL CONSIDERS THE FLEXURAL AND INPLANE BEHAVIOR OF THE DECK SLAB AND THE FLEXURAL AND AXIAL DEFORMATIONS OF THE BEAMS. TRANSVERSE SHEAR DEFORMATION NORMAL TO THE PLANE OF THE DECK SLAB IS NOT CONSIDERED.

THE ACCURACY OF THE RESULTS DEPENDS UPON THE ACCURACY OF THE INPUT OF THE MATERIAL PROPERTIES, DEFINITION OF THE BRIDGE DESIGN PARAMETERS, AND THE CORRECT SIMULATION OF THE OVERLOAD CONFIGURATION. SUBSTANTIAL DEVIATIONS FROM ANY ONE OF THESE VALUES WILL RESULT IN A SOLUTION THAT MAY NOT BE REPRESENTATIVE OF THE ACTUAL BRIDGE BEHAVIOR.

ANY SUBSTANTIAL DEVIATION IN THE INPUT FROM THE ACTUAL STATE OF THE SUPERSTRUCTURE MAY RESULT IN AN INCORRECT SIMULATION OF THE OVERLOAD RESPONSE OF THE BRIDGE.

CRACK WIDTHS IN THE CONCRETE SLAB ARE COMPUTED FROM FORMULAE THAT ARE BASED ON EMPIRICALLY DERIVED RELATIONSHIPS AND ARE THEREFORE CONSIDERED TO BE APPROXIMATE.

THE ANALYSIS IS CARRIED OUT FOR THE LANE LOCATION OF THE OVERLOAD VEHICLE THAT IS DEFINED BY THE USER OF THE PROGRAM. ANY DEVIATION FROM THIS INPUT LOADING IN THE ACTUAL OVERLOADING OF THE BRIDGE MAY RESULT IN A RESPONSE DIFFERENT FROM THAT PREDICTED BY THE PROGRAM.

THE ANALYSIS IS CARRIED OUT FOR THE GIVEN LOADING SPECIFIED BY THE USER. IF DURING THE ACTUAL LOADING OF THE BRIDGE OTHER VEHICLES OF QUESTIONABLE WEIGHT ARE PRESENT IN ADDITION TO THE GIVEN LOADING, THEN THE ACTUAL BRIDGE RESPONSE MAY BE DIFFERENT AS COMPARED TO THAT PREDICTED BY THE PROGRAM.

THE COMPUTER PROGRAM ASSUMES THAT DYNAMIC EFFECTS ARE PRESENT. THE ACTUAL VEHICULAR LOAD SHOULD BE INPUT AND THE PROGRAM WILL APPLY AN IMPACT FACTOR IN ACCORDANCE WITH THE STANDARD SPECIFICATIONS

FOR HIGHWAY BRIDGES (TWELFTH ED., 1977, AASHTO).

IF THE VEHICULAR SPEED SHOULD BE REDUCED TO A CRAWL SPEED (I.E. A MAXIMUM OF 5 MPH) DURING THE TRAVEL ACROSS THE BRIDGE, NO IMPACT FACTOR SHOULD BE APPLIED TO THE INPUT LOAD. THE INPUT LOAD SHOULD BE DIVIDED BY THE COMPUTED IMPACT FACTOR. THIS IS VALID ONLY IF THE TRAVERSE OF THE VEHICLE IS CONTROLLED BY AN ESCORT VEHICLE AND THE SPEED OF THE VEHICLE IS NO GREATER THAN THE CRAWL SPEED.

SUBSTANTIAL RESIDUAL STRESSES EXIST IN BOTH ROLLED AND BUILT-UP GIRDERS AT THE VICINITY OF THE FLANGE-TO-WEB CONNECTION AREA. THE MAGNITUDE OF THE RESIDUAL STRESSES VARIES DEPENDING UPON THE ROLLING PROCESS OR THE CUTTING AND WELDING SCHEME EMPLOYED. THEREFORE THE ACCURATE ASSESSMENT OF THESE RESIDUAL STRESSES IS EXTREMELY DEMANDING AND USUALLY UNKNOWN. IF RESIDUAL STRESSES ARE INPUTTED (SOPHISTICATED VERSION ONLY), THE ACCURACY OF THE RESULTS OBTAINED BY THE PROGRAM ARE CONTROLLED BY THE ACCURACY OF THE INPUT.

THE SIMPLIFIED VERSION ASSUMES THE RESIDUAL STRESSES ARE ZERO AND ARE THEREBY NEGLECTED IN THE ANALYSIS. THIS ASSUMPTION PRODUCES RESULTS WHICH UNDER ESTIMATE THE MAXIMUM TENSILE STRESSES IN THE ACTUAL STRUCTURE AT THE COVER PLATES AND THE TENSION FLANGE. UNDER THESE CIRCUMSTANCES THE ENGINEER SHOULD APPLY PRUDENT CONSERVATISM IN THE PERMIT OPERATIONS. HOWEVER, IF THE USER ONLY ALLOWS A MAXIMUM ALLOWABLE TENSILE STRESS EQUAL TO 75 PER CENT OF THE YIELD STRESS (AS PERMITTED IN THE AASHTO MANUAL FOR MAINTENANCE INSPECTION OF BRIDGES, 1978), THEN SUFFICIENT CONSERVATISM MAY EXIST TO ACCOUNT FOR THE NEGLECTED RESIDUAL STRESSES.

BASED ON THEORY AND AVAILABLE LIMITED TEST RESULTS, IT IS FOUND THAT THE PROGRAM ACCURATELY PREDICTS THE STRUCTURAL BEHAVIOR OF FULLY COMPOSITE CONSTRUCTION.

IN NONCOMPOSITE CONSTRUCTION THERE EXISTS SUBSTANTIAL FRICTION FORCES BETWEEN THE SLAB AND THE TOP FLANGE OR COVER PLATE OF THE GIRDERS. AT THIS TIME (1982) THESE FORCES HAVE NOT BEEN QUANTIFIED. THE PROGRAM APPROXIMATES THE BEHAVIOR OF NONCOMPOSITE CONSTRUCTION. HOWEVER, DEPENDING UPON THE CONSTRUCTION PRACTICES AND THE CONDITION OF THE BRIDGE, THE OBTAINED RESULTS MAY NOT BE TRULY REPRESENTATIVE OF THE ACTUAL BEHAVIOR OF THE STRUCTURE. THUS ENGINEERING JUDGMENT SHOULD BE APPLIED IN THE INTERPRETATION OF NONCOMPOSITE BRIDGES.

AT THIS TIME (1982) NO DEFINITE REFERENCES CAN BE CITED TO ASSIST IN THE QUANTIFICATION OF THE FRICTION FORCES IN PARTIAL COMPOSITE STRUCTURES. THUS THE ACCURACY OF THE RESULTS IS DEPENDENT UPON THE FORMULATION SELECTED FOR THE PROGRAM. BASED ON LIMITED STUDIES THE USE OF FULLY COMPOSITE CONSTRUCTION COULD BE CONSIDERED IN LIEU OF PARTIAL COMPOSITE CONSTRUCTION.

```
                ***************************************************************************************************************

*****************************DETAILED VERSION- BOVAS EXAMPLE BRIDGE 2- AASHO BRIDGE 3B                          ********************


***************    ALL UNITS OF INPUT SHOULD BE AS FOLLOWS-
                         FORCE- KIPS
                         LENGTH- INCHES
                         ALL OTHER UNITS MUST BE IN COMPLIANCE WITH THESE BASIC UNITS.



    NUMBER OF SPANS, NSPANS                         =        1

    LENGTH OF SPAN   1  (IN), SPANL(I)              =   600.00

    WIDTH OF BRIDGE (IN), WIDTH                     =   192.00

    BRIDGE OVERHANG (IN), OVHANG                    =    36.00

    SPAN OF ENTIRE BRIDGE (IN), TSPAN               =   600.00

    SPAN OF DISCRETIZATION (IN), TSPANM             =   300.00

    WIDTH OF DISCRETIZATION (IN), WIDTHM            =    96.00

    TYPE OF SYMMETRY USED IN DISCRETIZATION,TSYM,=  QUAR

    NUMBER OF ELEMENTS IN X DIRECTION, NELX         =        6
    NUMBER OF ELEMENTS IN Y DIRECTION, NELY         =        3
    NUMBER OF BEAMS IN THE MODEL, NOMB              =        2
    NUMBER OF CONCRETE LAYERS IN SLAB, NULAY        =        6
    NUMBER OF STEEL LAYERS IN SLAB, NSLAYR          =        4
    NUMBER OF DIFFERENT REINFORCEMENT SECTIONS      =        1
    NUMBER OF WEB SHEAR PANELS, NPNL                =        0
    NUMBER OF STEEL LAYERS IN BEAM, NULAYB          =       12
    MAX. NO. OF SECT. WHERE BEAM GEOM. IS DEFINED=           2
    NUMBER OF FATIGUE ELEMENT, LAYER CHECKS         =        0


    LONG  OUTPUT WILL BE PRINTED

    SCALE INITIAL SOLUTION AND PRESCRIBED FORCES =         YES
    IS THERE A DEAD LOAD ON THE STRUCTURE, IDEAD =         YES
    SOLUTION MODE IS ITERATIVE, MODES               =      YES

    ARE THERE INITIAL START CARDS, ICARDS           =       NO
```

```
WILL THERE BE END CARDS, FCARDS                =        NO

MAXIMUM RUN TIME (SECONDS), ETIME              =50000.00

MAXIMUM DISPLACEMENT FOR SIGNIFICANT POINT     = 60.0000 (IN)
SPECIFIED OVERLOAD                             =    1.000 (KIPS)
MAXIMUM RATIO OF APPLIED LOAD TO OVERLOAD      = .10E+21

FORCE RATIO INCREMENT ,CAPA                    =      .400

DISPLACEMENT RATIO INCREMENT FOR PRINTING      =   0.0000
FORCE RATIO INCREMENT FOR PRINTING             =   0.0000

NUMBER OF LOAD CYCLES, LCYCLE                  =      300


IS THERE A DEAD LOAD BEAM SOLUTION, IDEADB     =      YES


COMPUTE ELEMENT STRESS USING                   =  NODE



SKEW ANGLE (DEGREES)                           =  90.000


             ELEMENT LENGTHS IN X DIRECTION
                BEAM ELEMENT      LENGTH
                  NUMBER           (IN)

                    1             75.0000
                    2             75.0000
                    3             45.0000
                    4             45.0000
                    5             30.0000
                    6             30.0000


             ELEMENT LENGTHS IN Y DIRECTION
                BEAM ELEMENT      LENGTH
                  NUMBER           (IN)

                    1             36.0000
                    2             30.0000
                    3             30.0000


                   TOTAL SLAB SIZE
          X-DIRECTION  Y-DIRECTION      THICKNESS

           600.0000     192.0000         6.4500


                BEAM DEPTH AND TOP AND BOTTOM COVERPLATE THICKNESS

                   BEAM DEPTH,                        =    13.25
                   TOP COVERPLATE THICKNESS,          =     0.00
                   BOTTOM COVERPLATE THICKNESS,       =      .44
```

```
         FLANGE WIDTH AND FLANGE AND WEB THICKNESSES

              FLANGE WIDTH,                       =    7.558
              FLANGE THICKNESS                    =     .695
              WEB THICKNESS,                      =     .416


        REFERENCE PLANE LOCATIONS

           ZBAR          ZBARTF

         12.3500          3.2250


         STARTING NODES FOR BEAMS
   *****      3     6

 EQUATION NUMBERS

 NODE       1     2     3     4     5     6     7     8     9    10    11    12    13    14    15    16    17    18    19    20
    U       1     5     8    10    14    17    19    24    29    31    36    41    43    48    53    55    60    65    67    72
    V       0     0     0     0     0     0    20    25     0    32    37     0    44    49     0    56    61     0    68    73
    W       2     0     0    11     0     0    21    26     0    33    38     0    45    50     0    57    62     0    69    74
   XX       3     6     0    12    15     0    22    27     0    34    39     0    46    51     0    58    63     0    70    75
   YY       4     7     9    13    16    18    23    28    30    35    40    42    47    52    54    59    64    66    71    76
   ZZ       0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0


 NODE      21    22    23    24    25    26    27    28    29    30    31    32    33    34    35    36    37    38    39    40
    U      77    79    84    89    91    96   101   103   108   113   115   120   125   127   132   137     0     0     0     0
    V       0    80    85     0    92    97     0   104   109     0   116   121     0   128   133     0     0     0     0     0
    W       0    81    86     0    93    98     0   105   110     0   117   122     0   129   134     0   139   141     0   143
   XX       0    82    87     0    94    99     0   106   111     0   118   123     0   130   135     0   140   142     0   144
   YY      78    83    88    90    95   100   102   107   112   114   119   124   126   131   136   138     0     0     0     0
   ZZ       0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0     0


 NODE      41    42
    U       0     0
    V       0     0
    W     145     0
   XX     146     0
   YY       0     0
   ZZ       0     0



               SLAB- LAYER GEOMETRY

LAYER        THICKNESS          CENTROID

  1           1.250000          -2.600000
  2           1.250000          -1.350000
  3           1.475000            .012500
  4           1.475000           1.487500
  5            .500000           2.475000
  6            .500000           2.975000

               SLAB- CONCRETE MATERIAL PROPERTIES (KSI)

  UNIAXIL CONCRETE COMPRESSIVE STRENGTH, FC      =    5.7400

  DIRECT TENSILE STRENGTH, FT                    =     .4592

  INITIAL MODULUS, EC                            =   4365.38

  UNLOADING MODULUS IN COMPRESSION               =   1000.00

  UNLOADING MODULUS IN TENSION                   =    800.00

               SLAB- STEEL MATERIAL PROPERTIES
```

```
 MAT. TYPE      YOUNGS MODULUS       YIELD STRENGTH        RAMBERG-M  RAMBERG-N
     1           29000.00 KSI            61.20 KSI            .70      300.0

               SLAB- STEEL LAYER GEOMETRY

                     NUMBER OF DIFFERENT
          REINFORCEMENT PATTERNS LONGITUDINALLY
                             1


    SECTION   ELEMENT
      NO.    START END

       1        1   18
               LAYER  MAT. TYPE  BAR NO.  SPACING (IN)  THICKNESS (IN)  CENTROID (IN)  ANGLE (DEGREES)

SECTION    1
                 1        1         5        6.0000        .05167         -.41250        -90.000
                 2        1         4       12.0000        .01667          .15000          0.000
                 3        1         5        8.7403        .03547         1.28750          0.000
                 4        1         5        6.0000        .05167         1.91250        -90.000

 NUMBER OF CARDS TO SPECIFY TERMINATION CHECKS =  2

               TERMINATION CHECKS FOR THE SLAB LAYERS
               (STRESS IN KSI, STRAIN IN PERCENT)
 MAT. NO.  MAX STRAIN  MAX TENSILE  MAX COMP  NUMBER OF CRACKED   NUMBER OF
                          STRESS     STRESS   OR YIELDED LAYERS  CRUSHED LAYERS

     0        2.500       4.592      4.592          3                1
     1         .301      61.200     61.200          1                0

   TOP SURFACE OF SLAB (IN)

      BAR SPACING               =    6.000

      CONCRETE COVER            =    2.500

      MAX ALLOWABLE CRACK WIDTH =    .00400


 BOTTOM SURFACE OF SLAB (IN)

      BAR SPACING               =    6.000

      CONCRETE COVER            =    1.000

      MAX ALLOWABLE CRACK WIDTH =    .00400

 NUMBER OF STEEL MATERIALS =    2

               BEAM MATERIAL PROPERTIES

 MATERIAL   YIELD        YOUNGS       RAMBERG    RAMBERG    STRAIN HARDENING  STRAIN HARDENING  ULTIMATE        ULTIMATE
  NUMBER  STRESS (KSI) MODULUS (KSI) OSGOOD-M   OSGOOD-N    , MODULUS (KSI)   STRAIN (IN/IN)  STRESS (KSI)  STRAIN (IN/IN)

    1      36.0000     29000.00        .6700     400.000        900.000           .01400         59.000            .1200
    2      42.0000     29000.00        .6700     400.000        900.000           .01400         60.000            .1200
    3      36.0000         3.00        .6700     400.000           .080        140.0000          53.500         1200.0000


 MATERIAL   SHEAR         ALPHA        BETA        GAMMA        (GSTI-GB)/
  NUMBER  MODULUS (KSI)   (KSI)      (KSI**2)     (KSI**2)     (STRAN-SINY)

    1      11153.8462    33.07112   -70.46188    6765.12577   -386311.[illegible]
```

```
  2        11153.[illegible]    40.28661   -6[illegible].72816    3627.8[illegible]     -394712.40
  3            1.1[illegible]38    32.33207   -72.81523        .63131           -.00


*****THE LAST MATERIAL NUMBER CORRESPONDS TO A FICTITIOUS STEEL MATERIAL      *****



AVERAGE DISTANCE BETWEEN BEAMS =        60.00000
    IF YDIST = ZERO READ IN KSC VALUES



NUMBER OF CARDS TO SPECIFY TERMINATION CHECKS =     3


                    TERMINATION CHECKS FOR BEAM LAYERS
                    (STRESS IN KSI, STRAIN IN PERCENT)
 MAT. NO.   MAX STRAIN   MAX TENSILE   MAX COMP   NUMBER OF YIELDED    NUMBER OF
                            STRESS      STRESS         LAYERS         BUCKLED LAYERS

     1            .00        27.00       27.00            0                0
     2            .00        31.50       31.50            0                0
     3      999999.00    999999.00   999999.00         9999             9999

  NUMBER OF DIFFERENT SECTIONS IN BEAM  1 IS   2
     IF ISAME = 1 USE SECTIONS FROM LAST BEAM, ISAME =     0
 X-COORDINATE DISTANCES FROM START OF BEAM (INCHES)

     0.000   195.000


                          SECTION PROPERTIES BY LAYER


     FOR BEAM SECTION NUMBER  1
   THICKNESS           WIDTH     INITIAL STRESS    MATERIAL    SHEAR WIDTH
     (IN)              (IN)          (KIPS)          TYPE          (IN)

      .3475           7.5580        0.0000           1.0          .0010
      .3475           7.5580        0.0000           1.0          .0010
     2.8100            .4160        0.0000           2.0          .4160
     2.8100            .4160        0.0000           2.0          .4160
     2.8100            .4160        0.0000           2.0          .4160
     2.8100            .4160        0.0000           2.0          .4160
     2.8100            .4160        0.0000           2.0          .4160
     2.8100            .4160        0.0000           2.0          .4160
      .3475           7.5580        0.0000           1.0          .0010
      .3475           7.5580        0.0000           1.0          .0010
      .2188           6.0000        0.0000           3.0          .0010
      .2188           6.0000        0.0000           3.0          .0010

     FOR BEAM SECTION NUMBER  2
   THICKNESS           WIDTH     INITIAL STRESS    MATERIAL    SHEAR WIDTH
     (IN)              (IN)          (KIPS)          TYPE          (IN)

      .3475           7.5560        0.0000           1.0          .0010
      .3475           7.5580        0.0000           1.0          .0010
     2.8100            .4160        0.0000           2.0          .4160
     2.8100            .4160        0.0000           2.0          .4160
     2.8100            .4160        0.0000           2.0          .4160
     2.8100            .4160        0.0000           2.0          .4160
     2.8100            .4160        0.0000           2.0          .4160
     2.8100            .4160        0.0000           2.0          .4160
      .3475           7.5580        0.0000           1.0          .0010
      .3475           7.5580        0.0000           1.0          .0010
      .2188           6.0000        0.0000           3.0          .0010
      .2188           6.0000        0.0000           3.0          .0010
```

```
 ELEMENT     CRITICAL FLANGE  LAYER  LAYER     WEB      FLANGE     FLANGE       WEB
 NUMBER      BUCKLING STRESS   CODE   CODE THICKNESS THICKNESS    WIDTH       DEPTH
                 (KSI)          1      2      (IN)      (IN)      (IN)        (IN)

    1           36.3600         9     10     .4160     .6950     7.5540     16.8600
    2           36.3600         9     10     .4160     .6950     7.5540     16.8600
    3           36.3600         9     10     .4160     .6950     7.5540     16.8600
    4           39.3900         9     12     .4160    1.1325     6.9561     16.8600
    5           39.3900         9     12     .4160    1.1325     6.9561     16.8600
    6           39.3900         9     12     .4160    1.1325     6.9561     16.8600

BEAM NO.   1 HAS THE FOLLOWING ELEMENT/LAYER PROPERTIES (LAYERS VERTICAL, ELEMENTS HORIZONTAL).


     INITIAL STRESS (KSI) IN LAYERS

   LAYER       1           2           3           4           5           6
       1    0.0000      0.0000      0.0000      0.0000      0.0000      0.0000
       2    0.0000      0.0000      0.0000      0.0000      0.0000      0.0000
       3    0.0000      0.0000      0.0000      0.0000      0.0000      0.0000
       4    0.0000      0.0000      0.0000      0.0000      0.0000      0.0000
       5    0.0000      0.0000      0.0000      0.0000      0.0000      0.0000
       6    0.0000      0.0000      0.0000      0.0000      0.0000      0.0000
       7    0.0000      0.0000      0.0000      0.0000      0.0000      0.0000
       8    0.0000      0.0000      0.0000      0.0000      0.0000      0.0000
       9    0.0000      0.0000      0.0000      0.0000      0.0000      0.0000
      10    0.0000      0.0000      0.0000      0.0000      0.0000      0.0000
      11    0.0000      0.0000      0.0000      0.0000      0.0000      0.0000
      12    0.0000      0.0000      0.0000      0.0000      0.0000      0.0000


     MATERIAL TYPE FOR LAYERS

   LAYER       1     2     3     4     5     6
       1       1     1     1     1     1     1
       2       1     1     1     1     1     1
       3       2     2     2     2     2     2
       4       2     2     2     2     2     2
       5       2     2     2     2     2     2
       6       2     2     2     2     2     2
       7       2     2     2     2     2     2
       8       2     2     2     2     2     2
       9       1     1     1     1     1     1
      10       1     1     1     1     1     1
      11       3     3     3     2     2     2
      12       3     3     3     2     2     2


     AREAS (SQ.IN) OF LAYERS

   LAYER       1           2           3           4           5           6
       1    2.6264      2.6264      2.6264      2.6264      2.6264      2.6264
       2    2.6264      2.6264      2.6264      2.6264      2.6264      2.6264
       3    1.1690      1.1690      1.1690      1.1690      1.1690      1.1690
       4    1.1690      1.1690      1.1690      1.1690      1.1690      1.1690
       5    1.1690      1.1690      1.1690      1.1690      1.1690      1.1690
       6    1.1690      1.1690      1.1690      1.1690      1.1690      1.1690
       7    1.1690      1.1690      1.1690      1.1690      1.1690      1.1690
       8    1.1690      1.1690      1.1690      1.1690      1.1690      1.1690
       9    2.6264      2.6264      2.6264      2.6264      2.6264      2.6264
      10    2.6264      2.6264      2.6264      2.6264      2.6264      2.6264
      11    1.3125      1.3125      1.3125      1.3125      1.3125      1.3125
      12    1.3125      1.3125      1.3125      1.3125      1.3125      1.3125
```

```
SHEAR AREAS (SQ.IN) OF LAYERS

LAYER        1          2          3          4          5          6
    1      .0003      .0003      .0003      .0003      .0003      .0003
    2      .0003      .0003      .0003      .0003      .0003      .0003
    3     1.1690     1.1690     1.1690     1.1690     1.1690     1.1690
    4     1.1690     1.1690     1.1690     1.1690     1.1690     1.1690
    5     1.1690     1.1690     1.1690     1.1690     1.1690     1.1690
    6     1.1690     1.1690     1.1690     1.1690     1.1690     1.1690
    7     1.1690     1.1690     1.1690     1.1690     1.1690     1.1690
    8     1.1690     1.1690     1.1690     1.1690     1.1690     1.1690
    9      .0003      .0003      .0003      .0003      .0003      .0003
   10      .0003      .0003      .0003      .0003      .0003      .0003
   11      .0002      .0002      .0002      .0002      .0002      .0002
   12      .0002      .0002      .0002      .0002      .0002      .0002


MOMENT OF INERTIA OF LAYERS

LAYER        1          2          3          4          5          6
    1      .0264      .0264      .0264      .0264      .0264      .0264
    2      .0264      .0264      .0264      .0264      .0264      .0264
    3      .7692      .7692      .7692      .7692      .7692      .7692
    4      .7692      .7692      .7692      .7692      .7692      .7692
    5      .7692      .7692      .7692      .7692      .7692      .7692
    6      .7692      .7692      .7692      .7692      .7692      .7692
    7      .7692      .7692      .7692      .7692      .7692      .7692
    8      .7692      .7692      .7692      .7692      .7692      .7692
    9      .0264      .0264      .0264      .0264      .0264      .0264
   10      .0264      .0264      .0264      .0264      .0264      .0264
   11      .0052      .0052      .0052      .0052      .0052      .0052
   12      .0052      .0052      .0052      .0052      .0052      .0052


CENTROIDAL DISTANCE (IN) OF LAYERS FROM REFERENCE PLANE

LAYER        1          2          3          4          5          6
    1    -8.9513    -8.9513    -8.9513    -8.9513    -8.9513    -8.9513
    2    -8.6038    -8.6038    -8.6038    -8.6038    -8.6038    -8.6038
    3    -7.0250    -7.0250    -7.0250    -7.0250    -7.0250    -7.0250
    4    -4.2150    -4.2150    -4.2150    -4.2150    -4.2150    -4.2150
    5    -1.4050    -1.4050    -1.4050    -1.4050    -1.4050    -1.4050
    6     1.4050     1.4050     1.4050     1.4050     1.4050     1.4050
    7     4.2150     4.2150     4.2150     4.2150     4.2150     4.2150
    8     7.0250     7.0250     7.0250     7.0250     7.0250     7.0250
    9     8.6037     8.6037     8.6037     8.6037     8.6037     8.6037
   10     8.9512     8.9512     8.9512     8.9512     8.9512     8.9512
   11     9.2344     9.2344     9.2344     9.2344     9.2344     9.2344
   12     9.4531     9.4531     9.4531     9.4531     9.4531     9.4531


 NUMBER OF DIFFERENT SECTIONS IN BEAM  2 IS    2
    IF ISAME = 1 USE SECTIONS FROM LAST BEAM, ISAME =      1

X-COORDINATE DISTANCES FROM START OF BEAM (INCHES)

   0.000   195.000
```

```
               SECTION PROPERTIES BY LAYER


  FOR BEAM SECTION NUMBER  1
THICKNESS           WIDTH     INITIAL STRESS    MATERIAL     SHEAR WIDTH
  (IN)              (IN)         (KIPS)           TYPE          (IN)

   .3475           3.7790        0.0000            1.0          .0010
   .3475           3.7790        0.0000            1.0          .0010
  2.8100            .2080        0.0000            2.0          .2080
  2.8100            .2080        0.0000            2.0          .2080
  2.8100            .2080        0.0000            2.0          .2080
  2.8100            .2080        0.0000            2.0          .2080
  2.8100            .2080        0.0000            2.0          .2080
  2.8100            .2080        0.0000            2.0          .2080
   .3475           3.7790        0.0000            1.0          .0010
   .3475           3.7790        0.0000            1.0          .0010
   .2188           3.0000        0.0000            3.0          .0010
   .2188           3.0000        0.0000            3.0          .0010

  FOR BEAM SECTION NUMBER  2
THICKNESS           WIDTH     INITIAL STRESS    MATERIAL     SHEAR WIDTH
  (IN)              (IN)         (KIPS)           TYPE          (IN)

   .3475           3.7790        0.0000            1.0          .0010
   .3475           3.7790        0.0000            1.0          .0010
  2.8100            .2080        0.0000            2.0          .2080
  2.8100            .2080        0.0000            2.0          .2080
  2.8100            .2080        0.0000            2.0          .2080
  2.8100            .2080        0.0000            2.0          .2080
  2.8100            .2080        0.0000            2.0          .2080
  2.8100            .2080        0.0000            2.0          .2080
   .3475           3.7790        0.0000            1.0          .0010
   .3475           3.7790        0.0000            1.0          .0010
   .2188           3.0000        0.0000            2.0          .0010
   .2188           3.0000        0.0000            2.0          .0010




 ELEMENT    CRITICAL FLANGE  LAYER  LAYER    WEB     FLANGE    FLANGE     WEB
 NUMBER     BUCKLING STRESS   CODE   CODE THICKNESS THICKNESS  WIDTH     DEPTH
                (KSI)          1      2     (IN)     (IN)      (IN)      (IN)

    7          36.3600         9     10     .4160    .6950    7.5580   16.8600
    8          36.3600         9     10     .4160    .6950    7.5580   16.8600
    9          36.3600         9     10     .4160    .6950    7.5580   16.8600
   10          39.3900         9     12     .4160   1.1325    6.9561   16.8600
   11          39.3900         9     12     .4160   1.1325    6.9561   16.8600
   12          39.3900         9     12     .4160   1.1325    6.9561   16.8600

BEAM NO.   2 HAS THE FOLLOWING ELEMENT/LAYER PROPERTIES (LAYERS VERTICAL, ELEMENTS HORIZONTAL).


      INITIAL STRESS (KSI) IN LAYERS

     LAYER       1           2           3           4           5           6
        1     0.0000      0.0000      0.0000      0.0000      0.0000      0.0000
        2     0.0000      0.0000      0.0000      0.0000      0.0000      0.0000
        3     0.0000      0.0000      0.0000      0.0000      0.0000      0.0000
        4     0.0000      0.0000      0.0000      0.0000      0.0000      0.0000
        5     0.0000      0.0000      0.0000      0.0000      0.0000      0.0000
        6     0.0000      0.0000      0.0000      0.0000      0.0000      0.0000
        7     0.0000      0.0000      0.0000      0.0000      0.0000      0.0000
        8     0.0000      0.0000      0.0000      0.0000      0.0000      0.0000
        9     0.0000      0.0000      0.0000      0.0000      0.0000      0.0000
       10     0.0000      0.0000      0.0000      0.0000      0.0000      0.0000
       11     0.0000      0.0000      0.0000      0.0000      0.0000      0.0000
       12     0.0000      0.0000      0.0000      0.0000      0.0000      0.0000
```

FEL 435.2

```
MATERIAL TYPE OF LAYERS

LAYER       1     2     3     4     5     6
   1        1     1     1     1     1     1
   2        1     1     1     1     1     1
   3        2     2     2     2     2     2
   4        2     2     2     2     2     2
   5        2     2     2     2     2     2
   6        2     2     2     2     2     2
   7        2     2     2     2     2     2
   8        2     2     2     2     2     2
   9        1     1     1     1     1     1
  10        1     1     1     1     1     1
  11        3     3     3     2     2     2
  12        3     3     3     2     2     2
```

```
AREAS (SQ.IN) OF LAYERS

LAYER         1         2         3         4         5         6
   1     1.3132    1.3132    1.3132    1.3132    1.3132    1.3132
   2     1.3132    1.3132    1.3132    1.3132    1.3132    1.3132
   3      .5845     .5845     .5845     .5845     .5845     .5845
   4      .5845     .5845     .5845     .5845     .5845     .5845
   5      .5845     .5845     .5845     .5845     .5845     .5845
   6      .5845     .5845     .5845     .5845     .5845     .5845
   7      .5845     .5845     .5845     .5845     .5845     .5845
   8      .5845     .5845     .5845     .5845     .5845     .5845
   9     1.3132    1.3132    1.3132    1.3132    1.3132    1.3132
  10     1.3132    1.3132    1.3132    1.3132    1.3132    1.3132
  11      .6563     .6563     .6562     .6563     .6563     .6563
  12      .6563     .6563     .6562     .6563     .6563     .6563
```

```
SHEAR AREAS (SQ.IN) OF LAYERS

LAYER         1         2         3         4         5         6
   1      .0003     .0003     .0003     .0003     .0003     .0003
   2      .0003     .0003     .0003     .0003     .0003     .0003
   3      .5845     .5845     .5845     .5845     .5845     .5845
   4      .5845     .5845     .5845     .5845     .5845     .5845
   5      .5845     .5845     .5845     .5845     .5845     .5845
   6      .5845     .5845     .5845     .5845     .5845     .5845
   7      .5845     .5845     .5845     .5845     .5845     .5845
   8      .5845     .5845     .5845     .5845     .5845     .5845
   9      .0003     .0003     .0003     .0003     .0003     .0003
  10      .0003     .0003     .0003     .0003     .0003     .0003
  11      .0002     .0002     .0002     .0002     .0002     .0002
  12      .0002     .0002     .0002     .0002     .0002     .0002
```

```
MOMENT OF INERTIA OF LAYERS

LAYER         1         2         3         4         5         6
   1      .0132     .0132     .0132     .0132     .0132     .0132
   2      .0132     .0132     .0132     .0132     .0132     .0132
   3      .3846     .3846     .3846     .3846     .3846     .3846
   4      .3846     .3846     .3846     .3846     .3846     .3846
   5      .3846     .3846     .3846     .3846     .3846     .3846
   6      .3846     .3846     .3846     .3846     .3846     .3846
   7      .3846     .3846     .3846     .3846     .3846     .3846
   8      .3846     .3846     .3846     .3846     .3846     .3846
   9      .0132     .0132     .0132     .0132     .0132     .0132
  10      .0132     .0132     .0132     .0132     .0132     .0132
  11      .0026     .0026     .0026     .0026     .0026     .0026
  12      .0026     .0026     .0026     .0026     .0026     .0026
```

```
    CENTROIDAL DISTANCE (IN) OF LAYERS FROM REFERENCE PLANE

  LAYER         1         2         3         4         5         6
     1      -8.9513   -8.9513   -8.9513   -8.9513   -8.9513   -8.9513
     2      -8.6038   -8.6038   -8.6038   -8.6038   -8.6038   -8.6038
     3      -7.0250   -7.0250   -7.0250   -7.0250   -7.0250   -7.0250
     4      -4.2150   -4.2150   -4.2150   -4.2150   -4.2150   -4.2150
     5      -1.4050   -1.4050   -1.4050   -1.4050   -1.4050   -1.4050
     6       1.4050    1.4050    1.4050    1.4050    1.4050    1.4050
     7       4.2150    4.2150    4.2150    4.2150    4.2150    4.2150
     8       7.0250    7.0250    7.0250    7.0250    7.0250    7.0250
     9       8.6037    8.6037    8.6037    8.6037    8.6037    8.6037
    10       8.9512    8.9512    8.9512    8.9512    8.9512    8.9512
    11       9.2344    9.2344    9.2344    9.2344    9.2344    9.2344
    12       9.4531    9.4531    9.4531    9.4531    9.4531    9.4531


             SHEAR CONNECTOR STIFFNES KSC,

 BEAM ELEMENT        KSC
   NUMBER         (KIP/IN)

      1           694.4014
      2           694.4014
      3          1928.8927
      4          2143.6204
      5          4823.1459
      6          4823.1459
      7           392.5848
      8           392.5848
      9          1090.5133
     10          1222.8065
     11          2767.0645
     12          2767.0645


    MODEL ASSUMES FULL COMPOSITE ACTION


  LOADS FOR DEAD LOAD BEAM SOLUTION


  NUMBER OF PATCH LOAD CARDS        =     2

  LOAD CARD    LOAD (KSI)   X OF CENTER(IN)  Y OF C ENTER(IN)  LENGTH(IN)   WIDTH(IN)
      1          4.4408       150.00             36.00         300.00         .01

 THE IMPACT FACTOR APPLIED TO THE ABOVE LOAD  =      1.000

      2          4.0851       150.00             96.00         300.00         .01

 THE IMPACT FACTOR APPLIED TO THE ABOVE LOAD  =      1.000


              FOR DEAD LOAD SOLUTION OF BEAMS
```

```
NODAL POINT FORCES WITH SPECIFIED UNIFORM AND CONCENTRATED LOADS

NODE          U            V            W            XX           YY           ZZ

  1        0.00000      0.00000       .00000      -.00000      -.00072      0.00000
  2        0.00000      0.00000      1.66530       .00000    -20.81456      0.00000
  3        0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
  4        0.00000      0.00000       .00000       .00000      -.00167      0.00000
  5        0.00000      0.00000       .76596       .00191     -9.57370      0.00000
  6        0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
  7        0.00000      0.00000       .00000      -.00000      0.00000      0.00000
  8        0.00000      0.00000      3.33060       .00000      0.00000      0.00000
  9        0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
 10        0.00000      0.00000       .00000       .00000      0.00000      0.00000
 11        0.00000      0.00000      1.53192       .00383      0.00000      0.00000
 12        0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
 13        0.00000      0.00000       .00000      -.00000       .00046      0.00000
 14        0.00000      0.00000      2.66448       .00000     13.32138      0.00000
 15        0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
 16        0.00000      0.00000       .00000       .00000       .00107      0.00000
 17        0.00000      0.00000      1.22554       .00306      6.12717      0.00000
 18        0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
 19        0.00000      0.00000       .00000      -.00000      0.00000      0.00000
 20        0.00000      0.00000      1.99836       .00000      0.00000      0.00000
 21        0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
 22        0.00000      0.00000       .00000       .00000      0.00000      0.00000
 23        0.00000      0.00000       .91915       .00230      0.00000      0.00000
 24        0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
 25        0.00000      0.00000       .00000      -.00000       .00014      0.00000
 26        0.00000      0.00000      1.66530       .00000      4.16293      0.00000
 27        0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
 28        0.00000      0.00000       .00000       .00000       .00033      0.00000
 29        0.00000      0.00000       .76596       .00191      1.91474      0.00000
 30        0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
 31        0.00000      0.00000       .00000      -.00000      0.00000      0.00000
 32        0.00000      0.00000      1.33224       .00000      0.00000      0.00000
 33        0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
 34        0.00000      0.00000       .00000       .00000      0.00000      0.00000
 35        0.00000      0.00000       .61277       .00153      0.00000      0.00000
 36        0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
 37        0.00000      0.00000       .00000      -.00000       .00017      0.00000
 38        0.00000      0.00000       .66612       .00000      3.33035      0.00000
 39        0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
 40        0.00000      0.00000       .00000       .00000       .00027      0.00000
 41        0.00000      0.00000       .30638       .00077      1.53179      0.00000
 42        0.00000      0.00000      0.00000      0.00000      0.00000      0.00000

TOTAL FORCES ON STRUCTURE

NODE       U            V            W            XY           YY           ZZ

  1        0.00000      0.00000       .00000      -.00000      -.00072      0.00000
  2        0.00000      0.00000      0.00000       .00000    -20.81465      0.00000
  3        0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
  4        0.00000      0.00000       .00000       .00000      -.00167      0.00000
  5        0.00000      0.00000      0.00000       .00191     -9.57370      0.00000
  6        0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
  7        0.00000      0.00000       .00000      -.00000      0.00000      0.00000
  8        0.00000      0.00000      3.33060       .00000      0.00000      0.00000
  9        0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
 10        0.00000      0.00000       .00000       .00000      0.00000      0.00000
 11        0.00000      0.00000      1.53192       .00383      0.00000      0.00000
 12        0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
 13        0.00000      0.00000       .00000      -.00000       .00046      0.00000
 14        0.00000      0.00000      2.66448       .00000     13.32138      0.00000
 15        0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
 16        0.00000      0.00000       .00000       .00000       .00107      0.00000
 17        0.00000      0.00000      1.22554       .00306      6.12717      0.00000
 18        0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
 19        0.00000      0.00000       .00000      -.00000      0.00000      0.00000
 20        0.00000      0.00000      1.99836       .00000      0.00000      0.00000
 21        0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
 22        0.00000      0.00000       .00000       .00000      0.00000      0.00000
 23        0.00000      0.00000       .91915       .00230      0.00000      0.00000
 24        0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
 25        0.00000      0.00000       .00000      -.00000       .00014      0.00000
 26        0.00000      0.00000      1.66530       .00000      4.16293      0.00000
 27        0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
 28        0.00000      0.00000       .00000       .00000       .00033      0.00000
```

```
   29          0.00000        0.00000        .76596       .00191       1.91474       0.00000
   30          0.00000        0.00000       0.00000      0.00000       0.00000       0.00000
   31          0.00000        0.00000        .00000      -.00000       0.00000       0.00000
   32          0.00000        0.00000       1.33224       .00000       0.00000       0.00000
   33          0.00000        0.00000       0.00000      0.00000       0.00000       0.00000
   34          0.00000        0.00000        .00000       .00000       0.00000       0.00000
   35          0.00000        0.00000        .61277       .00151       0.00000       0.00000
   36          0.00000        0.00000       0.00000      0.00000       0.00000       0.00000
   37          0.00000        0.00000        .00000      -.00000       0.00000       0.00000
   38          0.00000        0.00000        .66612       .00000       0.00000       0.00000
   39          0.00000        0.00000       0.00000      0.00000       0.00000       0.00000
   40          0.00000        0.00000        .00000       .00000       0.00000       0.00000
   41          0.00000        0.00000        .30638       .00077       0.00000       0.00000
   42          0.00000        0.00000       0.00000      0.00000       0.00000       0.00000

  SUM          0.00000        0.00000      17.01892       .01532      -4.86252       0.00000


      MEMORY REQUIREMENTS FOR OVERLAY CMPLTS

    WITHOUT DATA       070715 OCTAL       29133 DECIMAL

    WITH    DATA       102405 OCTAL       34053 DECIMAL



                               DEAD LOAD BEAM SOLUTION



 NUMBER OF TRIALS      =       0

 NUMBER OF ITERATIONS  =       1

 NUMBER OF TRIALS      =       0

 NUMBER OF ITERATIONS  =       2

 NUMBER OF TRIALS      =       1

 NUMBER OF ITERATIONS  =       1


     APPLIED NODAL POINT FORCES IN KIPS AND IN-KIPS

  NODE            U              V              W            XX            YY              ZZ

    1          0.00000        0.00000        .00000      -.00000        -.00072       0.00000
    2          0.00000        0.00000       1.66530       .00000      -20.81466       0.00000
    3          0.00000        0.00000       0.00000      0.00000        0.00000       0.00000
    4          0.00000        0.00000        .00000       .00000        -.00167       0.00000
    5          0.00000        0.00000        .76596       .00191       -9.57370       0.00000
    6          0.00000        0.00000       0.00000      0.00000        0.00000       0.00000
    7          0.00000        0.00000        .00000      -.00000        0.00000       0.00000
    8          0.00000        0.00000       3.33060       .00000        0.00000       0.00000
    9          0.00000        0.00000       0.00000      0.00000        0.00000       0.00000
   10          0.00000        0.00000        .00000       .00000        0.00000       0.00000
   11          0.00000        0.00000       1.53192       .00333        0.00000       0.00000
   12          0.00000        0.00000       0.00000      0.00000        0.00000       0.00000
   13          0.00000        0.00000        .00000      -.00000         .00046       0.00000
   14          0.00000        0.00000       2.56448       .00000       13.32138       0.00000
   15          0.00000        0.00000       0.00000      0.00000        0.00000       0.00000
   16          0.00000        0.00000        .00000       .00000         .00107       0.00000
   17          0.00000        0.00000       1.22554       .00306        5.12717       0.00000
   18          0.00000        0.00000       0.00000      0.00000        0.00000       0.00000
   19          0.00000        0.00000        .00000      -.00000        0.00000       0.00000
   20          0.00000        0.00000       1.39835       .00000        0.00000       0.00000
   21          0.00000        0.00000       0.00000      0.00000        0.00000       0.00000
   22          0.00000        0.00000        .00000       .00000        0.00000       0.00000
   23          0.00000        0.00000        .91915       .00239        0.00000       0.00000
   24          0.00000        0.00000       0.00000      0.00000        0.00000       0.00000
   25          0.00000        0.00000        .00000      -.00000         .00014       0.00000
   26          0.00000        0.00000       1.66530       .00000        4.16293       0.00000
   27          0.00000        0.00000       0.00000      0.00000        0.00000       0.00000
   28          0.00000        0.00000        .00000       .00000         .00033       0.00000
   29          0.00000        0.00000        .76596       .00191        1.91474       0.00000
   30          0.00000        0.00000       0.00000      0.00000        0.00000       0.00000
   31          0.00000        0.00000        .00000      -.00000        0.00000       0.00000
```

FEL 435.2

```
  32         0.00000      0.00000      1.33226       .00036      0.00000      0.00000
  33         0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
  34         0.00000      0.00000       .00000       .00000      0.00000      0.00000
  35         0.00000      0.00000       .61277       .00153      0.00000      0.00000
  36         0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
  37         0.00000      0.00000       .00000      -.00000       .00012      0.00000
  38         0.00000      0.00000       .66612       .00000      3.33035      0.00000
  39         0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
  40         0.00000      0.00000       .00000       .00000       .00027      0.00000
  41         0.00000      0.00000       .30633       .00077      1.53179      0.00000
  42         0.00000      0.00000      0.00000      0.00000      0.00000      0.00000


NODAL POINT DISPLACEMENTS IN INCHES AND RADIANS

NODE            U            V            W           XX           YY           ZZ

   1          .16249      0.00000       .02511       .00085      -.01333      0.00000
   2          .16856      0.00000      0.00000       .00037      -.01313      0.00000
   3          .00710      0.00000      0.00000      0.00000      -.01290      0.00000
   4          .15739      0.00000      -.00222      -.00001      -.01261      0.00000
   5          .15554      0.00000      0.00000      -.00003      -.01209      0.00000
   6          .00660      0.00000      0.00000      0.00000      -.01188      0.00000
   7          .14834      -.00137       .98997       .00127      -.01210      0.00000
   8          .15350      -.00162       .94359       .00125      -.01197      0.00000
   9          .00711      0.00000      0.00000      0.00000      -.01169      0.00000
  10          .14356      -.00179       .90642       .00123      -.01135      0.00000
  11          .14139      -.00177       .86873       .00131      -.01093      0.00000
  12          .00660      0.00000      0.00000      0.00000      -.01076      0.00000
  13          .10989      -.00241      1.78955       .00203      -.00889      0.00000
  14          .11299      -.00281      1.71538       .00213      -.00851      0.00000
  15          .00713      0.00000      0.00000      0.00000      -.00849      0.00000
  16          .10620      -.00306      1.64926       .00227      -.00821      0.00000
  17          .10410      -.00299      1.57937       .00240      -.00793      0.00000
  18          .00661      0.00000      0.00000      0.00000      -.00782      0.00000
  19          .07925      -.00279      2.13277       .00243      -.00631      0.00000
  20          .08041      -.00309      2.04398       .00254      -.00597      0.00000
  21          .00714      0.00000      0.00000      0.00000      -.00590      0.00000
  22          .07674      -.00333      1.96513       .00270      -.00579      0.00000
  23          .07409      -.00333      1.88203       .00284      -.00550      0.00000
  24          .00661      0.00000      0.00000      0.00000      -.00543      0.00000
  25          .04542      -.00224      2.35665       .00273      -.00365      0.00000
  26          .04724      -.00244      2.25726       .00282      -.00351      0.00000
  27          .00420      0.00000      0.00000      0.00000      -.00347      0.00000
  28          .04459      -.00269      2.17037       .00298      -.00334      0.00000
  29          .04353      -.00281      2.07847       .00314      -.00323      0.00000
  30          .00392      0.00000      0.00000      0.00000      -.00319      0.00000
  31          .02252      -.00093      2.43921       .00292      -.00184      0.00000
  32          .02243      -.00135      2.33645       .00292      -.00177      0.00000
  33          .00212      0.00000      0.00000      0.00000      -.00175      0.00000
  34          .02247      -.00163      2.24621       .00307      -.00170      0.00000
  35          .02196      -.00164      2.15141       .00324      -.00163      0.00000
  36          .00196      0.00000      0.00000      0.00000      -.00161      0.00000
  37         0.00000      0.00000      2.46694       .00285      0.00000      0.00000
  38         0.00000      0.00000      2.36298       .00296      0.00000      0.00000
  39         0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
  40         0.00000      0.00000      2.27171       .00312      0.00000      0.00000
  41         0.00000      0.00000      2.17585       .00327      0.00000      0.00000
  42         0.00000      0.00000      0.00000      0.00000      0.00000      0.00000


        DISPLACEMENT/REFERENCE DISPLACEMENT =     2.17585

        FORCE/REFERENCE FORCE               =      .00000

        SUM OF NODAL POINT W-LOADS          =     13.4501

        SUM OF W-LOADS FOR TOTAL STRUCTURE  =     77.8003

        (SUM OF W-LOADS FOR TOTAL STRUCTURE
             WITHOUT IMPACT FACTOR)         =     77.8003

FOR THE DEAD LOAD ON THE BEAM SOLUTION (WET CONCRETE), INTERNAL MOMENTS, NORMAL FORCES, AND TOTAL STRESSES
     IN THE CONCRETE SLAB WILL ALWAYS BE ZERO FOR ALL ELEMENTS AND FOR ALL LAYERS
```

```
    INTERNAL MOMENTS (IN-KIPS), NORMAL FORCES (KIPS), AND SHEAR FORCES (KIPS) IN BEAM ELEMENTS
   ELEM        MB                     NB               VB

    1        455.1403               .0474            -9.9403
    2       1199.8709               .1285            -8.5045
    3       1623.5496               .1735            -5.6636
    4       1833.6721               .1880            -3.5517
    5       1941.3457               .1986            -2.0792
    6       1981.0976               .2029             -.6565
    7        209.5513               .0059            -4.5734
    8        552.4794               .0139            -3.9129
    9        747.6028               .0159            -2.6059
   10        844.3907               .0120            -1.6343
   11        894.0064               .0099             -.9557
   12        912.3434               .0078             -.3022
TOTAL STRESSES IN BEAM LAYERS (STRESS (KSI), ANG. (DEGREES), + TEN., - COMP.)

  EL LAYER      SXX          SYY          SXY          S1           S2         THETA1

   1   1     -4.19195     0.00000      -.00014     -4.19195      .00000       .00195
   1   2     -4.02911     0.00000      -.03192     -4.02936      .00025       .45392
   1   3     -3.28930     0.00000     -1.13493     -3.64289      .35359     17.30430
   1   4     -1.97253     0.00000     -1.33658     -2.64733      .67481     26.78816
   1   5      -.65575     0.00000     -1.45750     -1.82179     1.16605     38.66098
   1   6       .66103     0.00000     -1.49769      1.86424    -1.20321    -38.77764
   1   7      1.97780     0.00000     -1.45716      2.74994     -.77213    -27.91859
   1   8      3.29458     0.00000     -1.33590      3.76819     -.47360    -19.52048
   1   9      4.03439     0.00000      -.06241      4.03535     -.00097      -.88609
   1  10      4.19723     0.00000      -.03183      4.19747     -.00024      -.43441
   1  11       .00045     0.00000      -.00000       .00045     -.00000      -.55330
   1  12       .00046     0.00000      -.00000       .00046     -.00000      -.27344

   2   1    -11.05089     0.00000      -.00012    -11.05089      .00000       .00063
   2   2    -10.62160     0.00000      -.02731    -10.62167      .00007       .14732
   2   3     -8.67127     0.00000      -.97099     -8.77867      .10740      6.31173
   2   4     -5.19990     0.00000     -1.14351     -5.44026      .24036     11.87046
   2   5     -1.72853     0.00000     -1.24697     -2.38146      .65293     27.63723
   2   6      1.74284     0.00000     -1.28136      2.42102     -.67818    -27.89069
   2   7      5.21421     0.00000     -1.24568      5.49695     -.28274    -12.77826
   2   8      8.68558     0.00000     -1.14294      8.83346     -.14788     -7.37241
   2   9     10.63591     0.00000      -.05340     10.63617     -.00027      -.28764
   2  10     11.06519     0.00000      -.02723     11.06526     -.00007      -.14099
   2  11       .00118     0.00000      -.00000       .00118     -.00000      -.17958
   2  12       .00121     0.00000      -.00000       .00121     -.00000      -.08874

   3   1    -14.95301     0.00000      -.00007    -14.95301      .00000       .00027
   3   2    -14.37214     0.00000      -.01510    -14.37216      .00002       .06018
   3   3    -11.73315     0.00000      -.54182    -11.75811      .02497      2.63834
   3   4     -7.03602     0.00000      -.64997     -7.09556      .05954      5.23381
   3   5     -2.33890     0.00000      -.73866     -2.55265      .21374     16.13880
   3   6      2.35822     0.00000      -.80788      2.60844     -.25022    -17.20872
   3   7      7.05534     0.00000      -.85764      7.15810     -.10276     -6.83228
   3   8     11.75246     0.00000      -.88794     11.81917     -.06671     -4.29640
   3   9     14.39146     0.00000      -.04947     14.39163     -.00017      -.19695
   3  10     14.97233     0.00000      -.04946     14.97250     -.00016      -.18926
   3  11       .00160     0.00000      -.06191       .06271     -.06112    -44.63034
   3  12       .00164     0.00000      -.03137       .03220     -.03055    -44.25334

   4   1    -15.91763     0.00000      -.00004    -15.91763      .00000       .00014
   4   2    -15.37336     0.00000      -.00810    -15.37336      .00000       .03017
   4   3    -12.90064     0.00000      -.29331    -12.90730      .00667      1.30173
   4   4     -8.49946     0.00000      -.35814     -8.51453      .01506      2.40959
   4   5     -4.09829     0.00000      -.42254     -4.14140      .04311      5.82557
   4   6       .30289     0.00000      -.48649       .66096     -.35807    -36.35431
   4   7      4.70406     0.00000      -.54999      4.76751     -.06345     -6.58070
   4   8      9.10523     0.00000      -.61306      9.14632     -.04109     -3.83466
   4   9     11.57796     0.00000      -.03719     11.57808     -.00012      -.18404
   4  10     12.12223     0.00000      -.04490     12.12240     -.00017      -.21223
   4  11     12.56568     0.00000      -.06627     12.56603     -.00035      -.30215
   4  12     12.90829     0.00000      -.03358     12.90838     -.00009      -.14905

   5   1    -16.85236     0.00000      -.00003    -16.85236      .00000       .00013
   5   2    -16.27613     0.00000      -.00636    -16.27613      .00000       .02233
   5   3    -13.65820     0.00000      -.22656    -13.66196      .00376       .95308
   5   4     -8.99859     0.00000      -.26804     -9.00656      .00798      1.70469
   5   5     -4.33897     0.00000      -.29537     -4.35899      .02002      3.87655
   5   6       .32065     0.00000      -.30855       .50804     -.18739    -31.27185
   5   7      4.98026     0.00000      -.30758      4.99918     -.01892     -3.52072
   5   8      9.63988     0.00000      -.29245      9.66974     [illegible]  -1.73619
```

```
 5  9     12.25790      0.00000      -.01449     12.25742      -.00002      -.06771
 5 10     12.83403      0.00000      -.00988     12.83404      -.00001      -.04412
 5 11     13.30352      0.00000      -.00638     13.30352      -.00000      -.02746
 5 12     13.66626      0.00000      -.00323     13.66626      -.00000      -.01355

 6  1    -17.19741      0.00000      -.00001    -17.19741       .00000       .00003
 6  2    -15.60938      0.00000      -.00201    -15.60938       .00000       .00693
 6  3    -13.93785      0.00000      -.07155    -13.93822       .00037       .23411
 6  4     -9.18282      0.00000      -.08464     -9.18361       .00078       .52808
 6  5     -4.42780      0.00000      -.09327     -4.42976       .00196      1.20624
 6  6       .32722      0.00000      -.09743       .35404      -.02681    -15.39723
 6  7      5.08225      0.00000      -.09713      5.08410      -.00186     -1.09443
 6  8      9.83727      0.00000      -.09235      9.83814      -.00087      -.53781
 6  9     12.50890      0.00000      -.00457     12.50880      -.00010      -.02095
 6 10     13.09683      0.00000      -.00312     13.09683      -.00000      -.01365
 6 11     13.57593      0.00000      -.00201     13.57593      -.00000      -.00850
 6 12     13.94610      0.00000      -.00102     13.94610      -.00000      -.00419

 7  1     -3.86186      0.00000      -.00003     -3.86186       .00000       .00042
 7  2     -3.71192      0.00000      -.02931     -3.71215       .00023       .45240
 7  3     -3.03069      0.00000     -1.04390     -3.35545       .32476     17.28120
 7  4     -1.81817      0.00000     -1.22973     -2.43835       .62018     26.76303
 7  5      -.60565      0.00000     -1.34121     -1.67780      1.07215     38.63840
 7  6       .60687      0.00000     -1.37835      1.71479     -1.10792    -38.79241
 7  7      1.81939      0.00000     -1.34115      2.53025      -.71087    -27.92562
 7  8      3.03190      0.00000     -1.22960      3.46788      -.43598    -19.52294
 7  9      3.71313      0.00000      -.05745      3.71402      -.00089      -.88615
 7 10      3.86308      0.00000      -.02929      3.86330      -.00022      -.43444
 7 11       .00041      0.00000      -.00000       .00041      -.00000      -.55335
 7 12       .00042      0.00000      -.00000       .00042      -.00000      -.27346

 8  1    -10.18190      0.00000      -.00002    -10.18190       .00000       .00010
 8  2     -9.78657      0.00000      -.02507     -9.78664       .00006       .14680
 8  3     -7.99052      0.00000      -.89311     -8.08913       .09861      6.30042
 8  4     -4.79374      0.00000     -1.05211     -5.01449       .22075     11.84961
 8  5     -1.59696      0.00000     -1.14751     -2.19646       .59950     27.58414
 8  6      1.59981      0.00000     -1.17929      2.22489      -.62508    -27.92562
 8  7      4.79659      0.00000     -1.14747      5.05696      -.26037    -12.78445
 8  8      7.99337      0.00000     -1.05204      8.12951      -.13614     -7.37364
 8  9      9.78942      0.00000      -.04915      9.78967      -.00025      -.28766
 8 10     10.18475      0.00000      -.02506     10.18482      -.00006      -.14100
 8 11       .00109      0.00000      -.00000       .00109      -.00000      -.17960
 8 12       .00111      0.00000      -.00000       .00111      -.00000      -.08875

 9  1    -13.77826      0.00000       .00001    -13.77826       .00000      -.00003
 9  2    -13.24330      0.00000      -.01385    -13.24332       .00001       .05990
 9  3    -10.81292      0.00000      -.49826    -10.83584       .02291      2.63275
 9  4     -6.48712      0.00000      -.59798     -6.54178       .05466      5.22284
 9  5     -2.16131      0.00000      -.67975     -2.35732       .19601     16.08530
 9  6      2.16450      0.00000      -.74357      2.39533      -.23083    -17.24578
 9  7      6.49031      0.00000      -.78945      6.58495      -.09465     -6.83642
 9  8     10.81611      0.00000      -.81738     10.87754      -.06142     -4.29737
 9  9     13.24650      0.00000      -.04554     13.24665      -.00016      -.19697
 9 10     13.78145      0.00000      -.04553     13.78160      -.00015      -.18927
 9 11       .00147      0.00000      -.05699       .05773      -.05626    -44.63035
 9 12       .00151      0.00000      -.02898       .02964      -.02813    -44.25336

10  1    -14.66885      0.00000       .00002    -14.66885       .00000      -.00007
10  2    -14.16753      0.00000      -.00742    -14.16754       .00000       .02999
10  3    -11.88995      0.00000      -.26966    -11.89606       .00611      1.29855
10  4     -7.83611      0.00000      -.32947     -7.84994       .01383      2.40338
10  5     -3.78227      0.00000      -.38885     -3.92183       .03956      5.80961
10  6       .27158      0.00000      -.44780       .60373      -.33215    -36.56545
10  7      4.32542      0.00000      -.50632      4.38390      -.05849     -6.58815
10  8      8.37726      0.00000      -.56440      8.41711      -.03764     -3.83613
10  9     10.65685      0.00000      -.03424     10.65696      -.00011      -.18407
10 10     11.15317      0.00000      -.04134     11.15332      -.00015      -.21225
10 11     11.56662      0.00000      -.06100     11.56694      -.00032      -.30217
10 12     11.88220      0.00000      -.03091     11.88228      -.00008      -.14906

11  1    -15.53112      0.00000       .00002    -15.53112       .00000      -.00005
11  2    -15.00034      0.00000      -.00582    -15.00034       .00000       .02225
11  3    -12.58992      0.00000      -.20834    -12.59237       .00345       .94786
11  4     -9.29686      0.00000      -.24663     -9.30419       .00732      1.70115
11  5     -4.00480      0.00000      -.27188     -4.02317       .01837      3.86603
11  6       .28726      0.00000      -.28407       .46195      -.17469    -31.58917
11  7      4.57932      0.00000      -.28322      4.59677      -.01745     -3.52570
11  8      8.87138      0.00000      -.26932      8.87955      -.00817     -1.73725
11  9     11.28280      0.00000      -.01334     11.28282      -.00002      -.06774
11 10     11.81359      0.00000      -.00910     11.81359      -.00001      -.04414
11 11     12.24603      0.00000      -.00587     12.24604      -.00000      -.02749
11 12     12.58016      0.00000      -.00298     12.58016      -.00000      -.01355

12  1    -15.84307      0.00000       .00001    -15.84307       .00000      -.00003
12  2    -15.30830      0.00000      -.00184   [illegible]  [illegible]  [illegible]
```

```
12  3       -12.84741       0.00000        -.06576      -12.84775        .00033        .23335
12  4        -8.46730       0.00000        -.07799       -8.46682        .00172        .52647
12  5        -4.08714       0.00000        -.08587       -4.08690        .00115       1.20332
12  6          .29232       0.00000        -.08972         .31322       -.02731     -15.74633
12  7         4.67302       0.00000        -.08946        4.67474       -.00171      -1.09634
12  8         9.05313       0.00000        -.06507        9.06393       -.00960       -.53935
12  9        11.51402       0.00000        -.00421       11.51402       -.00069       -.02097
12 10        12.05569       0.00000        -.00287       12.05569       -.00003       -.01365
12 11        12.49701       0.00000        -.00196       12.49701       -.00002       -.00859
12 12        12.83799       0.00000        -.00094       12.83799       -.00090       -.00420


 LOADS FOR DEAD LOAD STRUCTURE SOLUTION


 NUMBER OF PATCH LOAD CARDS          =    1

 LOAD CARD     LOAD (KSI)     X OF CENTER(IN)  Y OF CENTER(IN)  LENGTH(IN)     WIDTH(IN)
     1           .0003        150.00                6.00        300.00         12.00


THE IMPACT FACTOR APPLIED TO THE ABOVE LOAD  =      1.000



                        NODAL POINT FORCES WITH SPECIFIED UNIFORM AND CONCENTRATED LOADS

   NODE             U                V                W                XX               YY               ZZ

     1           0.00000          0.00000           .11311          -.45705         -1.29844          0.00000
     2           0.00000          0.00000           .01154           .12465          -.25969          0.00000
     3           0.00000          0.00000          0.00000          0.00000          0.00000          0.00000
     4           0.00000          0.00000          0.00000          0.00000          0.00000          0.00000
     5           0.00000          0.00000          0.00000          0.00000          0.00000          0.00000
     6           0.00000          0.00000          0.00000          0.00000          0.00000          0.00000
     7           0.00000          0.00000           .22622          -.91410          0.00000          0.00000
     8           0.00000          0.00000           .02303           .24930          0.00000          0.00000
     9           0.00000          0.00000          0.00000          0.00000          0.00000          0.00000
    10           0.00000          0.00000          0.00000          0.00000          0.00000          0.00000
    11           0.00000          0.00000          0.00000          0.00000          0.00000          0.00000
    12           0.00000          0.00000          0.00000          0.00000          0.00000          0.00000
    13           0.00000          0.00000           .18097          -.73128           .83100          0.00000
    14           0.00000          0.00000           .01847           .19944           .16620          0.00000
    15           0.00000          0.00000          0.00000          0.00000          0.00000          0.00000
    16           0.00000          0.00000          0.00000          0.00000          0.00000          0.00000
    17           0.00000          0.00000          0.00000          0.00000          0.00000          0.00000
    18           0.00000          0.00000          0.00000          0.00000          0.00000          0.00000
    19           0.00000          0.00000           .13573          -.54845          0.00000          0.00000
    20           0.00000          0.00000           .01385           .14953          0.00000          0.00000
    21           0.00000          0.00000          0.00000          0.00000          0.00000          0.00000
    22           0.00000          0.00000          0.00000          0.00000          0.00000          0.00000
    23           0.00000          0.00000          0.00000          0.00000          0.00000          0.00000
    24           0.00000          0.00000          0.00000          0.00000          0.00000          0.00000
    25           0.00000          0.00000           .11311          -.45705           .25969          0.00000
    26           0.00000          0.00000           .01154           .12465           .05194          0.00000
    27           0.00000          0.00000          0.00000          0.00000          0.00000          0.00000
    28           0.00000          0.00000          0.00000          0.00000          0.00000          0.00000
    29           0.00000          0.00000          0.00000          0.00000          0.00000          0.00000
    30           0.00000          0.00000          0.00000          0.00000          0.00000          0.00000
    31           0.00000          0.00000           .09049          -.36564          0.00000          0.00000
    32           0.00000          0.00000           .00923           .09972          0.00000          0.00000
    33           0.00000          0.00000          0.00000          0.00000          0.00000          0.00000
    34           0.00000          0.00000          0.00000          0.00000          0.00000          0.00000
    35           0.00000          0.00000          0.00000          0.00000          0.00000          0.00000
    36           0.00000          0.00000          0.00000          0.00000          0.00000          0.00000
    37           0.00000          0.00000           .04524          -.18282           .20775          0.00000
    38           0.00000          0.00000           .00462           .04985           .04155          0.00000
    39           0.00000          0.00000          0.00000          0.00000          0.00000          0.00000
    40           0.00000          0.00000          0.00000          0.00000          0.00000          0.00000
    41           0.00000          0.00000          0.00000          0.00000          0.00000          0.00000
    42           0.00000          0.00000          0.00000          0.00000          0.00000          0.00000

   TOTAL FORCES ON STRUCTURE
   NODE          U                V                W                XX               YY               ZZ
```

```
   1        0.00000     0.00000      .11311     -.45705    -1.29844     0.00000
   2        0.00000     0.00000     0.00000      .12465     -.25969     0.00000
   3        0.00000     0.00000     0.00000     0.00000     0.00000     0.00000
   4        0.00000     0.00000     0.00000     0.00000     0.00000     0.00000
   5        0.00000     0.00000     0.00000     0.00000     0.00000     0.00000
   6        0.00000     0.00000     0.00000     0.00000     0.00000     0.00000
   7        0.00000     0.00000      .22622     -.91410     0.00000     0.00000
   8        0.00000     0.00000      .02308      .24930     0.00000     0.00000
   9        0.00000     0.00000     0.00000     0.00000     0.00000     0.00000
  10        0.00000     0.00000     0.00000     0.00000     0.00000     0.00000
  11        0.00000     0.00000     0.00000     0.00000     0.00000     0.00000
  12        0.00000     0.00000     0.00000     0.00000     0.00000     0.00000
  13        0.00000     0.00000      .18097     -.73128      .83100     0.00000
  14        0.00000     0.00000      .01847      .19944      .16620     0.00000
  15        0.00000     0.00000     0.00000     0.00000     0.00000     0.00000
  16        0.00000     0.00000     0.00000     0.00000     0.00000     0.00000
  17        0.00000     0.00000     0.00000     0.00000     0.00000     0.00000
  18        0.00000     0.00000     0.00000     0.00000     0.00000     0.00000
  19        0.00000     0.00000      .13573     -.54846     0.00000     0.00000
  20        0.00000     0.00000      .01385      .14958     0.00000     0.00000
  21        0.00000     0.00000     0.00000     0.00000     0.00000     0.00000
  22        0.00000     0.00000     0.00000     0.00000     0.00000     0.00000
  23        0.00000     0.00000     0.00000     0.00000     0.00000     0.00000
  24        0.00000     0.00000     0.00000     0.00000     0.00000     0.00000
  25        0.00000     0.00000      .11311     -.45705      .25969     0.00000
  26        0.00000     0.00000      .01154      .12465      .05194     0.00000
  27        0.00000     0.00000     0.00000     0.00000     0.00000     0.00000
  28        0.00000     0.00000     0.00000     0.00000     0.00000     0.00000
  29        0.00000     0.00000     0.00000     0.00000     0.00000     0.00000
  30        0.00000     0.00000     0.00000     0.00000     0.00000     0.00000
  31        0.00000     0.00000      .09049     -.36564     0.00000     0.00000
  32        0.00000     0.00000      .00923      .09972     0.00000     0.00000
  33        0.00000     0.00000     0.00000     0.00000     0.00000     0.00000
  34        0.00000     0.00000     0.00000     0.00000     0.00000     0.00000
  35        0.00000     0.00000     0.00000     0.00000     0.00000     0.00000
  36        0.00000     0.00000     0.00000     0.00000     0.00000     0.00000
  37        0.00000     0.00000      .04524     -.18282     0.00000     0.00000
  38        0.00000     0.00000      .00462      .04986     0.00000     0.00000
  39        0.00000     0.00000     0.00000     0.00000     0.00000     0.00000
  40        0.00000     0.00000     0.00000     0.00000     0.00000     0.00000
  41        0.00000     0.00000     0.00000     0.00000     0.00000     0.00000
  42        0.00000     0.00000     0.00000     0.00000     0.00000     0.00000

 SUM        0.00000     0.00000      .98566    -2.65920     -.24930     0.00000


LOADS FOR LIVE LOAD SOLUTION


NUMBER OF PATCH LOAD CARDS          =    1

LOAD CARD    LOAD (KSI)   X OF CENTER(IN)  Y OF CENTER(IN)  LENGTH(IN)   WIDTH(IN)
    1          .0025        210.00              60.00         180.00       72.00


THE IMPACT FACTOR APPLIED TO THE ABOVE LOAD  =     1.286


                    NODAL POINT FORCES WITH SPECIFIED UNIFORM AND CONCENTRATED LOADS

 NODE         U           V           W           XX          YY          ZZ

   1       0.00000     0.00000     0.00000     0.00000     0.00000     0.00000
   2       0.00000     0.00000     0.00000     0.00000     0.00000     0.00000
   3       0.00000     0.00000     0.00000     0.00000     0.00000     0.00000
   4       0.00000     0.00000     0.00000     0.00000     0.00000     0.00000
   5       0.00000     0.00000     0.00000     0.00000     0.00000     0.00000
   6       0.00000     0.00000     0.00000     0.00000     0.00000     0.00000
   7       0.00000     0.00000      .00542     -.17665     -.41694     0.00000
   8       0.00000     0.00000      .25145     -.46155    -5.21100     0.00000
   9       0.00000     0.00000     0.00000     0.00000     0.00000     0.00000
  10       0.00000     0.00000    [illegible]  0.00000    -6.25320     0.00000
  11       0.00000     0.00000    [illegible]  1.11674    -3.12660     0.00000
```

```
 12           0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
 13           0.00000       0.00000        .13893      -1.38464        .38338       0.00000
 14           0.00000       0.00000       3.12127      -3.57698       4.79226       0.00000
 15           0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
 16           0.00000       0.00000       3.62239       -.00000       5.75071       0.00000
 17           0.00000       0.00000       1.81119       8.65398       2.87536       0.00000
 18           0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
 19           0.00000       0.00000        .12407      -1.33497       0.00000       0.00000
 20           0.00000       0.00000       2.89086      -3.46159       0.00000       0.00000
 21           0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
 22           0.00000       0.00000       3.34993       -.00000       0.00000       0.00000
 23           0.00000       0.00000       1.67496       9.37482       0.00000       0.00000
 24           0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
 25           0.00000       0.00000        .10339      -1.11664        .46527       0.00000
 26           0.00000       0.00000       2.40905      -2.88466       5.81585       0.00000
 27           0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
 28           0.00000       0.00000       2.79161       -.00000       6.97902       0.00000
 29           0.00000       0.00000       1.39580       6.97902       3.48951       0.00000
 30           0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
 31           0.00000       0.00000        .08271       -.89331       0.00000       0.00000
 32           0.00000       0.00000       1.92724      -2.30773       0.00000       0.00000
 33           0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
 34           0.00000       0.00000       2.23329       -.00000       0.00000       0.00000
 35           0.00000       0.00000       1.11664       5.58321       0.00000       0.00000
 36           0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
 37           0.00000       0.00000        .04136       -.44666        .37221       0.00000
 38           0.00000       0.00000        .96362      -1.15386       4.65268       0.00000
 39           0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
 40           0.00000       0.00000       1.11664       0.00000       5.58321       0.00000
 41           0.00000       0.00000        .55832       2.79161       2.79161       0.00000
 42           0.00000       0.00000       0.00000       0.00000       0.00000       0.00000

TOTAL FORCES ON STRUCTURE

NODE      U             V             W             XX            YY            ZZ

  1           0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
  2           0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
  3           0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
  4           0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
  5           0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
  6           0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
  7           0.00000       0.00000        .00592       -.17866       -.41688       0.00000
  8           0.00000       0.00000        .25145       -.46155      -5.21100       0.00000
  9           0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
 10           0.00000       0.00000        .28586       0.00000      -6.25320       0.00000
 11           0.00000       0.00000        .14293       1.11664      -3.12660       0.00000
 12           0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
 13           0.00000       0.00000        .13893      -1.38464        .38338       0.00000
 14           0.00000       0.00000       3.12127      -3.57698       4.79226       0.00000
 15           0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
 16           0.00000       0.00000       3.62239       -.00000       5.75071       0.00000
 17           0.00000       0.00000       1.81119       8.65398       2.87536       0.00000
 18           0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
 19           0.00000       0.00000        .12407      -1.33497       0.00000       0.00000
 20           0.00000       0.00000       2.89086      -3.46159       0.00000       0.00000
 21           0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
 22           0.00000       0.00000       3.34993       -.00000       0.00000       0.00000
 23           0.00000       0.00000       1.67496       9.37482       0.00000       0.00000
 24           0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
 25           0.00000       0.00000        .10339      -1.11664        .46527       0.00000
 26           0.00000       0.00000       2.40905      -2.88466       5.81585       0.00000
 27           0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
 28           0.00000       0.00000       2.79161       -.00000       6.97902       0.00000
 29           0.00000       0.00000       1.39580       6.97902       3.48951       0.00000
 30           0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
 31           0.00000       0.00000        .08271       -.89331       0.00000       0.00000
 32           0.00000       0.00000       1.92724      -2.30773       0.00000       0.00000
 33           0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
 34           0.00000       0.00000       2.23329       -.00000       0.00000       0.00000
 35           0.00000       0.00000       1.11664       5.58321       0.00000       0.00000
 36           0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
 37           0.00000       0.00000        .04136       -.44666       0.00000       0.00000
 38           0.00000       0.00000        .96362      -1.15386       0.00000       0.00000
 39           0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
 40           0.00000       0.00000       1.11664       0.00000       0.00000       0.00000
 41           0.00000       0.00000        .55832       2.79161       0.00000       0.00000
 42           0.00000       0.00000       0.00000       0.00000       0.00000       0.00000

SUM           0.00000       0.00000      32.15931      14.29303      15.54367       0.00000
```

```
DEAD LOAD SOLUTION
 NUMBER OF TRIALS      =     0
 NUMBER OF ITERATIONS =     1

      SLAB - NEWLY CRACKED, CRUSHED OR YIELDED LAYERS
ELEMENT  LAYER     ANGLE

      NEW BEAM LAYER FAILURES
ELEMENT  LAYER  TYPE OF FAILURE

DEAD LOAD SOLUTION
 NUMBER OF TRIALS      =     0
 NUMBER OF ITERATIONS =     2

      SLAB - NEWLY CRACKED, CRUSHED OR YIELDED LAYERS
ELEMENT  LAYER     ANGLE

      NEW BEAM LAYER FAILURES
ELEMENT  LAYER  TYPE OF FAILURE

DEAD LOAD SOLUTION
 NUMBER OF TRIALS      =     0
 NUMBER OF ITERATIONS =     3

      SLAB - NEWLY CRACKED, CRUSHED OR YIELDED LAYERS
ELEMENT  LAYER     ANGLE

      NEW BEAM LAYER FAILURES
ELEMENT  LAYER  TYPE OF FAILURE

DEAD LOAD SOLUTION
 NUMBER OF TRIALS      =     1
 NUMBER OF ITERATIONS =     1

      SLAB - NEWLY CRACKED, CRUSHED OR YIELDED LAYERS
ELEMENT  LAYER     ANGLE

      NEW BEAM LAYER FAILURES
ELEMENT  LAYER  TYPE OF FAILURE

DEAD LOAD SOLUTION
 NUMBER OF TRIALS      =     1
 NUMBER OF ITERATIONS =     2

      SLAB - NEWLY CRACKED, CRUSHED OR YIELDED LAYERS
ELEMENT  LAYER     ANGLE

      NEW BEAM LAYER FAILURES
ELEMENT  LAYER  TYPE OF FAILURE

DEAD LOAD SOLUTION
 NUMBER OF TRIALS      =     1
 NUMBER OF ITERATIONS =     3

      SLAB - NEWLY CRACKED, CRUSHED OR YIELDED LAYERS
ELEMENT  LAYER     ANGLE

      NEW BEAM LAYER FAILURES
ELEMENT  LAYER  TYPE OF FAILURE

DEAD LOAD SOLUTION
 NUMBER OF TRIALS      =     1
 NUMBER OF ITERATIONS =     4

      SLAB - NEWLY CRACKED, CRUSHED OR YIELDED LAYERS
```

FEL 435.2

```
ELEMENT  LAYER     ANGLE

       NEW BEAM LAYER FAILURES
ELEMENT  LAYER  TYPE OF FAILURE


DEAD LOAD SOLUTION
 NUMBER OF TRIALS       =     1
 NUMBER OF ITERATIONS =     5


       SLAB - NEWLY CRACKED, CRUSHED OR YIELDED LAYERS
ELEMENT  LAYER      ANGLE

       NEW BEAM LAYER FAILURES
ELEMENT  LAYER  TYPE OF FAILURE


       SOLUTION FOR DEAD LOAD ON THE STRUCTURE



       APPLIED NODAL POINT FORCES IN KIPS AND IN-KIPS

       NODE          U              V              W              XX             YY             ZZ

          1       0.00000        0.00000         .11311        -.45705       -1.29844        0.00000
          2       0.00000        0.00000         .01154         .12465        -.25969        0.00000
          3       0.00000        0.00000        0.00000        0.00000        0.00000        0.00000
          4       0.00000        0.00000        0.00000        0.00000        0.00000        0.00000
          5       0.00000        0.00000        0.00000        0.00000        0.00000        0.00000
          6       0.00000        0.00000        0.00000        0.00000        0.00000        0.00000
          7       0.00000        0.00000         .22622        -.91412        0.00000        0.00000
          8       0.00000        0.00000         .02308         .24930        0.00000        0.00000
          9       0.00000        0.00000        0.00000        0.00000        0.00000        0.00000
         10       0.00000        0.00000        0.00000        0.00000        0.00000        0.00000
         11       0.00000        0.00000        0.00000        0.00000        0.00000        0.00000
         12       0.00000        0.00000        0.00000        0.00000        0.00000        0.00000
         13       0.00000        0.00000         .18097        -.73129         .83190        0.00000
         14       0.00000        0.00000         .01647         .19944         .16620        0.00000
         15       0.00000        0.00000        0.00000        0.00000        0.00000        0.00000
         16       0.00000        0.00000        0.00000        0.00000        0.00000        0.00000
         17       0.00000        0.00000        0.00000        0.00000        0.00000        0.00000
         18       0.00000        0.00000        0.00000        0.00000        0.00000        0.00000
         19       0.00000        0.00000         .13573        -.54846        0.00000        0.00000
         20       0.00000        0.00000         .01385         .14958        0.00000        0.00000
         21       0.00000        0.00000        0.00000        0.00000        0.00000        0.00000
         22       0.00000        0.00000        0.00000        0.00000        0.00000        0.00000
         23       0.00000        0.00000        0.00000        0.00000        0.00000        0.00000
         24       0.00000        0.00000        0.00000        0.00000        0.00000        0.00000
         25       0.00000        0.00000         .11311        -.45705         .25969        0.00000
         26       0.00000        0.00000         .01154         .12465         .05194        0.00000
         27       0.00000        0.00000        0.00000        0.00000        0.00000        0.00000
         28       0.00000        0.00000        0.00000        0.00000        0.00000        0.00000
         29       0.00000        0.00000        0.00000        0.00000        0.00000        0.00000
         30       0.00000        0.00000        0.00000        0.00000        0.00000        0.00000
         31       0.00000        0.00000         .09049        -.36564        0.00000        0.00000
         32       0.00000        0.00000         .00923         .09972        0.00000        0.00000
         33       0.00000        0.00000        0.00000        0.00000        0.00000        0.00000
         34       0.00000        0.00000        0.00000        0.00000        0.00000        0.00000
         35       0.00000        0.00000        0.00000        0.00000        0.00000        0.00000
         36       0.00000        0.00000        0.00000        0.00000        0.00000        0.00000
         37       0.00000        0.00000         .04524        -.18282         .20775        0.00000
         38       0.00000        0.00000         .00462         .04986         .04155        0.00000
         39       0.00000        0.00000        0.00000        0.00000        0.00000        0.00000
         40       0.00000        0.00000        0.00000        0.00000        0.00000        0.00000
         41       0.00000        0.00000        0.00000        0.00000        0.00000        0.00000
         42       0.00000        0.00000        0.00000        0.00000        0.00000        0.00000



       NODAL POINT DISPLACEMENTS IN INCHES AND RADIANS

       NODE          U              V              W              XX             YY             ZZ

          1        .00340        0.00000         .02380         .00072        -.00194        0.00000
          2        .00357        0.00000        0.00000         .00041        -.00146        0.00000
          3       -.01202        0.00000        0.00000        0.00000        -.00141        0.00000
```

```
   4        .00324       0.00000      -.00427      -.00003      -.00107      0.00000
   5        .00315       0.00000      0.00000      -.00013      -.00057      0.00000
   6       -.00371       0.00000      0.00000      0.00000      -.00095      0.00000
   7        .00304        .00001       .15111       .00132      -.00160      0.00000
   8        .00317       -.00007       .13496       .00121      -.00131      0.00000
   9       -.01246       0.00000      0.00000      0.00000      -.00176      0.00000
  10        .00295       -.00013       .07111       .00105      -.00093      0.00000
  11        .00289       -.00014       .04095       .00098      -.00053      0.00000
  12       -.00350       0.00000      0.00000      0.00000      -.00051      0.00000
  13        .00220       -.00001       .25941       .00232      -.00119      0.00000
  14        .00231       -.00009       .18833       .00194      -.00092      0.00000
  15       -.00476       0.00000      0.00000      0.00000      -.00089      0.00000
  16        .00219       -.00015       .13134       .00186      -.00066      0.00000
  17        .00221       -.00021       .07625       .00182      -.00040      0.00000
  18       -.00265       0.00000      0.00000      0.00000      -.00039      0.00000
  19        .00197        .00004       .30664       .00234      -.00084      0.00000
  20        .00165       -.00006       .22297       .00226      -.00063      0.00000
  21       -.00546       0.00000      0.00000      0.00000      -.00060      0.00000
  22        .00159       -.00013       .15642       .00218      -.00046      0.00000
  23        .00161       -.00022       .09167       .00214      -.00028      0.00000
  24       -.00178       0.00000      0.00000      0.00000      -.00027      0.00000
  25        .00091        .00009       .33581       .00255      -.00048      0.00000
  26        .00096       -.00001       .24517       .00247      -.00037      0.00000
  27       -.00344       0.00000      0.00000      0.00000      -.00035      0.00000
  28        .00092       -.00010       .17253       .00238      -.00026      0.00000
  29        .00095       -.00019       .10173       .00234      -.00017      0.00000
  30       -.00105       0.00000      0.00000      0.00000      -.00016      0.00000
  31        .00047        .00011       .34672       .00262      -.00025      0.00000
  32        .00047        .00000       .25337       .00254      -.00018      0.00000
  33       -.00174       0.00000      0.00000      0.00000      -.00018      0.00000
  34        .00045       -.00006       .17846       .00246      -.00013      0.00000
  35        .00050       -.00015       .10548       .00242      -.00008      0.00000
  36       -.00053       0.00000      0.00000      0.00000      -.00008      0.00000
  37       0.00000       0.00000       .35041       .00265      0.00000      0.00000
  38       0.00000       0.00000       .25617       .00257      0.00000      0.00000
  39       0.00000       0.00000      0.00000      0.00000      0.00000      0.00000
  40       0.00000       0.00000       .18045       .00249      0.00000      0.00000
  41       0.00000       0.00000       .10675       .00244      0.00000      0.00000
  42       0.00000       0.00000      0.00000      0.00000      0.00000      0.00000


          DISPLACEMENT/REFERENCE DISPLACEMENT =       .10675

          FORCE/REFERENCE FORCE               =       .22622

          SUM OF NODAL POINT W-LOADS          =        .9972

          SUM OF W-LOADS FOR TOTAL STRUCTURE  =       3.9888

          (SUM OF W-LOADS FOR TOTAL STRUCTURE
               WITHOUT IMPACT FACTOR)         =       3.9888


   INTERNAL MOMENTS (IN-KIPS/IN) AND NORMAL FORCES (KIPS/IN) IN THE SLAB
 EL             MY          MX           MXY          NX          NY          NXY
  1            -.24       -2.23          -.98         -.16         -.08         -.07
  2            -.25       -2.27          -.88         -.15         -.08          .11
  3            -.03        -.89         -1.21         -.39         -.01          .02
  4             .97         .10          -.57         -.32          .01         -.03
  5             .16        -.39          -.99         -.26          .02          .04
  6             .11         .00         -1.00         -.24         -.01          .01
  7             .64         .04          -.57         -.40         -.00         -.02
  8             .59        -.19          -.66         -.40         -.01          .05
  9             .23         .01          -.65         -.37         -.01         -.01
 10             .79         .07          -.47         -.42          .01         -.01
 11             .49        -.23          -.43         -.42         -.00          .03
 12             .23        -.02          -.43         -.42         -.00          .03
 13             .72         .07          -.24         -.42          .01         -.01
 14             .50        -.26          -.27         -.46         -.02          .02
 15             .35        -.12          -.25         -.46         -.01          .03
 16             .49        -.35          -.13         -.45         -.00         -.00
 17             .49        -.26          -.13         -.41         -.03          .01
 18             .37        -.14          -.12         -.44         -.00          .01


   INTERNAL MOMENTS (IN-KIPS), NORMAL FORCES (KIPS), AND SHEAR FORCES (KIPS) IN BEAM ELEMENTS
 ELEM           MB                  NB                  VB

  1        512.6232            10.2444            -12.9[illegible]
```

```
      2        1337.9924           25.2060          -11.0190
      3        1806.3983           32.8969           -7.3941
      4        2061.6606           35.5003           -4.7417
      5        2184.9569           37.4370           -2.7408
      6        2228.7417           38.2294            -.8622
      7         217.0028             .7326           -5.0695
      8         575.9508            2.8967           -4.4346
      9         784.5149            4.8866           -3.0742
     10         892.4679            5.6103           -1.9325
     11         945.7419            6.0390           -1.1115
     12         965.1803            6.1351            -.3528
OTAL STRESSES IN SLAB LAYERS (STRESS (KSI), ANG. (DEGREES), + TEN., - COMP.)

   EL LAYER      SXX           SYY           SXY           S1            S2         THETA1

    1  1        .00582        .24881        .10687       -.03449        .28912     -20.66970
    1  2       -.00789        .12703        .05051       -.02470        .14384     -18.41254
    1  3       -.02401       -.00599       -.01072       -.02900       -.00100      24.97616
    1  4       -.03941       -.14977       -.07778        .00077       -.18996     -27.32432
    1  5       -.04939       -.24932       -.12490        .01062       -.30934     -25.66391
    1  6       -.05365       -.29993       -.14925        .01670       -.37028     -25.23844
    1  7       -.00000        .26063        .00000        .26063       -.00000     -90.00000
    1  8       -.14319       -.00000       -.00000       -.14319       -.00000       0.00000
    1  9       -.07491       -.00000       -.00000       -.07491       -.00000       0.00000
    1 10       -.00000      -1.20838       -.00000      -1.20838       -.00000     -90.00000

    2  1        .00764        .25489        .12411       -.04391        .30643     -22.55554
    2  2       -.00641        .13049        .07273       -.03783        .16191     -23.36931
    2  3       -.02406       -.00601        .01761       -.03482        .00475     -31.42775
    2  4       -.04021       -.15337       -.04342       -.02547       -.16811     -18.75074
    2  5       -.05104       -.25203       -.08427       -.02039       -.28269     -19.99072
    2  6       -.05550       -.30194       -.10495       -.01775       -.34070     -20.26786
    2  7       -.00000        .26647        .00000        .26647       -.00000     -90.00000
    2  8       -.14319       -.00000        .00000       -.14319       -.00000       0.00000
    2  9       -.07491       -.00000       -.00000       -.07491       -.00000       0.00000
    2 10       -.00000      -1.23546       -.00000      -1.23546       -.00000     -90.00000

    3  1       -.00646        .10619        .15100       -.11130        .21103     -34.77139
    3  2       -.01151        .05362        .07949       -.06484        .10695     -33.86115
    3  3       -.01805       -.00411        .00194       -.01831       -.00385      -7.76319
    3  4       -.01552       -.05682       -.08031        .04675       -.11909     -37.79069
    3  5       -.01422       -.09220       -.13557        .08786       -.19427     -36.97713
    3  6       -.01355       -.11011       -.16355        .10869       -.23235     -36.77637
    3  7       -.00000        .11016        .00000        .11016       -.00000     -90.00000
    3  8       -.10856       -.00000       -.00000       -.10856       -.00000       0.00000
    3  9       -.06046       -.00000       -.00000       -.06046       -.00000       0.00000
    3 10       -.00000       -.51072       -.00000       -.51072       -.00000     -90.00000

    4  1       -.16855       -.01057        .06513       -.19194        .01282     -19.75335
    4  2       -.10903       -.00529        .02995       -.11706        .00273     -15.00215
    4  3       -.04850        .00039       -.00654       -.04936        .00125       7.48487
    4  4        .01815        .00832       -.04471        .05822       -.03175     -41.86250
    4  5        .06169        .01307       -.07087        .11230       -.03754     -35.53355
    4  6        .08380        .01547       -.08409        .14040       -.04113     -33.94421
    4  7       -.00000        .07969        .00000        .07969       -.00000     -90.00000
    4  8       -.28236        .00000       -.00000       -.28236        .00000       0.00000
    4  9        .04439        .00000       -.00000        .04439        .00000       0.00000
    4 10        .00000        .00857       -.00000        .00857        .00000     -90.00000

    5  1       -.05687        .05126        .13263       -.14603        .14042     -33.91098
    5  2       -.04910        .02705        .07469       -.09486        .07281     -31.49525
    5  3       -.04399       -.00031        .01264       -.04739        .00309     -15.02697
    5  4       -.02672       -.02234       -.05516       -.07974        .03068      43.86142
    5  5       -.01629       -.03672       -.10069        .07470       -.12771     -42.10233
    5  6       -.01396       -.04402       -.12374        .09735       -.15533     -41.19480
    5  7       -.00000        .11035        .00000        .11035       -.00000     -90.00000
    5  8       -.27841        .00000        .00000       -.27841        .00000       0.00000
    5  9       -.18654       -.00000       -.00000       -.18654       -.00000       0.00000
    5 10       -.00000       -.18828       -.00000       -.18828       -.00000     -90.00000

    6  1       -.04747        .00039        .12301       -.14885        .10177     -39.49622
    6  2       -.04327       -.00228        .06437       -.09033        .04478     -36.16986
    6  3       -.04098       -.00566        .00116       -.04102       -.00562      -1.87252
    6  4       -.02759       -.00156       -.06766       -.08349        .05434      39.55577
    6  5       -.01995        .00090       -.11418       -.12419        .10513      42.39104
    6  6       -.01605        .00215       -.13774       -.14499        .13109      43.11022
    6  7       -.00000        .01947        .00000        .01947       -.00000     -90.00000
    6  8       -.25918        .00000       -.00000       -.25918        .00000       0.00000
    6  9       -.21582        .00000       -.00000       -.21582        .00000       0.00000
    6 10       -.00000        .00525       -.00000        .00525       -.00000     -90.00000

    7  1       -.13793       -.00458        .06757       -.16618        .02368     -22.69093
    7  2       -.10237       -.00373        .03351       -.11267        .00657     -17.09682
```

```
 7  3      -.06103      -.00217      -.00393      -.06135      -.00151      3.79767
 7  4      -.01542       .00179      -.04209      -.04977       .03615     39.22174
 7  5       .01323       .00396      -.06837       .07712      -.05393    -43.06173
 7  6       .02785       .00504      -.08168       .09892      -.05612    -41.02537
 7  7      -.00000       .07969       .00000       .07969      -.00000    -90.00000
 7  8      -.37633       .00000      -.00000      -.37633       .00000      0.00000
 7  9      -.15923       .00000      -.00000      -.15923       .00000      0.00000
 7 10      -.00000       .00857      -.00000       .00857      -.00000    -90.00000

 8  1      -.13050       .02200       .08732      -.17018       .06166    -24.43454
 8  2      -.09677       .00979       .04909      -.11594       .02695    -21.32805
 8  3      -.06489      -.00454       .00826      -.06600      -.00343     -7.65477
 8  4      -.01787      -.01412      -.03704      -.05308       .02110     43.55042
 8  5       .01203      -.02054      -.06793       .06563      -.07409    -39.24905
 8  6       .02737      -.02382      -.08356       .08917      -.09562    -36.48381
 8  7      -.00000       .09631       .00000       .09631      -.00000    -90.00000
 8  8      -.39574       .00000       .00000      -.39574       .00000      0.00000
 8  9      -.15707      -.00000      -.00000      -.15707      -.00000      0.00000
 8 10      -.00000      -.12401      -.00000      -.12401      -.00000    -90.00000

 9  1      -.08015       .00017       .07672      -.12658       .04660    -31.18379
 9  2      -.07415      -.00391       .04162      -.09350       .01542    -24.91921
 9  3      -.05963      -.00411      -.00106      -.05865      -.00409      1.11158
 9  4      -.03728      -.00137      -.04498      -.06776       .02911     34.12145
 9  5      -.02520       .00012      -.07499      -.08859       .06351     40.20753
 9  6      -.01901       .00087      -.09020      -.09981       .08168     41.85673
 9  7      -.00000       .05682       .00000       .05682      -.00000    -90.00000
 9  8      -.37311       .00000      -.00000      -.37311       .00000      0.00000
 9  9      -.28630       .00000      -.00000      -.28630       .00000      0.00000
 9 10      -.00000       .02251      -.00000       .02251      -.00000    -90.00000

10  1      -.16212      -.00808       .05702      -.18093       .01073    -18.25724
10  2      -.11299      -.00456       .02784      -.11972       .00217    -13.59289
10  3      -.06349      -.00077      -.00236      -.06358      -.00069      2.15571
10  4      -.00325       .00500      -.03371      -.03598       .03273     39.43851
10  5       .02698       .00838      -.05541       .07387      -.03651    -40.23596
10  6       .04498       .01006      -.06639       .09617      -.04112    -37.63339
10  7      -.00000       .09151       .00000       .09151      -.00000    -90.00000
10  8      -.38806       .00000      -.00000      -.38806       .00000      0.00000
10  9      -.12023       .00000      -.00000      -.12023       .00000      0.00000
10 10       .00000       .02395      -.00000       .02395       .00000    -90.00000

11  1      -.12026       .02656       .05660      -.13954       .04585    -18.81694
11  2      -.09217       .01329       .03160      -.10092       .02203    -15.46624
11  3      -.06669      -.00214       .00488      -.06705      -.00177     -4.29972
11  4      -.03044      -.01654      -.02620      -.05059       .00361     37.56820
11  5      -.00323      -.02257      -.04466       .03279      -.05859    -38.89385
11  6       .00324      -.02672      -.05491       .04904      -.06652    -35.93496
11  7      -.00000       .11565       .00000       .11565      -.00000    -90.00000
11  8      -.41545       .00000       .00000      -.41545       .00000      0.00000
11  9      -.21419      -.00000      -.00000      -.21419      -.00000      0.00000
11 10      -.00000      -.11025      -.00000      -.11025      -.00000    -90.00000

12  1      -.08716       .00100       .05178      -.11108       .02492    -24.79650
12  2      -.08182      -.00239       .02884      -.09119       .00697    -17.99254
12  3      -.06473      -.00272      -.00026      -.06473      -.00272       .23599
12  4      -.04323      -.00115      -.02964      -.05854       .01416     27.31145
12  5      -.03162      -.00038      -.04980      -.06819       .03619     36.29128
12  6      -.02562       .00001      -.06005      -.07421       .04860     38.97734
12  7      -.00000       .07500       .00000       .07500      -.00000    -90.00000
12  8      -.41524       .00000      -.00000      -.41524       .00000      0.00000
12  9      -.32639       .00000      -.00000      -.32639       .00000      0.00000
12 10      -.00000       .03595      -.00000       .03595      -.00000    -90.00000

13  1      -.15191      -.00788       .02795      -.15714      -.00264    -10.60585
13  2      -.10957      -.00432       .01370      -.11132      -.00257     -7.29614
13  3      -.06343      -.00045      -.00182      -.06348      -.00040      1.65619
13  4      -.01202       .00459      -.01788      -.02343       .01601     32.54444
13  5       .02051       .00747      -.02931       .04402      -.01603    -33.72702
13  6       .03727       .00889      -.03506       .06031      -.01475    -33.98341
13  7      -.00000       .09230       .00000       .09230      -.00000    -90.00000
13  8      -.39012       .00000      -.00000      -.39012       .00000      0.00000
13  9      -.13911       .00000      -.00000      -.13911       .00000      0.00000
13 10      -.00000       .03172      -.00000       .03172      -.00000    -90.00000

14  1      -.12647       .03051       .03498      -.13391       .03756    -12.01061
14  2      -.10569       .01428       .02091      -.10923       .01762     -7.60784
14  3      -.07106      -.00147       .00338      -.07123      -.00130     -2.77581
14  4      -.03352      -.01802      -.01553      -.04313       .00542     31.73412
14  5      -.00659      -.02624      -.02672       .01206      -.04481    -34.90094
14  6       .00512      -.03124      -.03306       .02541      -.05053    -30.26874
14  7      -.00000       .13062       .00000       .13062      -.00000    -90.00000
14  8      -.44444       .00000       .00000      -.44444       .00000      0.00000
14  9      -.23524      -.00000      -.00000      -.23524      -.00000      0.00000
14 10      -.00000      -.12108      -.00000      -.12108      -.00000    -90.00000
```

```
 15  1      -.111[illegible]     .01264      .03102     -.111[illegible]   [illegible]   -13.24[illegible]
 15  2      -.09221      .00579      .01653     -.09423     [illegible]   -1.31[illegible]
 15  3      -.06[illegible]     -.00190      .00026     -.06615     -.[illegible]     -.22227
 15  4      -.04342     -.00997     -.01706     -.05062     -.[illegible]     22.90[illegible]
 15  5      -.02593     -.01571     -.02374     -.04[illegible]03     .[illegible]     33.31[illegible]
 15  6      -.01597     -.01562     -.03290     -.04670      .01710     44.[illegible]731
 15  7      -.00000      .10278      .00000      .10278     -.[illegible]     -90.00000
 15  8      -.43353      .00000     -.00000     -.43353      .00000      0.00000
 15  9      -.29875      .00000     -.00000     -.29875      .00000      0.00000
 15 10      -.00000     -.03342     -.00000     -.03342     -.00000    -90.00000

 16  1      -.12164      .02832      .01543     -.12519      .02[illegible]87     -5.73[illegible]
 16  2      -.10393      .01323      .00845     -.10454      .01[illegible]     -4.10040
 16  3      -.06908     -.00157     -.00029     -.06908     -.00157       .24362
 16  4      -.03225     -.01719     -.00965     -.03696     -.01249     26.01618
 16  5      -.00758     -.02749     -.01534      .00121     -.03643    -28.978[illegible]
 16  6       .00592     -.03010     -.01816      .01349     -.03766    -22.61674
 16  7      -.00000      .12525      .00000      .12525     -.00000    -90.00000
 16  8      -.43171      .00000     -.00000     -.43171      .00000      0.00000
 16  9      -.22717     -.00000     -.00000     -.22717     -.00000      0.00000
 16 10      -.00000     -.11529     -.00000     -.11529     -.00000    -90.00000

 17  1      -.12391      .02681      .01691     -.12579      .02868     -6.32459
 17  2      -.10480      .01103      .01001     -.10566      .01189     -4.90393
 17  3      -.06970     -.00453      .00116     -.06972     -.00451     -1.01832
 17  4      -.03309     -.02094     -.00828     -.03721     -.01673     26.96824
 17  5      -.00844     -.03193     -.01458     -.00146     -.03891    -25.57343
 17  6       .00502     -.03435     -.01687      .01126     -.04060    -20.29925
 17  7      -.00000      .10789      .00000      .10789     -.00000    -90.00000
 17  8      -.43171      .00000      .00000     -.43171      .00000      0.00000
 17  9      -.22717     -.00000     -.00000     -.22717     -.00000      0.00000
 17 10      -.00000     -.14068     -.00000     -.14068     -.00000    -90.00000

 18  1      -.11274      .01490      .01623     -.11478      .01693     -7.13580
 18  2      -.09115      .00720      .00901     -.09196      .00801     -5.19371
 18  3      -.06565     -.00114      .00101     -.06567     -.00112      -.89632
 18  4      -.03939     -.00991     -.00752     -.04119     -.00810     13.51123
 18  5      -.02176     -.01578     -.01322     -.03232     -.00521     38.62057
 18  6      -.01284     -.01875     -.01611      .00059     -.03216    -39.81137
 18  7      -.00000      .10643      .00000      .10643     -.00000    -90.00000
 18  8      -.41693      .00000      .00000     -.41693      .00000      0.00000
 18  9      -.27336     -.00000     -.00000     -.27336     -.00000      0.00000
 18 10      -.00000     -.04030     -.00000     -.04030     -.00000    -90.00000
TOTAL STRESSES IN BEAM LAYERS (STRESS (KSI), ANG. (DEGRESS), + TEN., - COMP.)

 EL LAYER      SXX          SYY          SXY          S1           S2          THETA1

  1  1      -4.13968     0.00000      -.02639     -4.13984      .00017       .36529
  1  2      -3.95527     0.00000      -.05769     -3.95711      .00084       .83513
  1  3      -3.12303     0.00000     -1.59157     -3.79118      .66815     22.77303
  1  4      -1.63995     0.00000     -1.78324     -2.78271     1.14275     32.65294
  1  5       -.15588     0.00000     -1.88545     -1.96552     1.80964     43.80986
  1  6       1.32620     0.00000     -1.89819      2.67378    -1.34759    -35.37203
  1  7       2.80927     0.00000     -1.82146      3.70480     -.89552    -26.18106
  1  8       4.29235     0.00000     -1.65527      4.85652     -.56418    -18.82092
  1  9       5.12559     0.00000      -.07704      5.12675     -.00116      -.86088
  1 10       5.30899     0.00000      -.03920      5.30929     -.00029      -.42307
  1 11        .00056     0.00000      -.00001       .00056     -.00000      -.53840
  1 12        .00058     0.00000      -.00000       .00058     -.00000      -.26644

  2  1     -10.89241     0.00000      -.02169    -10.89245      .00004       .11402
  2  2     -10.41371     0.00000      -.04855    -10.41393      .00023       .26712
  2  3      -8.23887     0.00000     -1.34908     -8.45416      .21529      9.06660
  2  4      -4.36791     0.00000     -1.51397     -4.84136      .47345     17.36534
  2  5       -.49695     0.00000     -1.60240     -1.87003     1.37307     40.59281
  2  6       3.37401     0.00000     -1.61436      4.02198     -.64798    -21.86972
  2  7       7.24497     0.00000     -1.54985      7.56259     -.31762    -11.58165
  2  8      11.11593     0.00000     -1.40888     11.29172     -.17579     -7.11219
  2  9      13.29076     0.00000      -.06558     13.29108     -.00032      -.28263
  2 10      13.76947     0.00000      -.03338     13.76955     -.00008      -.13888
  2 11        .00145     0.00000      -.00000       .00146     -.00000      -.17674
  2 12        .00150     0.00000      -.00000       .00150     -.00000      -.08745

  3  1     -14.77032     0.00000      -.01231    -14.77033      .00001       .04774
  3  2     -14.12403     0.00000      -.02740    -14.12409      .00005       .11116
  3  3     -11.18783     0.00000      -.76653    -11.24012      .05229      3.90160
  3  4      -5.96172     0.00000      -.87510     -6.08752      .12580      8.18042
  3  5       -.73561     0.00000      -.96373     -1.39934      .66373     34.55538
  3  6       4.49050     0.00000     -1.03252      4.71653     -.22603    -12.34803
  3  7       9.71561     0.00000     -1.08146      9.83552     -.11991     -6.27479
  3  8      14.94272     0.00000     -1.11057     15.02491     -.08219     -4.22737
  3  9      17.87392     0.00000      -.09164     17.87914     -.00[illegible]     -.197[illegible]
```

```
 3 10     18.52521       0.00000       -.06140      18.52542       -.00020       -.18991
 3 11       .00197       0.00000       -.07667        .07766       -.07569     -44.63182
 3 12       .00201       0.00000       -.03379        .03981       -.03780     -44.75593

 4  1    -15.77169       0.00000       -.00724     -15.77170        .00000        .02632
 4  2    -15.17250       0.00000       -.01553     -15.17252        .00002        .05866
 4  3    -12.45028       0.00000       -.43307     -12.46533        .01505       1.98978
 4  4     -7.60503       0.00000       -.50079      -7.63787        .03284       3.75134
 4  5     -2.75979       0.00000       -.56953      -2.87270        .11291      11.21375
 4  6      2.08546       0.00000       -.63927       2.26583       -.18036     -15.75575
 4  7      6.93071       0.00000       -.71004       7.00271       -.07199      -5.78970
 4  8     11.77595       0.00000       -.78181      11.82764       -.05169      -3.78179
 4  9     14.49818       0.00000       -.04704      14.49833       -.00015       -.18589
 4 10     15.09737       0.00000       -.05611      15.09756       -.00021       -.21294
 4 11     15.58556       0.00000       -.08213      15.58599       -.00043       -.30191
 4 12     15.96275       0.00000       -.04156      15.96286       -.00011       -.14916

 5  1    -16.72613       0.00000       -.00532     -16.72613        .00000        .01922
 5  2    -16.09104       0.00000       -.01164     -16.09105        .00001        .04146
 5  3    -13.20571       0.00000       -.32207     -13.21356        .00785       1.39627
 5  4     -8.07015       0.00000       -.36246      -8.08640        .01625       2.56650
 5  5     -2.93459       0.00000       -.38717      -2.98481        .05022       7.39082
 5  6      2.20097       0.00000       -.39620       2.27012       -.06915      -9.90007
 5  7      7.33653       0.00000       -.38955       7.35716       -.02063      -3.03088
 5  8     12.47209       0.00000       -.36721      12.48289       -.01080      -1.68501
 5  9     15.35742       0.00000       -.01812      15.35744       -.00002       -.06760
 5 10     15.99251       0.00000       -.01233      15.99252       -.00001       -.04417
 5 11     16.50995       0.00000       -.00793      16.50995       -.00000       -.02753
 5 12     16.90974       0.00000       -.00401      16.90974       -.00000       -.01360

 6  1    -17.05456       0.00000       -.00190     -17.05456        .00000        .00639
 6  2    -16.40679       0.00000       -.00380     -16.40678        .00000        .01328
 6  3    -13.46382       0.00000       -.10233     -13.46459        .00078        .43544
 6  4     -8.22567       0.00000       -.11442      -8.22726        .00159        .79678
 6  5     -2.98753       0.00000       -.12170      -2.99248        .00495       2.32891
 6  6      2.25062       0.00000       -.12418       2.25745       -.00683      -3.14865
 6  7      7.48877       0.00000       -.12196       7.49075       -.00198       -.93198
 6  8     12.72691       0.00000       -.11473      12.72794       -.00103       -.51644
 6  9     15.66987       0.00000       -.00566      15.66987       -.00000       -.02069
 6 10     16.31765       0.00000       -.00385      16.31765       -.00000       -.01351
 6 11     16.84543       0.00000       -.00248      16.84543       -.00000       -.00842
 6 12     17.25320       0.00000       -.00125      17.25320       -.00000       -.00416

 7  1     -3.91624       0.00000       -.00764      -3.91625        .00001        .11171
 7  2     -3.76096       0.00000       -.03715      -3.76133        .00037        .56582
 7  3     -3.05551       0.00000      -1.18942      -3.46392        .40841      19.95108
 7  4     -1.79988       0.00000      -1.37471      -2.54302        .74314      28.39480
 7  5      -.54425       0.00000      -1.48218      -1.77908       1.23483      39.79826
 7  6       .71138       0.00000      -1.51193       1.90880      -1.19742     -39.38036
 7  7      1.96701       0.00000      -1.46367       2.74692       -.77991     -28.05057
 7  8      3.22264       0.00000      -1.33770       3.70555       -.48291     -19.84951
 7  9      3.92809       0.00000       -.06241       3.92909       -.00099       -.91003
 7 10      4.08337       0.00000       -.03180       4.08362       -.00025       -.44620
 7 11       .00044       0.00000       -.00000        .00044       -.00000       -.56782
 7 12       .00045       0.00000       -.00000        .00045       -.00000       -.28063

 8  1    -10.28544       0.00000       -.00821     -10.28545        .00001        .04571
 8  2     -9.87332       0.00000       -.03344      -9.87343        .00011        .19403
 8  3     -8.00096       0.00000      -1.04719      -8.13575        .13479       7.33450
 8  4     -4.66937       0.00000      -1.20517      -4.96114        .29276      13.65392
 8  5     -1.33579       0.00000      -1.29598      -2.12565        .79006      31.36762
 8  6      1.99680       0.00000      -1.31962       2.65315       -.65635     -25.44473
 8  7      5.32939       0.00000      -1.27609       5.61918       -.28979     -12.79459
 8  8      8.66197       0.00000      -1.16539       8.81602       -.15405      -7.53022
 8  9     10.53433       0.00000       -.05435      10.53461       -.00029       -.29562
 8 10     10.94645       0.00000       -.02769      10.94652       -.00007       -.14495
 8 11       .00117       0.00000       -.00000        .00117       -.00000       -.18445
 8 12       .00119       0.00000       -.00000        .00119       -.00000       -.09116

 9  1    -13.90260       0.00000       -.00652     -13.90260        .00000        .02685
 9  2    -13.34124       0.00000       -.02957     -13.34127        .00003        .08334
 9  3    -10.79086       0.00000       -.62374     -10.82679        .03593       3.29723
 9  4     -6.25147       0.00000       -.72417      -6.33427        .08279       6.52210
 9  5     -1.71209       0.00000       -.80532      -2.03136        .31927      21.62567
 9  6      2.82730       0.00000       -.86719       3.07209       -.24479     -15.76333
 9  7      7.36668       0.00000       -.90977       7.47737       -.11069      -6.93707
 9  8     11.90507       0.00000       -.93307      11.97875       -.07268      -4.45394
 9  9     14.45644       0.00000       -.05158      14.45663       -.00019       -.20442
 9 10     15.01781       0.00000       -.05073      15.01798       -.00017       -.19356
 9 11       .00160       0.00000       -.06247        .06328       -.06168     -44.63297
 9 12       .00164       0.00000       -.03164        .03247       -.03083     -44.25885

10  1    -14.82990       0.00000       -.00364     -14.82990        .00000        .01407
10  2    -14.30408       0.00000       -.01127     -14.30409        .00001        .04514
10  3    -11.91521       0.00000       -.34333     -11.92509        .00761       1.64867
```

```
10  4     -7.66327     0.00000     -.40458     -7.68457      .02130      3.01373
10  5     -3.41133     0.00000     -.46541     -3.47369      .06236      7.63109
10  6       .84060     0.00000     -.52572      1.09338     -.25278    -25.67929
10  7      5.09254     0.00000     -.58552      5.15900     -.06646     -6.47512
10  8      9.34448     0.00000     -.64481      9.38876     -.04429     -3.92845
10  9     11.73335     0.00000     -.03873     11.73348     -.00013      -.18910
10 10     12.25917     0.00000     -.04596     12.25934     -.00017      -.21477
10 11     12.68759     0.00000     -.06699     12.68794     -.00035      -.30252
10 12     13.01859     0.00000     -.03393     13.01867     -.00008      -.14932

11  1    -15.70344     0.00000     -.00194    -15.70344      .00000       .00707
11  2    -15.14670     0.00000     -.00798    -15.14671      .00001       .03017
11  3    -12.61553     0.00000     -.25071    -12.62051      .00498      1.13904
11  4     -9.11034     0.00000     -.28990     -9.12069      .01035      2.04455
11  5     -3.60514     0.00000     -.31504     -3.63246      .02732      4.95660
11  6       .90006     0.00000     -.32612      1.00590     -.10584    -17.96463
11  7      5.40525     0.00000     -.32314      5.42451     -.01925     -3.40909
11  8      9.91046     0.00000     -.30610      9.91990     -.00945     -1.76743
11  9     12.44163     0.00000     -.01514     12.44165     -.00002      -.06971
11 10     12.99876     0.00000     -.01031     12.99877     -.00001      -.04546
11 11     13.45269     0.00000     -.00665     13.45269     -.00000      -.02831
11 12     13.80341     0.00000     -.00337     13.80341     -.00000      -.01397

12  1    -16.04735     0.00000     -.00042    -16.04735      .00000       .00151
12  2    -15.47915     0.00000     -.00241    -15.47915      .00000       .00893
12  3    -12.89217     0.00000     -.07873    -12.89265      .00048       .34986
12  4     -8.28941     0.00000     -.09168     -8.29042      .00101       .63360
12  5     -3.68665     0.00000     -.10007     -3.68936      .00271      1.55369
12  6       .91611     0.00000     -.10389       .92775     -.01163     -6.38919
12  7      5.51888     0.00000     -.10313      5.52080     -.00193     -1.07022
12  8     10.12164     0.00000     -.09781     10.12258     -.00095      -.55363
12  9     12.70762     0.00000     -.00484     12.70762     -.00000      -.02182
12 10     13.27682     0.00000     -.00330     13.27682     -.00000      -.01424
12 11     13.74058     0.00000     -.00213     13.74058     -.00000      -.00887
12 12     14.09889     0.00000     -.00108     14.09889     -.00000      -.00439
```

FEL 435.2

```
      SOLUTION FOR LIVE LOAD ON THE STRUCTURE


 SCALING PROCEDURE
  NUMBER OF TRIALS     =     0
  NUMBER OF ITERATIONS =     1


  PCTC OR PCTT LIMITS EXCEEDED IN PSCALE

  ELEMENT   10  LAYER    1   ALLOWABLE STRESS CHANGE OF     .984116769E-03  HAS BEEN EXCEEDED


 FIND THE FORCE INCREMENT

  REFERENCE DISPLACEMENT =   .23891E+01 NODE=  41 W DISP
  REFERENCE FORCE        =   .89453E-02 NODE=   7 W FORCE

      SLAB - NEWLY CRACKED, CRUSHED OR YIELDED LAYERS
 ELEMENT  LAYER    ANGLE

      NEW BEAM LAYER FAILURES
 ELEMENT  LAYER  TYPE OF FAILURE


      APPLIED NODAL POINT FORCES IN KIPS AND IN-KIPS

      NODE          U            V            W            XX           YY           ZZ

         1       0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
         2       0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
         3       0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
         4       0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
         5       0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
         6       0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
         7       0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
         8       0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
         9       0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
        10       0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
        11       0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
        12       0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
        13       0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
        14       0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
        15       0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
        16       0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
        17       0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
        18       0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
        19       0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
        20       0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
        21       0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
        22       0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
        23       0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
        24       0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
        25       0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
        26       0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
        27       0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
        28       0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
        29       0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
        30       0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
        31       0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
        32       0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
        33       0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
        34       0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
        35       0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
        36       0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
        37       0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
        38       0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
        39       0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
```

```
 40        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
 41        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
 42        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000


NODAL POINT DISPLACEMENTS IN INCHES AND RADIANS

NODE          U             V             W             XX            YY            ZZ

  1        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
  2        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
  3        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
  4        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
  5        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
  6        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
  7        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
  8        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
  9        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
 10        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
 11        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
 12        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
 13        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
 14        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
 15        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
 16        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
 17        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
 18        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
 19        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
 20        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
 21        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
 22        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
 23        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
 24        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
 25        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
 26        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
 27        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
 28        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
 29        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
 30        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
 31        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
 32        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
 33        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
 34        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
 35        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
 36        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
 37        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
 38        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
 39        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
 40        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
 41        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
 42        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000


          DISPLACEMENT/REFERENCE DISPLACEMENT =      0.00000

          FORCE/REFERENCE FORCE               =      0.00000

          SUM OF NODAL POINT W-LOADS          =       0.0000

          SUM OF W-LOADS FOR TOTAL STRUCTURE  =       0.0000

          (SUM OF W-LOADS FOR TOTAL STRUCTURE
               WITHOUT IMPACT FACTOR)         =       0.0000


 INTERNAL MOMENTS (IN-KIPS/IN) AND NORMAL FORCES (KIPS/IN) IN THE SLAB

EL            MY            MX           MXY           NX            NY           NXY
 1          -.24         -2.23          -.98         -.15          -.08          -.07
 2          -.25         -2.27          -.88         -.15          -.08           .11
 3          -.03          -.89         -1.21         -.14          -.01           .02
 4           .27           .10          -.57         -.32           .01          -.03
 5           .16          -.32          -.95         -.26           .02           .08
 6           .11           .00         -1.00         -.24          -.01           .01
 7           .64           .04          -.57         -.45          -.00          -.02
 8           .57          -.12          -.66         -.55          -.01           .03
 9           .23           .01          -.55         -.37          -.01          -.00
```

FEL 435.2

```
    10          .73          .07          -.47          -.42          .01          -.01
    11          .44         -.23          -.43          -.42         -.00           .03
    12          .23         -.03          -.43          -.42         -.00           .00
    13          .72          .07          -.24          -.42          .01          -.01
    14          .53         -.26          -.27          -.46         -.00           .02
    15          .35         -.12          -.25          -.46         -.01           .00
    16          .49         -.25          -.13          -.45         -.00          -.00
    17          .49         -.26          -.13          -.45         -.03           .01
    18          .37         -.14          -.12          -.44         -.00           .01

      INTERNAL MOMENTS (IN-KIPS), NORMAL FORCES (KIPS), AND SHEAR FORCES (KIPS) IN BEAM ELEMENTS
     ELEM          MB                NB                VB

       1        512.6232          10.2444          -12.9582
       2       1337.9924          25.2060          -11.0100
       3       1906.3983          32.8963           -7.3941
       4       2061.6605          35.5003           -4.7417
       5       2184.9569          37.4370           -2.7403
       6       2229.7417          38.2934            -.8622
       7        217.0028            .7326           -5.0685
       8        575.9509           2.8967           -4.4346
       9        784.5149           4.8866           -3.0742
      10        892.4679           5.6103           -1.9325
      11        945.7419           6.0390           -1.1115
      12        966.1803           6.1351            -.3529
 TOTAL STRESSES IN SLAB LAYERS (STRESS (KSI), ANG. (DEGRESS), + TEN., - COMP.)

   EL LAYER       SXX           SYY           SXY           S1            S2          THETA1

    1  1        .00582        .24881        .10687       -.03449        .28912     -20.66870
    1  2       -.00789        .12703        .05051       -.02470        .14384     -19.41254
    1  3       -.02401       -.00599       -.01072       -.02900       -.00100      24.97616
    1  4       -.03941       -.14977       -.07778        .00077       -.18995     -27.32432
    1  5       -.04939       -.24932       -.12490        .01062       -.30934     -25.66391
    1  6       -.05365       -.29993       -.14925        .01670       -.37029     -25.23844
    1  7       -.00000        .26063        .00000        .26063       -.00000     -90.00000
    1  8       -.14319       -.00000       -.00000       -.14319       -.00000       0.00000
    1  9       -.07491       -.00000       -.00000       -.07491       -.00000       0.00000
    1 10       -.00000      -1.20838       -.00000      -1.20838       -.00000     -90.00000

    2  1        .00764        .25489        .12411       -.04391        .30643     -22.55554
    2  2       -.00641        .13049        .07273       -.03783        .16191     -23.36931
    2  3       -.02406       -.00601        .01761       -.03482        .00475     -31.42775
    2  4       -.04021       -.15337       -.04342       -.02547       -.16811     -18.75074
    2  5       -.05104       -.25203       -.08427       -.02039       -.28269     -19.99072
    2  6       -.05650       -.30194       -.10495       -.01775       -.34070     -20.26786
    2  7       -.00000        .26647        .00000        .26647       -.00000     -90.00000
    2  8       -.14319       -.00000        .00000       -.14319       -.00000       0.00000
    2  9       -.07491       -.00000       -.00000       -.07491       -.00000       0.00000
    2 10       -.00000      -1.23546       -.00000      -1.23546       -.00000     -90.00000

    3  1       -.00646        .10619        .15100       -.11130        .21103     -34.77138
    3  2       -.01151        .05362        .07949       -.06484        .10695     -33.86115
    3  3       -.01805       -.00411        .00194       -.01831       -.00385      -7.76312
    3  4       -.01552       -.05682       -.08031        .04675       -.11909     -37.79069
    3  5       -.01422       -.09220       -.13557        .08786       -.19427     -36.97713
    3  6       -.01355       -.11011       -.16355        .10869       -.23236     -36.77637
    3  7       -.00000        .11016        .00000        .11016       -.00000     -90.00000
    3  8       -.10856       -.00000       -.00000       -.10856       -.00000       0.00000
    3  9       -.06046       -.00000       -.00000       -.06046       -.00000       0.00000
    3 10       -.00000       -.51072       -.00000       -.51072       -.00000     -90.00000

    4  1       -.16855       -.01057        .06513       -.19194        .01281     -19.75335
    4  2       -.10303       -.00529        .02995       -.11706        .00873     -15.00215
    4  3       -.04850        .00039       -.00554       -.04936        .00125       7.48487
    4  4        .01815        .00832       -.04471        .05822       -.03175     -41.86250
    4  5        .06168        .01307       -.07087        .11230       -.03754     -35.53355
    4  6        .08380        .01547       -.08409        .14040       -.04113     -33.94421
    4  7       -.00000        .07969        .00000        .07969       -.00000     -90.00000
    4  8       -.28236        .00000       -.00000       -.28236        .00000       0.00000
    4  9        .04439        .00000       -.00000        .04439        .00000       0.00000
    4 10        .00000        .00857       -.00000        .00857        .00000     -90.00000

    5  1       -.05557        .05126        .13263       -.14473        .14042     -33.91094
    5  2       -.04910        .02705        .07469       -.09466        .07261     -31.49525
    5  3       -.04399       -.00031        .01264       -.04739        .00309     -15.02657
    5  4       -.02572       -.02234       -.05516       -.07974        .03168      43.86142
    5  5       -.01629       -.03672       -.10069        .07470       -.12771     -42.10233
    5  6       -.01096       -.04402       -.12374        .09735       -.15233     -41.19480
    5  7       -.00000        .11035        .00000        .11035       -.00000     -90.00000
    5  8       -.27841        .00000        .00000       -.27841        .00000       0.00000
```

```
 5  9    -.18654    -.00000    -.00000    -.18654    -.00000     0.00000
 5 10    -.00000    -.18928    -.00000    -.18928    -.00000   -90.00000

 6  1    -.04747     .00039     .12301    -.14885     .10177   -39.49622
 6  2    -.04327    -.00228     .06437    -.07033     .04473   -36.16985
 6  3    -.04098    -.00566     .00116    -.04102    -.00562    -1.87252
 6  4    -.02759    -.00156    -.06766    -.08348     .05432    39.55577
 6  5    -.01995     .00090    -.11418    -.12418     .10513    42.39104
 6  6    -.01605     .00215    -.13774    -.14499     .13106    43.11029
 6  7    -.00000     .01947     .00000     .01947    -.00000   -90.00000
 6  8    -.25918     .00000    -.00000    -.25918     .00000     0.00000
 6  9    -.21582     .00000    -.00000    -.21582     .00000     0.00000
 6 10    -.00000     .00525    -.00000     .00525    -.00000   -90.00000

 7  1    -.13793    -.00456     .06757    -.16618     .02368   -22.69083
 7  2    -.10237    -.00373     .03351    -.11267     .00657   -17.09682
 7  3    -.06109    -.00217    -.00393    -.06135    -.00191     3.79767
 7  4    -.01542     .00179    -.04209    -.04977     .03615    39.22174
 7  5     .01323     .00396    -.06837     .07712    -.05993   -43.06173
 7  6     .02785     .00504    -.08168     .09892    -.06602   -41.02537
 7  7    -.00000     .07969     .00000     .07969    -.00000   -90.00000
 7  8    -.37633     .00000    -.00000    -.37633     .00000     0.00000
 7  9    -.15923     .00000    -.00000    -.15923     .00000     0.00000
 7 10    -.00000     .00857    -.00000     .00857    -.00000   -90.00000

 8  1    -.13050     .02200     .08732    -.17018     .06168   -24.43454
 8  2    -.09677     .00979     .04909    -.11594     .02895   -21.32805
 8  3    -.06489    -.00454     .00826    -.06600    -.00343    -7.65477
 8  4    -.01787    -.01412    -.03704    -.05308     .02110    43.55042
 8  5     .01208    -.02054    -.06793     .06563    -.07409   -38.24905
 8  6     .02737    -.02382    -.08356     .08917    -.08562   -36.48361
 8  7    -.00000     .09631     .00000     .09631    -.00000   -90.00000
 8  8    -.39574     .00000     .00000    -.39574     .00000     0.00000
 8  9    -.15707    -.00000    -.00000    -.15707    -.00000     0.00000
 8 10    -.00000    -.12401    -.00000    -.12401    -.00000   -90.00000

 9  1    -.08015     .00017     .07672    -.12658     .04660   -31.18379
 9  2    -.07416    -.00391     .04162    -.09350     .01542   -24.91921
 9  3    -.05863    -.00411    -.00106    -.05865    -.00409     1.11158
 9  4    -.03728    -.00137    -.04498    -.06776     .02911    34.12145
 9  5    -.02520     .00012    -.07499    -.08859     .06351    40.20753
 9  6    -.01301     .00087    -.09020    -.09981     .08168    41.85673
 9  7    -.00000     .05682     .00000     .05682    -.00000   -90.00000
 9  8    -.37311     .00000    -.00000    -.37311     .00000     0.00000
 9  9    -.28630     .00000    -.00000    -.28630     .00000     0.00000
 9 10    -.00000     .02251    -.00000     .02251    -.00000   -90.00000

10  1    -.16212    -.00808     .05702    -.18093     .01073   -18.25724
10  2    -.11299    -.00456     .02784    -.11972     .00217   -13.59289
10  3    -.06349    -.00077    -.00236    -.06358    -.00069     2.15571
10  4    -.00825     .00500    -.03371    -.03598     .03273    39.43851
10  5     .02698     .00838    -.05541     .07387    -.03851   -40.23596
10  6     .04498     .01006    -.06639     .09617    -.04112   -37.63338
10  7    -.00000     .09151     .00000     .09151    -.00000   -90.00000
10  8    -.38806     .00000    -.00000    -.38806     .00000     0.00000
10  9    -.12023     .00000    -.00000    -.12023     .00000     0.00000
10 10     .00000     .02395    -.00000     .02395     .00000   -90.00000

11  1    -.12026     .02656     .05660    -.13954     .04565   -18.81694
11  2    -.09217     .01329     .03160    -.10092     .02203   -15.46624
11  3    -.06569    -.00214     .00488    -.06705    -.00177    -4.29972
11  4    -.03044    -.01654    -.02620    -.05059     .00361    37.56820
11  5    -.00323    -.02257    -.04466     .03279    -.05959   -38.89385
11  6     .00924    -.02672    -.05491     .04904    -.06652   -35.93496
11  7    -.00000     .11565     .00000     .11565    -.00000   -90.00000
11  8    -.41545     .00000     .00000    -.41545     .00000     0.00000
11  9    -.21419    -.00000    -.00000    -.21419    -.00000     0.00000
11 10    -.00000    -.11025    -.00000    -.11025    -.00000   -90.00000

12  1    -.08716     .00100     .05178    -.11108     .02492   -24.79650
12  2    -.08182    -.00239     .02884    -.09118     .00697   -17.99254
12  3    -.06473    -.00272    -.00026    -.06473    -.00272      .23599
12  4    -.04323    -.00115    -.02754    -.05854     .01416    27.31145
12  5    -.03162    -.00038    -.04980    -.06819     .03619    36.29129
12  6    -.02562     .00001    -.06005    -.07421     .04860    39.97734
12  7    -.00000     .07500     .00000     .07500    -.00000   -90.00000
12  8    -.41524     .00000    -.00000    -.41524     .00000     0.00000
12  9    -.32639     .00000    -.00000    -.32639     .00000     0.00000
12 10    -.00000     .03595    -.00000     .03595    -.00000   -90.00000

13  1    -.15191    -.00788     .02795    -.15714    -.00264   -10.60565
13  2    -.10957    -.00432     .01370    -.11132    -.00257    -7.29614
13  3    -.06343    -.00045    -.00192    -.06348    -.00045     1.55619
13  4    -.01202     .00459    -.01788    -.02243     .01601    32.54444
13  5     .02051     .00747    -.02931     .04402    -.01603   -38.72702
```

```
 13  6        .03727         .00489        -.03506         .05691        -.01475       -33.98341
 13  7       -.00000         .09230         .00000         .09230        -.00000       -90.00000
 13  8       -.39012         .00000        -.00000        -.39012         .00000         0.00000
 13  9       -.13911         .00000        -.00000        -.13911         .00000         0.00000
 13 10       -.00000         .03172        -.00000         .03172        -.00000       -90.00000

 14  1       -.12647         .03051         .03498        -.13391         .03796       -12.01061
 14  2       -.10569         .01428         .02091        -.10923         .01782        -9.60984
 14  3       -.07106        -.00147         .00338        -.07123        -.00130        -2.77581
 14  4       -.03352        -.01802        -.01553        -.04313        -.00842        31.73912
 14  5       -.00659        -.02626        -.02672         .01206        -.04488       -34.90094
 14  6        .00612        -.03124        -.03306         .02541        -.05053       -30.26874
 14  7       -.00000         .13062         .00000         .13062        -.00000       -90.00000
 14  8       -.44444         .00000         .00000        -.44444         .00000         0.00000
 14  9       -.23524        -.00000        -.00000        -.23524        -.00000         0.00000
 14 10       -.00000        -.12108        -.00000        -.12108        -.00000       -90.00000

 15  1       -.11155         .01294         .03102        -.11885         .02025       -13.24497
 15  2       -.09221         .00579         .01653        -.09493         .00850        -9.31897
 15  3       -.06815        -.00190         .00026        -.06815        -.00190         -.22277
 15  4       -.04343        -.00997        -.01709        -.05062        -.00279        22.80295
 15  5       -.02683        -.01531        -.02874        -.05039         .00925        39.33164
 15  6       -.01599        -.01562        -.03290        -.04870         .01710        44.83731
 15  7       -.00000         .10278         .00000         .10278        -.00000       -90.00000
 15  8       -.43353         .00000        -.00000        -.43353         .00000         0.00000
 15  9       -.29875         .00000        -.00000        -.29875         .00000         0.00000
 15 10       -.00000        -.03342        -.00000        -.03342        -.00000       -90.00000

 16  1       -.12364         .02832         .01543        -.12519         .02987        -5.73863
 16  2       -.10393         .01329         .00845        -.10454         .01389        -4.10040
 16  3       -.06908        -.00157        -.00029        -.06908        -.00157          .24362
 16  4       -.03225        -.01719        -.00965        -.03696        -.01249        26.01618
 16  5       -.00758        -.02769        -.01594         .00121        -.03649       -28.87858
 16  6        .00592        -.03010        -.01816         .01349        -.03766       -22.61674
 16  7       -.00000         .12525         .00000         .12525        -.00000       -90.00000
 16  8       -.43171         .00000        -.00000        -.43171         .00000         0.00000
 16  9       -.22717        -.00000        -.00000        -.22717        -.00000         0.00000
 16 10       -.00000        -.11529        -.00000        -.11529        -.00000       -90.00000

 17  1       -.12391         .02681         .01691        -.12579         .02868        -6.32450
 17  2       -.10480         .01103         .01001        -.10566         .01189        -4.90388
 17  3       -.06970        -.00453         .00116        -.06972        -.00451        -1.01832
 17  4       -.03300        -.02094        -.00828        -.03721        -.01673        26.96824
 17  5       -.00944        -.03193        -.01458        -.00146        -.03891       -25.57343
 17  6        .00502        -.03435        -.01687         .01126        -.04060       -20.29925
 17  7       -.00000         .10789         .00000         .10789        -.00000       -90.00000
 17  8       -.43171         .00000         .00000        -.43171         .00000         0.00000
 17  9       -.22717        -.00000        -.00000        -.22717        -.00000         0.00000
 17 10       -.00000        -.14068        -.00000        -.14068        -.00000       -90.00000

 18  1       -.11274         .01490         .01623        -.11478         .01693        -7.13580
 18  2       -.09115         .00720         .00901        -.09196         .00801        -5.19371
 18  3       -.06565        -.00114         .00101        -.06567        -.00112         -.89632
 18  4       -.03939        -.00991        -.00752        -.04119        -.00810        13.51129
 18  5       -.02176        -.01578        -.01322        -.03232        -.00521        38.62057
 18  6       -.01284        -.01875        -.01611         .00059        -.03218       -39.81137
 18  7       -.00000         .10643         .00000         .10643        -.00000       -90.00000
 18  8       -.41693         .00000         .00000        -.41693         .00000         0.00000
 18  9       -.27336        -.00000        -.00000        -.27336        -.00000         0.00000
 18 10       -.00000        -.04030        -.00000        -.04030        -.00000       -90.00000
TOTAL STRESSES IN BEAM LAYERS (STRESS (KSI), ANG. (DEGRESS), + TEN., - COMP.)

 EL LAYER        SXX            SYY            SXY            S1             S2           THETA1

  1  1       -4.13968        0.00000        -.02639       -4.13984         .00017          .36527
  1  2       -3.95527        0.00000        -.05769       -3.95711         .00184          .83513
  1  3       -3.12303        0.00000       -1.59157       -3.79118         .66815        22.77303
  1  4       -1.63395        0.00000       -1.78324       -2.76271        1.14275        32.65294
  1  5        -.15688        0.00000       -1.86545       -1.96552        1.80864        43.80836
  1  6        1.32620        0.00000       -1.89819        2.67378       -1.34758       -35.37203
  1  7        2.80927        0.00000       -1.82146        3.70490        -.89562       -26.18105
  1  8        4.29235        0.00000       -1.65527        4.85652        -.56417       -19.82097
  1  9        5.12559        0.00000        -.07704        5.12675        -.00116         -.86088
  1 10        5.30899        0.00000        -.03920        5.30928        -.00029         -.42307
  1 11         .00056        0.00000        -.00001         .00056        -.00000         -.53840
  1 12         .00059        0.00000        -.00000         .00058        -.00000         -.26644

  2  1      -10.59241        0.00000        -.02168      -10.59245         .00004          .11402
  2  2      -10.41371        0.00000        -.04855      -10.41393         .00023          .26712
  2  3       -8.23887        0.00000       -1.34908       -8.45416         .21529         9.06660
  2  4       -4.36791        0.00000       -1.51397       -4.84136         .47345        17.36534
  2  5        -.49695        0.00000       -1.60240       -1.87003        1.37307        40.59211
  2  6        3.37401        0.00000       -1.61436        4.02198        -.64797       -21.86072
```

```
2  7       7.24497      0.00000     -1.54986      7.56259     -.31762    -11.58165
2  8      11.11593      0.00000     -1.40888     11.29172     -.17579     -7.11210
2  9      13.29076      0.00000      -.06558     13.29108     -.00032      -.28269
2 10      13.76947      0.00000      -.03339     13.76955     -.00008      -.13889
2 11        .00146      0.00000      -.00000       .00146     -.00000      -.17674
2 12        .00150      0.00000      -.00000       .00150     -.00000      -.08745

3  1     -14.77032      0.00000      -.01231    -14.77033      .00001       .04774
3  2     -14.12403      0.00000      -.02740    -14.12409      .00005       .11116
3  3     -11.18783      0.00000      -.76663    -11.24012      .05229      3.90180
3  4      -5.96172      0.00000      -.87510     -6.08752      .12580      8.18042
3  5       -.73561      0.00000      -.96373     -1.39934      .66373     34.55533
3  6       4.49050      0.00000     -1.03252      4.71653     -.22603    -12.34809
3  7       9.71661      0.00000     -1.08146      9.83552     -.11891     -6.27475
3  8      14.94272      0.00000     -1.11057     15.02481     -.08209     -4.22737
3  9      17.87892      0.00000      -.06164     17.87914     -.00021      -.19752
3 10      18.52521      0.00000      -.06140     18.52542     -.00020      -.18991
3 11        .00197      0.00000      -.07667       .07766     -.07569    -44.63182
3 12        .00201      0.00000      -.03879       .03981     -.03780    -44.25693

4  1     -15.77169      0.00000      -.00724    -15.77170      .00000       .02632
4  2     -15.17250      0.00000      -.01553    -15.17252      .00002       .05866
4  3     -12.45028      0.00000      -.43307    -12.46533      .01505      1.98978
4  4      -7.60503      0.00000      -.50079     -7.63787      .03284      3.75134
4  5      -2.75979      0.00000      -.56953     -2.87270      .11291     11.21375
4  6       2.08546      0.00000      -.63927      2.26583     -.18036    -15.75575
4  7       6.93071      0.00000      -.71004      7.00271     -.07199     -5.78970
4  8      11.77596      0.00000      -.78181     11.82764     -.05168     -3.78179
4  9      14.49818      0.00000      -.04704     14.49833     -.00015      -.18589
4 10      15.09737      0.00000      -.05611     15.09758     -.00021      -.21294
4 11      15.58556      0.00000      -.08213     15.58599     -.00043      -.30191
4 12      15.96275      0.00000      -.04156     15.96286     -.00011      -.14916

5  1     -16.72613      0.00000      -.00532    -16.72613      .00000       .01822
5  2     -16.09104      0.00000      -.01164    -16.09105      .00001       .04156
5  3     -13.20571      0.00000      -.32207    -13.21356      .00785      1.39627
5  4      -8.07015      0.00000      -.36246     -8.08640      .01625      2.56650
5  5      -2.93459      0.00000      -.38717     -2.98481      .05022      7.39082
5  6       2.20097      0.00000      -.39620      2.27012     -.06915     -9.90007
5  7       7.33653      0.00000      -.38955      7.35716     -.02063     -3.03089
5  8      12.47209      0.00000      -.36721     12.48289     -.01080     -1.68501
5  9      15.35742      0.00000      -.01812     15.35744     -.00002      -.06760
5 10      15.99251      0.00000      -.01233     15.99252     -.00001      -.04417
5 11      16.50995      0.00000      -.00793     16.50995     -.00000      -.02753
5 12      16.90974      0.00000      -.00401     16.90974     -.00000      -.01360

6  1     -17.05456      0.00000      -.00190    -17.05456      .00000       .00639
6  2     -16.40678      0.00000      -.00380    -16.40678      .00000       .01328
6  3     -13.46382      0.00000      -.10233    -13.46459      .00078       .43544
6  4      -8.22567      0.00000      -.11442     -8.22726      .00159       .79678
6  5      -2.98753      0.00000      -.12170     -2.99248      .00495      2.37891
6  6       2.25062      0.00000      -.12418      2.25745     -.00683     -3.14865
6  7       7.48877      0.00000      -.12186      7.49075     -.00198      -.93198
6  8      12.72691      0.00000      -.11473     12.72794     -.00103      -.51644
6  9      15.66987      0.00000      -.00566     15.66987     -.00000      -.02069
6 10      16.31765      0.00000      -.00385     16.31765     -.00000      -.01351
6 11      16.84543      0.00000      -.00248     16.84543     -.00000      -.00842
6 12      17.25320      0.00000      -.00125     17.25320     -.00000      -.00415

7  1      -3.91624      0.00000      -.00764     -3.91625      .00001       .11171
7  2      -3.76096      0.00000      -.03715     -3.76133      .00037       .56562
7  3      -3.05551      0.00000     -1.18942     -3.46392      .40841     18.95108
7  4      -1.79988      0.00000     -1.37471     -2.54302      .74314     28.39480
7  5       -.54425      0.00000     -1.48218     -1.77908     1.23483     39.79826
7  6        .71138      0.00000     -1.51183      1.90880    -1.19742    -38.38036
7  7       1.96701      0.00000     -1.46367      2.74692     -.77991    -28.05057
7  8       3.22264      0.00000     -1.33770      3.70555     -.48291    -19.84951
7  9       3.92809      0.00000      -.06241      3.92909     -.00099      -.91003
7 10       4.08337      0.00000      -.03180      4.08362     -.00025      -.44620
7 11        .00044      0.00000      -.00000       .00044     -.00000      -.56782
7 12        .00045      0.00000      -.00000       .00045     -.00000      -.28063

8  1     -10.28544      0.00000      -.00821    -10.28545      .00001       .04571
8  2      -9.87332      0.00000      -.03344     -9.87343      .00011       .19403
8  3      -8.00096      0.00000     -1.04719     -8.13575      .13479      7.33450
8  4      -4.66837      0.00000     -1.20517     -4.96114      .29276     13.65392
8  5      -1.33579      0.00000     -1.29598     -2.12595      .79066     31.36762
8  6       1.99680      0.00000     -1.31962      2.65315     -.65635    -26.44473
8  7       5.32938      0.00000     -1.27609      5.61918     -.28979    -12.79459
8  8       8.66197      0.00000     -1.16539      8.81602     -.15405     -7.53029
8  9      10.53433      0.00000      -.05435     10.53461     -.00023      -.29562
8 10      10.94645      0.00000      -.02769     10.94652     -.00007      -.14495
8 11        .00117      0.00000      -.00000       .00117     -.00000      -.18445
8 12        .00119      0.00000      -.00000       .00119     -.00000      -.09116
```

FEL 435.2

```
  9  1     -13.90260       0.00000        -.00652     -13.90260        .00000       .02685
  9  2     -13.34124       0.00000        -.02057     -13.34127        .00003       .08834
  9  3     -10.79086       0.00000        -.62374     -10.82679        .03593      3.29720
  9  4      -6.25147       0.00000        -.72417      -6.33427        .08279      6.52210
  9  5      -1.71209       0.00000        -.80532      -2.03136        .31927     21.52567
  9  6       2.92730       0.00000        -.96719       3.07209       -.24479    -15.76393
  9  7       7.36668       0.00000        -.90977       7.47737       -.11069     -6.93707
  9  8      11.90607       0.00000        -.93307      11.97875       -.07268     -4.45398
  9  9      14.45644       0.00000        -.05158      14.45663       -.00018      -.20442
  9 10      15.01781       0.00000        -.05073      15.01798       -.00017      -.19356
  9 11        .00160       0.00000        -.06247        .06328       -.06163    -44.63297
  9 12        .00164       0.00000        -.03164        .03247       -.03083    -44.25885

 10  1     -14.82990       0.00000        -.00364     -14.82990        .00000       .01407
 10  2     -14.30409       0.00000        -.01127     -14.30409        .00001       .04514
 10  3     -11.91521       0.00000        -.34323     -11.92509        .00988      1.64867
 10  4      -7.66327       0.00000        -.40458      -7.68457        .02130      3.01373
 10  5      -3.41133       0.00000        -.46541      -3.47369        .06236      7.63107
 10  6        .84060       0.00000        -.52572       1.09338       -.25279    -25.67929
 10  7       5.09254       0.00000        -.58552       5.15900       -.06645     -6.47512
 10  8       9.34448       0.00000        -.64481       9.38876       -.04429     -3.92885
 10  9      11.73335       0.00000        -.03873      11.73348       -.00013      -.18910
 10 10      12.25917       0.00000        -.04596      12.25934       -.00017      -.21479
 10 11      12.68758       0.00000        -.06699      12.68794       -.00035      -.30252
 10 12      13.01858       0.00000        -.03393      13.01867       -.00009      -.14932

 11  1     -15.70384       0.00000        -.00194     -15.70384        .00000       .00707
 11  2     -15.14670       0.00000        -.00798     -15.14671        .00000       .03017
 11  3     -12.61553       0.00000        -.25071     -12.62051        .00498      1.13804
 11  4      -8.11034       0.00000        -.28990      -8.12069        .01035      2.04455
 11  5      -3.60514       0.00000        -.31504      -3.63246        .02732      4.95680
 11  6        .90006       0.00000        -.32612       1.00580       -.10574    -17.96463
 11  7       5.40526       0.00000        -.32314       5.42451       -.01925     -3.40909
 11  8       9.91046       0.00000        -.30610       9.91990       -.00945     -1.76743
 11  9      12.44163       0.00000        -.01514      12.44165       -.00002      -.06971
 11 10      12.99876       0.00000        -.01031      12.99877       -.00001      -.04546
 11 11      13.45269       0.00000        -.00665      13.45269       -.00000      -.02831
 11 12      13.80341       0.00000        -.00337      13.80341       -.00000      -.01397

 12  1     -16.04735       0.00000        -.00042     -16.04735        .00000       .00151
 12  2     -15.47815       0.00000        -.00241     -15.47815        .00000       .00893
 12  3     -12.89217       0.00000        -.07873     -12.89265        .00048       .34986
 12  4      -8.28941       0.00000        -.09168      -8.29042        .00101       .63360
 12  5      -3.68665       0.00000        -.10007      -3.68936        .00271      1.55369
 12  6        .91611       0.00000        -.10389        .92775       -.01163     -6.38913
 12  7       5.51888       0.00000        -.10313       5.52080       -.00193     -1.07022
 12  8      10.12164       0.00000        -.09781      10.12258       -.00095      -.55363
 12  9      12.70762       0.00000        -.00484      12.70762       -.00000      -.02182
 12 10      13.27682       0.00000        -.00330      13.27682       -.00000      -.01424
 12 11      13.74058       0.00000        -.00213      13.74058       -.00000      -.00887
 12 12      14.09889       0.00000        -.00108      14.09889       -.00000      -.00438
   DIRECTION OF PRINCIPAL AXIS (DEG.) 1ST AND 2ND CRACK (ANG. = 999.0 IF NO CRACK)
 ELEMENT LAYER   PRINCIPAL        FIRST                        SECOND

   BEAM LAYER FAILURES
   ELEMENT  LAYER  TYPE OF FAILURE



PLOT SHOWING CRACK-CRUSH AREAS, STRESSES, NODE AND LAYER MARKERS FOR REFERENCE
(SEE USERS MANUAL FOR DETAILS)


BEAM NUMBER  1

  *                          **                          **               **               **         **           *


* 2222222222222222222222222444444444444444444444444444444445555555555555555555555555555555555555555555555555555555555 *
* 2222222222222222222222222333333333333333333333333333333344444444444444445555555555555555555555555555555555555555555 *
* 1111111111111111111111111222222222222222222222222222222223333333333333333333333333333333333333444444444444444444444 *
* 1111111111111111111111111222222222222222222222222222222222222222222222222222222222222222222222222222222222222222222 *
* 1111111111111111111111111111111111111111111111111111111111111111111111111111111111111111111111111111111111111111111 *
* AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAABBBBBBBBBBBBBBBAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA *
* AAAAAAAAAAAAAAAAAAAAAAAAABBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBCCCCCCCCCCCCCCCBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBB *
* BBBBBBBBBBBBBBBBBBBBBBBBBCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCDDDDDDDDDDDDDDDCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCDDDDDDDDDDD *
* BBBBBBBBBBBBBBBBBBBBBBBBBCCCDDDDDDDDDDDDDDDDDDDDDDDDDDDDDFFFFFFFFEFFFFFFFFFFFFFFFFEFFFFFFFFFEEFFFEEEFFFFFFFEEFEEEEE *
* BBBBBBBBBBBBBBBBBBBBBBBBBCCDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDFFFFFFFFFFFFFFFFFEFFFFFFEFFFFFFFFFFEEFFEFFEFEFFFFFEFEEEEEE *
* AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAADDDDDDDADDDDDDDDDDDDDDDDDDDDDDDDDDDFFFFFEFEF *
```

```
* AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAADDDDDDDDDDDDDDDDEEFFEFFEFFFFFEFEEEEE *

  *                       **                       **             **             **        **         *


BEAM NUMBER  2

  *                       **                       **             **             **        **         *

* 22222222222222222222222233333333333333333333333333444444444444444555555555555555555555555555555555555 *
* 22222222222222222222222233333333333333333333333333444444444444444444444444444444555555555555555555555 *
* 11111111111111111111111112222222222222222222222222333333333333333333333333333333444444444444444444444 *
* 11111111111111111111111112222222222222222222222222222222222222222222222222222222222222222222222222222 *
* 11111111111111111111111111111111111111111111111111111111111111111111111111111111111111111111111111111 *
* AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA *
* AAAAAAAAAAAAAAAAAAAAAAAAABBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBB *
* AAAAAAAAAAAAAAAAAAAAAAAAACCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC *
* BBBBBBBBBBBBBBBBBBBBBBBBBCCCCCCCCCCCCCCCCCCCCCCCCCFFFFFFFFFFFFFFEDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDD *
* BBBBBBBBBBBBBBBBBBBBBBBBBDDDDDDDDDDDDDDDDDDDDDDDDDEEFFFFFEFFFEEFEDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDD *
* AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAADDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDD *
* AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAADDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDD *

  *                       **                       **             **             **        **         *


     SLAB PLOT
          NODE J                                                                  NODE L
                 ELEMENT NUMBER                    Y = NUMBER OF YIELDED LAYERS
                 C  = NUMBER OF CRUSHED LAYERS     T = NUMBER OF CRACKED LAYERS
          NODE I                                                                  NODE K

5BBBBBBBBBBBBBBBBBBBBBB11BBBBBBBBBBBBBBBBBBBBB17BBBBBBBBBBB23BBBBBBBBBBB29BBBBBBBBBB35BBBBBBBBBBB41
*                      *                      *            *            *           *            *
*                      *                      *            *            *           *            *
*       3              *       6              *   9        *   12       *   15      *   18       *
*                      *                      *            *            *           *            *
*                      *                      *            *            *           *            *
*                      *                      *            *            *           *            *
*                      *                      *            *            *           *            *
*                      *                      *            *            *           *            *
*                      *                      *            *            *           *            *
*                      *                      *            *            *           *            *
4**********************10*********************16***********22***********28**********34***********40
*                      *                      *            *            *           *            *
*                      *                      *            *            *           *            *
*       2              *       5              *   8        *   11       *   14      *   17       *
*                      *                      *            *            *           *            *
*                      *                      *            *            *           *            *
*                      *                      *            *            *           *            *
*                      *                      *            *            *           *            *
*                      *                      *            *            *           *            *
*                      *                      *            *            *           *            *
*                      *                      *            *            *           *            *
2BBBBBBBBBBBBBBBBBBBBBB8BBBBBBBBBBBBBBBBBBBBBB14BBBBBBBBBBB20BBBBBBBBBBB26BBBBBBBBBB32BBBBBBBBBBB38
*                      *                      *            *            *           *            *
*                      *                      *            *            *           *            *
*       1              *       4              *   7        *   10       *   13      *   16       *
*                      *                      *            *            *           *            *
*                      *                      *            *            *           *            *
*                      *                      *            *            *           *            *
*                      *                      *            *            *           *            *
*                      *                      *            *            *           *            *
*                      *                      *            *            *           *            *
*                      *                      *            *            *           *            *
1**********************7**********************13***********19***********25**********31***********37

      LOAD CYCLE =            1
      ----LOAD RATIO AT START OF CYCLE      =    .40000000E+00
      ----RESCAN FACTOR AT START OF CYCLE   =    .10000000E+01
```

FEL 435.2

```
NUMBER OF TRIALS     =     1
NUMBER OF ITERATIONS =     1
NUMBER OF TRIALS     =     1
NUMBER OF ITERATIONS =     2
NUMBER OF TRIALS     =     1
NUMBER OF ITERATIONS =     3


        SLAB - NEWLY CRACKED, CRUSHED OR YIELDED LAYERS
ELEMENT  LAYER     ANGLE

        NEW BEAM LAYER FAILURES
ELEMENT  LAYER  TYPE OF FAILURE


        APPLIED NODAL POINT FORCES IN KIPS AND IN-KIPS

        NODE          U             V             W             XX            YY            ZZ

          1        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
          2        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
          3        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
          4        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
          5        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
          6        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
          7        0.00000       0.00000        .00358       -.10978       -.25616       0.00000
          8        0.00000       0.00000        .15451       -.28361      -3.20201       0.00000
          9        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
         10        0.00000       0.00000        .17565       0.00000      -3.84242       0.00000
         11        0.00000       0.00000        .08783        .68615      -1.92121       0.00000
         12        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
         13        0.00000       0.00000        .08537       -.85092        .23558       0.00000
         14        0.00000       0.00000       1.91790      -2.19795       2.94471       0.00000
         15        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
         16        0.00000       0.00000       2.22586       -.00000       3.53365       0.00000
         17        0.00000       0.00000       1.11293       5.31763       1.76682       0.00000
         18        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
         19        0.00000       0.00000        .07624       -.82337       0.00000       0.00000
         20        0.00000       0.00000       1.77635      -2.12705       0.00000       0.00000
         21        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
         22        0.00000       0.00000       2.05844       -.00000       0.00000       0.00000
         23        0.00000       0.00000       1.02922       5.14603       0.00000       0.00000
         24        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
         25        0.00000       0.00000        .06353       -.68615        .28589       0.00000
         26        0.00000       0.00000       1.48030      -1.77254       3.57367       0.00000
         27        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
         28        0.00000       0.00000       1.71536       -.00000       4.28841       0.00000
         29        0.00000       0.00000        .85768       4.28841       2.14420       0.00000
         30        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
         31        0.00000       0.00000        .05083       -.54892       0.00000       0.00000
         32        0.00000       0.00000       1.18424      -1.41803       0.00000       0.00000
         33        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
         34        0.00000       0.00000       1.37229       -.00000       0.00000       0.00000
         35        0.00000       0.00000        .68615       3.43073       0.00000       0.00000
         36        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
         37        0.00000       0.00000        .02541       -.27445        .22872       0.00000
         38        0.00000       0.00000        .59212       -.70902       2.85894       0.00000
         39        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000
         40        0.00000       0.00000        .68615       0.00000       3.43073       0.00000
         41        0.00000       0.00000        .34307       1.71536       1.71536       0.00000
         42        0.00000       0.00000       0.00000       0.00000       0.00000       0.00000


        NODAL POINT DISPLACEMENTS IN INCHES AND RADIANS

        NODE          U             V             W             XX            YY            ZZ

          1         .01303       0.00000       -.00329       -.00011       -.00469       0.00000
          2         .01395       0.00000       0.00000       -.00006       -.00486       0.00000
          3        -.04439       0.00000       0.00000       0.00000       -.00470       0.00000
          4         .01381       0.00000        .00075        .00001       -.00495       0.00000
          5         .01447       0.00000       0.00000        .00003       -.00520       0.00000
          6        -.04602       0.00000       0.00000       0.00000       -.00502       0.00000
          7         .01205        .00079        .33893       -.00024       -.00429       0.00000
          8         .01299        .00062        .35076       -.00036       -.00447       0.00000
          9        -.04071       0.00000       0.00000       0.00000       -.00431       0.00000
         10         .01270        .00047        .36217       -.00040       -.00458       0.00000
         11         .01332        .00033        .37453       -.00045       -.00479       0.00000
         12        -.04407       0.00000       0.00000       0.00000       -.00461       0.00000
```

```
 13        .00935       .00123       .62238      -.00053      -.00315      0.00000
 14        .00292       .00096       .64425      -.00069      -.00332      0.00000
 15       -.02975      0.00000      0.00000      0.00000      -.00318      0.00000
 16        .00363       .00367       .66591      -.00073      -.00337      0.00000
 17        .01002       .00039       .68804      -.00077      -.00354      0.00000
 18       -.03228      0.00000      0.00000      0.00000      -.00339      0.00000
 19        .00705       .00130       .74369      -.00064      -.00222      0.00000
 20        .00719       .00088       .76980      -.00092      -.00229      0.00000
 21       -.02015      0.00000      0.00000      0.00000      -.00217      0.00000
 22        .00701       .00052       .79557      -.00097      -.00236      0.00000
 23        .00712       .00018       .82164      -.00090      -.00243      0.00000
 24       -.02191      0.00000      0.00000      0.00000      -.00231      0.00000
 25        .00426       .00104       .82245      -.00071      -.00127      0.00000
 26        .00426       .00059       .85121      -.00093      -.00135      0.00000
 27       -.01189      0.00000      0.00000      0.00000      -.00129      0.00000
 28        .00408       .00021       .87946      -.00075      -.00136      0.00000
 29        .00412      -.00015       .90792      -.00097      -.00142      0.00000
 30       -.01296      0.00000      0.00000      0.00000      -.00137      0.00000
 31        .00722       .00076       .85123      -.00075      -.00063      0.00000
 32        .00209       .00031       .88139      -.00093      -.00067      0.00000
 33       -.00603      0.00000      0.00000      0.00000      -.00065      0.00000
 34        .00202       .00003       .91045      -.00098      -.00070      0.00000
 35        .00209      -.00033       .93990      -.00101      -.00072      0.00000
 36       -.00656      0.00000      0.00000      0.00000      -.00069      0.00000
 37       0.00000      0.00000       .86081      -.00077      0.00000      0.00000
 38       0.00000      0.00000       .89145      -.00094      0.00000      0.00000
 39       0.00000      0.00000      0.00000      0.00000      0.00000      0.00000
 40       0.00000      0.00000       .92090      -.00093      0.00000      0.00000
 41       0.00000      0.00000       .95065      -.00102      0.00000      0.00000
 42       0.00000      0.00000      0.00000      0.00000      0.00000      0.00000


          DISPLACEMENT/REFERENCE DISPLACEMENT =      .39790

          FORCE/REFERENCE FORCE               =      .40000

          SUM OF NODAL POINT W-LOADS          =    19.7610

          SUM OF W-LOADS FOR TOTAL STRUCTURE  =    79.0440

          (SUM OF W-LOADS FOR TOTAL STRUCTURE
               WITHOUT IMPACT FACTOR)         =    61.4786


  INTERNAL MOMENTS (IN-KIPS/IN) AND NORMAL FORCES (KIPS/IN) IN THE SLAB
EL              MY            MX             MXY              NX              NY              NXY
 1             .12         -1.93            -.56            -.56            -.16              -.27
 2             .17         -1.93            -.69            -.56            -.15               .26
 3             .01          -.67            -.61            -.54            -.10              -.15
 4            2.86           .13            -.24           -1.37             .10              -.14
 5            1.10          -.33            -.72           -1.51            -.06               .19
 6            1.56           .10            -.46           -1.56            -.10              -.22
 7            2.39           .05            -.22           -1.92            -.01              -.20
 8            2.92          -.14            -.52           -2.20            -.07               .14
 9            2.74           .19            -.22           -2.30            -.09              -.21
10            2.69           .08            -.34           -2.25             .02              -.12
11            2.76          -.31            -.23           -2.45            -.00               .02
12            2.46           .11            -.25           -2.39            -.03              -.13
13            2.55           .07            -.07           -2.42             .01              -.12
14            2.79          -.39            -.22           -2.67            -.01              -.02
15            2.42           .53            -.10           -2.50            -.02              -.09
16            2.73          -.41            -.03           -2.58             .00              -.09
17            2.61          -.31            -.08           -2.54            -.14              -.07
18            2.64           .51            -.06           -2.43            -.01              -.03


 INTERNAL MOMENTS (IN-KIPS), NORMAL FORCES (KIPS), AND SHEAR FORCES (KIPS) IN BEAM ELEMENTS
ELEM        MB                NB              VB

 1        656.0490          35.1998        -23.1483
 2       1763.2257          99.4330        -20.6034
 3       2436.7840         141.3003        -15.1345
 4       2974.5582         156.6531         -9.9700
 5       3067.6071         166.9019         -5.5617
 6       3127.7161         171.1512         -1.6971
 7        294.2790          14.1170        -10.5596
 8        905.1043          42.8294         -9.6071
 9       1122.9245          63.4145         -7.2446
10       1327.2179          71.1665         -4.7282
```

```
       11        1413.2006             76.3792              -2.6357
       12        1445.5947             78.1681               -.8246

 TOTAL STRESSES IN SLAB LAYERS (STRESS (KSI), ANG. (DEGREES), + TEN., - COMP.)

      EL LAYER       SXX            SYY            SXY            S1             S2           THETA1

       1   1       -.10709         .19633         .02587        -.10928         .19852       -4.83835
       1   2       -.09420         .09466        -.00582        -.09438         .09484        1.76250
       1   3       -.08769        -.01854        -.04209        -.10759         .00136       25.30083
       1   4       -.07013        -.13898        -.07958        -.01785        -.19126      -33.30308
       1   5       -.05796        -.22299        -.10689        -.00544        -.27550      -26.16613
       1   6       -.05094        -.26544        -.12099         .00350        -.31987      -24.22312
       1   7       -.00000         .22968        -.00000         .22968        -.00000      -90.00000
       1   8       -.53009        -.00000        -.00000        -.53009        -.00000        0.00000
       1   9       -.31678        -.00000        -.00000        -.31678        -.00000        0.00000
       1  10       -.00000       -1.06489        -.00000       -1.06489        -.00000      -90.00000

       2   1       -.10551         .20313         .12438        -.14940         .24702      -19.43486
       2   2       -.09335         .09833         .08337        -.12453         .12952      -20.50913
       2   3       -.08764        -.01856         .04121        -.10687         .00067      -25.01809
       2   4       -.07066        -.14243        -.00762        -.06986        -.14323       -5.99215
       2   5       -.05944        -.22516        -.03994        -.05032        -.23429      -12.86779
       2   6       -.05364        -.26713        -.05643        -.03965        -.28113      -13.93077
       2   7       -.00000         .23527         .00000         .23527        -.00000      -90.00000
       2   8       -.53009        -.00000         .00000        -.53009        -.00000        0.00000
       2   9       -.31679        -.00000        -.00000        -.31678        -.00000        0.00000
       2  10       -.00000       -1.09082        -.00000       -1.09082        -.00000      -90.00000

       3   1       -.08200         .06598         .05169        -.09827         .08225      -17.47006
       3   2       -.07970         .02733         .01478        -.08170         .02933       -7.71933
       3   3       -.08527        -.01747        -.02638        -.09432        -.00841       18.94047
       3   4       -.07651        -.05571        -.06698        -.13390         .00167       40.58731
       3   5       -.07370        -.08126        -.09235         .01495        -.16991      -43.82932
       3   6       -.07072        -.09467        -.10602         .02400        -.19939      -41.77776
       3   7       -.00000         .08585        -.00000         .08585        -.00000      -90.00000
       3   8       -.53368        -.00000        -.00000        -.53368        -.00000        0.00000
       3   9       -.46695        -.00000        -.00000        -.46695        -.00000        0.00000
       3  10       -.00000        -.39802        -.00000        -.39802        -.00000      -90.00000

       4   1       -.55375        -.00445         .00906        -.55390        -.00430        -.94465
       4   2       -.38558         .00305        -.00739        -.38572         .00319        1.08949
       4   3       -.21161         .01134        -.02364        -.21409         .01382        5.98660
       4   4       -.00521         .01958        -.03835        -.03312         .04749       36.04270
       4   5        .12428         .02603        -.04943         .14485         .00547      -22.58812
       4   6        .19039         .02910        -.05503         .20737         .01211      -17.15447
       4   7       -.00000         .39458        -.00000         .39458        -.00000      -90.00000
       4   8      -1.23856         .00000        -.00000       -1.23856         .00000        0.00000
       4   9       -.24897         .00000        -.00000        -.24897         .00000        0.00000
       4  10        .00000         .07228        -.00000         .07228         .00000      -90.00000

       5   1       -.35275         .03138         .11641        -.38527         .06390      -15.61004
       5   2       -.31043         .00909         .07507        -.32724         .02490      -12.61855
       5   3       -.22588        -.01468         .02958        -.22994        -.01061       -7.82314
       5   4       -.14334        -.03230        -.02098        -.14717        -.02847       10.35137
       5   5       -.08951        -.04362        -.05497        -.12544        -.00669       33.89504
       5   6       -.06312        -.05004        -.07019        -.12707         .01391       42.33949
       5   7       -.00000         .27278         .00000         .27278        -.00000      -90.00000
       5   8      -1.42168         .00000         .00000       -1.42168         .00000        0.00000
       5   9      -1.00018        -.00000        -.00000       -1.00018        -.00000        0.00000
       5  10       -.00000        -.11650        -.00000        -.11650        -.00000      -90.00000

       6   1       -.42439        -.02723         .02113        -.42551        -.02611       -3.03696
       6   2       -.33330        -.02388        -.00559        -.33340        -.02378        1.03410
       6   3       -.23601        -.02062        -.03395        -.24124        -.01539        8.74936
       6   4       -.12218        -.00933        -.06463        -.15155         .02004       24.43844
       6   5       -.04435        -.00317        -.08692        -.11309         .06556       33.33563
       6   6       -.00830        -.00054        -.09872        -.10322         .09437       43.87430
       6   7       -.00000         .20437        -.00000         .20437        -.00000      -90.00000
       6   8      -1.46498         .00000        -.00000       -1.46498         .00000        0.00000
       6   9       -.90879         .00000        -.00000        -.90879         .00000        0.00000
       6  10       -.00000         .05072        -.00000         .05072        -.00000      -90.00000

       7   1       -.58229        -.01030        -.00329        -.58231        -.01028         .32921
       7   2       -.44183        -.00879        -.01691        -.44249        -.00813        2.23248
       7   3       -.28567        -.00549        -.03197        -.28927        -.00286        6.45014
       7   4       -.11905        -.00162        -.04588        -.13485         .01418       17.00333
       7   5       -.00419         .00056        -.05612        -.05798         .05436       43.79271
       7   6        .05061         .00137        -.06216         .09285        -.04087      -34.19559
       7   7       -.00000         .39458        -.00000         .39458        -.00000      -90.00000
       7   8      -1.78045         .00000        -.00000       -1.78045         .00000        0.00000
       7   9       -.93154         .00000        -.00000        -.93154         .00000        0.00000
       7  10      --.00000         .07228        -.00000         .07228        -.00000      -90.00000
```

```
 8  1     -.69372     .00345     .08355    -.70359     .01332    -6.73966
 8  2     -.51031    -.00686     .05427    -.51609    -.00102    -6.08272
 8  3     -.33217    -.01678     .02222    -.33373    -.01523    -4.01054
 8  4     -.12501    -.02134    -.01370    -.12679    -.01556     7.39986
 8  5      .01078    -.02543    -.03920     .03595    -.05051   -32.60762
 8  6      .07350    -.02703    -.05240     .10096    -.04849   -22.76538
 8  7     -.00000     .42074     .00000     .42074    -.00000   -90.00000
 8  8    -2.04560     .00000     .00000   -2.04560     .00000     0.00000
 8  9     -.99745     .00000    -.00000    -.99745     .00000     0.00000
 8 10     -.00000    -.08139    -.00000    -.08139    -.00000   -90.00000

 9  1     -.67942    -.03914    -.00779    -.67952    -.03905      .69680
 9  2     -.52375    -.03197    -.01796    -.52440    -.03132     2.08927
 9  3     -.34422    -.01985    -.03334    -.34761    -.01645     5.80800
 9  4     -.15098    -.00385    -.04769    -.16508     .01026    16.47749
 9  5     -.01792     .00509    -.05880    -.06633     .05350    39.46450
 9  6      .04547     .00918    -.06535     .09514    -.04050   -37.24025
 9  7     -.00000     .37329    -.00000     .37329    -.00000   -90.00000
 9  8    -2.12965     .00000    -.00000   -2.12965     .00000     0.00000
 9  9    -1.15975     .00000    -.00000   -1.15975     .00000     0.00000
 9 10     -.00000     .10730    -.00000     .10730    -.00000   -90.00000

10  1     -.67015    -.01151     .02252    -.67092    -.01074    -1.95590
10  2     -.50781    -.00762     .00129    -.50781    -.00762     -.14785
10  3     -.33409    -.00343    -.02018    -.33531    -.00220     3.47984
10  4     -.14965     .00306    -.04222    -.16055     .01395    14.46942
10  5     -.01715     .00686    -.05663    -.06303     .05274    39.01622
10  6      .04382     .00314    -.06520     .09357    -.04161   -37.34717
10  7     -.00000     .48285    -.00000     .48285    -.00000   -90.00000
10  8    -2.09303     .00000    -.00000   -2.09303     .00000     0.00000
10  9    -1.14072     .00000    -.00000   -1.14072     .00000     0.00000
10 10     -.00000     .13873    -.00000     .13873    -.00000   -90.00000

11  1     -.73530     .03450     .02890    -.73638     .03559    -2.14721
11  2     -.52154     .01381     .01849    -.52217     .01445    -1.97569
11  3     -.35274    -.00816     .00427    -.35279    -.00810     -.71066
11  4     -.17513    -.02657    -.01418    -.17647    -.02523     5.40540
11  5     -.05251    -.03510    -.02419    -.06951    -.01810    35.10212
11  6      .00716    -.04060    -.03082     .02227    -.05571   -26.11496
11  7     -.00000     .51619     .00000     .51619    -.00000   -90.00000
11  8    -2.21003     .00000     .00000   -2.21003     .00000     0.00000
11  9    -1.28229     .00000    -.00000   -1.28229     .00000     0.00000
11 10     -.00000    -.04658    -.00000    -.04658    -.00000   -90.00000

12  1     -.65737    -.02038     .00931    -.65751    -.02024     -.83710
12  2     -.51982    -.01746    -.00288    -.51983    -.01745      .32823
12  3     -.35769    -.01085    -.02017    -.35885    -.00968     3.31749
12  4     -.18157    -.00126    -.03673    -.18876     .00594    11.08398
12  5     -.06129     .00405    -.04807    -.08675     .02950    27.89899
12  6     -.00563     .00599    -.05493    -.05506     .05541    41.97980
12  7     -.00000     .45484    -.00000     .45484    -.00000   -90.00000
12  8    -2.24491     .00000    -.00000   -2.24491     .00000     0.00000
12  9    -1.36612     .00000    -.00000   -1.36612     .00000     0.00000
12 10     -.00000     .16610    -.00000     .16610    -.00000   -90.00000

13  1     -.67761    -.01197    -.01029    -.67777    -.01181      .88527
13  2     -.52620    -.00850    -.01444    -.52660    -.00910     1.59656
13  3     -.36052    -.00475    -.01890    -.36152    -.00375     3.03167
13  4     -.18077     .00030    -.02296    -.18363     .00316     7.11415
13  5     -.05490     .00389    -.02561    -.06450     .01348    20.53272
13  6      .00125     .00431    -.02764    -.02490     .03047    43.42413
13  7     -.00000     .50704    -.00000     .50704    -.00000   -90.00000
13  8    -2.27014     .00000    -.00000   -2.27014     .00000     0.00000
13  9    -1.35936     .00000    -.00000   -1.35936     .00000     0.00000
13 10     -.00000     .17433    -.00000     .17433    -.00000   -90.00000

14  1     -.75053     .04637     .02172    -.75112     .04696    -1.56030
14  2     -.57830     .01273     .01187    -.57854     .01297    -1.14992
14  3     -.38309    -.01026    -.00252    -.38910    -.01024      .38047
14  4     -.20139    -.03106    -.01878    -.20344    -.02902     6.21763
14  5     -.07285    -.04186    -.02812    -.08946    -.02525    30.57466
14  6     -.00910    -.04822    -.03344     .01008    -.06740   -29.83964
14  7     -.00000     .55892    -.00000     .55892    -.00000   -90.00000
14  8    -2.44103     .00000    -.00000   -2.44103     .00000     0.00000
14  9    -1.45928     .00000    -.00000   -1.45928     .00000     0.00000
14 10     -.00000    -.05033    -.00000    -.05033    -.00000   -90.00000

15  1     -.67590    -.06896    -.00139    -.67591    -.06896      .13069
15  2     -.53039    -.04046    -.00672    -.53048    -.04036      .78574
15  3     -.36973    -.00949    -.01300    -.37026    -.00902     2.06409
15  4     -.20319     .02646    -.01959    -.20485     .02812     4.84070
15  5     -.08189     .04649    -.02429    -.08632     .05093    10.36469
15  6     -.02607     .05904    -.02538    -.03307     .06603    15.40649
15  7     -.00000     .42858    -.00000     .42858    -.00000   -90.00000
15  8    -2.33316     .00000    -.00000   -2.33316     .00000     0.00000
```

```
 15  9        -1.50211          .00000         -.00000        -1.50211          .00000         0.00000
 15 10         -.00000          .42037         -.00000          .42037         -.00000       -90.00000

 16  1         -.73067          .05036         -.01010         -.73100          .05069          .74036
 16  2         -.56113          .01652         -.00989         -.56130          .01669          .98039
 16  3         -.37421         -.00344         -.01200         -.37460         -.00305         1.87633
 16  4         -.19236         -.03061         -.01531         -.19380         -.02917         5.35850
 16  5         -.06941         -.04519         -.01749         -.07859         -.03602        27.65170
 16  6         -.00667         -.04979         -.01762         -.00039         -.05607       -19.63679
 16  7         -.00000          .55162         -.00000          .55162         -.00000       -90.00000
 16  8        -2.34922          .00000         -.00000        -2.34922          .00000         0.00000
 16  9        -1.39565          .00000         -.00000        -1.39565          .00000         0.00000
 16 10         -.00000         -.05974         -.00000         -.05974         -.00000       -90.00000

 17  1         -.70621          .01323         -.00497         -.70624          .01327          .39586
 17  2         -.54765         -.00771         -.00786         -.54777         -.00760          .83640
 17  3         -.37892         -.02593         -.01344         -.37943         -.02542         2.17726
 17  4         -.19553         -.04477         -.01926         -.19795         -.04234         7.16757
 17  5         -.07166         -.05733         -.02308         -.08878         -.04040        36.26023
 17  6         -.00390         -.06066         -.02410          .00058         -.07015       -21.48358
 17  7         -.00000          .43653         -.00000          .43653         -.00000       -90.00000
 17  8        -2.34922          .00000         -.00000        -2.34922          .00000         0.00000
 17  9        -1.39565          .00000         -.00000        -1.39565          .00000         0.00000
 17 10         -.00000         -.14453         -.00000         -.14453         -.00000       -90.00000

 18  1         -.69254         -.06575          .00186         -.69255         -.06574         -.16957
 18  2         -.53419         -.03780         -.00147         -.53420         -.03780          .16939
 18  3         -.36058         -.00749         -.00520         -.36066         -.00741          .84329
 18  4         -.17705          .02705         -.00909         -.17746          .02746         2.54598
 18  5         -.05136          .04689         -.01194         -.05279          .04832         6.82816
 18  6          .00820          .05743         -.01308          .00494          .06069        13.99408
 18  7         -.00000          .43639         -.00000          .43639         -.00000       -90.00000
 18  8        -2.26614          .00000         -.00000        -2.26614          .00000         0.00000
 18  9        -1.36245          .00000         -.00000        -1.36245          .00000         0.00000
 18 10         -.00000          .39134         -.00000          .39134         -.00000       -90.00000
TOTAL STRESSES IN BEAM LAYERS (STRESS (KSI), ANG. (DEGRESS), + TEN., - COMP.)

 EL LAYER        SXX             SYY             SXY             S1              S2            THETA1

  1  1        -4.03706         0.00000         -.11332        -4.04024          .00318         1.60655
  1  2        -3.80234         0.00000         -.14361        -3.80776          .00542         2.15984
  1  3        -2.73598         0.00000        -3.12606        -4.78026         2.04429        33.18272
  1  4         -.93796         0.00000        -3.28873        -3.73429         2.79633        41.36985
  1  5         1.06005         0.00000        -3.33139         3.90331        -2.84326       -40.47997
  1  6         2.95807         0.00000        -3.25403         5.05343        -2.09536       -32.77854
  1  7         4.85609         0.00000        -3.05667         6.33171        -1.47562       -25.76918
  1  8         6.75410         0.00000        -2.73929         7.72540         -.97130       -19.52359
  1  9         7.82047         0.00000         -.12670         7.82252         -.00205         -.92792
  1 10         8.05519         0.00000         -.06427         8.05570         -.00051         -.45711
  1 11          .00085         0.00000         -.00001          .00085         -.00000         -.58020
  1 12          .00087         0.00000         -.00000          .00087         -.00000         -.28750

  2  1       -10.57455         0.00000         -.10282       -10.57555          .00100          .55704
  2  2        -9.94371         0.00000         -.12902        -9.94538          .00167          .74326
  2  3        -7.07770         0.00000        -2.79077        -8.04572          .96802        19.12982
  2  4        -1.97652         0.00000        -2.93022        -4.08065         2.10413        35.68130
  2  5         3.12466         0.00000        -2.96404         4.91292        -1.78826       -31.10327
  2  6         8.22584         0.00000        -2.89223         9.14095         -.91511       -17.55754
  2  7        13.32702         0.00000        -2.71477        13.85881         -.53179       -11.08320
  2  8        18.42820         0.00000        -2.43168        18.74367         -.31547        -7.39188
  2  9        21.29421         0.00000         -.11245        21.29480         -.00059         -.30254
  2 10        21.92505         0.00000         -.05703        21.92520         -.00015         -.14904
  2 11          .00232         0.00000         -.00001          .00232         -.00000         -.18919
  2 12          .00236         0.00000         -.00000          .00236         -.00000         -.09375

  3  1       -14.39239         0.00000         -.06973       -14.39272          .00033          .27361
  3  2       -13.52057         0.00000         -.08421       -13.52109          .00052          .35684
  3  3        -9.55973         0.00000        -1.80375        -9.88875          .32901        10.33733
  3  4        -2.50989         0.00000        -1.91062        -3.54085         1.03096        28.35105
  3  5         4.53996         0.00000        -1.99083         5.28929         -.74933       -20.62580
  3  6        11.58981         0.00000        -2.04437        11.93985         -.35004        -9.71610
  3  7        18.63965         0.00000        -2.07124        18.86703         -.22738        -6.26489
  3  8        25.68950         0.00000        -2.07144        25.85546         -.16596        -4.58054
  3  9        29.65033         0.00000         -.11256        29.65076         -.00043         -.21750
  3 10        30.52216         0.00000         -.10743        30.52253         -.00038         -.20167
  3 11          .00323         0.00000         -.12936          .12998         -.12675       -44.63946
  3 12          .00329         0.00000         -.06479          .06645         -.06316       -44.27328

  4  1       -15.53761         0.00000         -.04047       -15.53771          .00011          .14925
  4  2       -14.74089         0.00000         -.04983       -14.74106          .00017          .19370
  4  3       -11.12129         0.00000        -1.07622       -11.22449          .10319         5.47687
  4  4        -4.67979         0.00000        -1.15377        -4.94793          .26814        13.12607
  4  5         1.76372         0.00000        -1.22403         2.39840         -.63468       -27.22486
```

```
 4  6      8.20622      0.00000     -1.31700      8.41240     -.20618     -9.89770
 4  7     14.64972      0.00000     -1.40268     14.78183     -.13310     -5.42071
 4  8     21.09123      0.00000     -1.49108     21.19612     -.10489     -4.02394
 4  9     24.71084      0.00000      -.08709     24.71114     -.00031      -.20192
 4 10     25.50755      0.00000      -.09854     25.50793     -.00039      -.22134
 4 11     26.15667      0.00000      -.13861     26.15741     -.00073      -.30361
 4 12     26.65820      0.00000      -.06996     26.65839     -.00018      -.15037

 5  1    -16.60346      0.00000      -.02749    -16.60351      .00005       .09488
 5  2    -15.75311      0.00000      -.03394    -15.75318      .00007       .12344
 5  3    -11.88980      0.00000      -.72752    -11.93415      .04435      3.48850
 5  4     -5.01355      0.00000      -.76428     -5.12747      .11392      8.47785
 5  5      1.86270      0.00000      -.77862      2.14530     -.28260    -19.94806
 5  6      8.73896      0.00000      -.77055      8.80638     -.06742     -5.00062
 5  7     15.61521      0.00000      -.74007     15.65021     -.03500     -2.70741
 5  8     22.49146      0.00000      -.68718     22.51244     -.02098     -1.74837
 5  9     26.35477      0.00000      -.03368     26.35481     -.00004      -.07322
 5 10     27.20512      0.00000      -.02281     27.20514     -.00002      -.04803
 5 11     27.89795      0.00000      -.01460     27.89795     -.00001      -.02999
 5 12     28.43324      0.00000      -.00737     28.43324     -.00000      -.01485

 6  1    -16.86372      0.00000      -.00959    -16.86372      .00001       .03259
 6  2    -15.99709      0.00000      -.01110    -15.99710      .00001       .03975
 6  3    -12.05986      0.00000      -.22731    -12.06414      .00428      1.07942
 6  4     -5.05203      0.00000      -.23527     -5.06296      .01093      2.66058
 6  5      1.95580      0.00000      -.23707      1.98413     -.02833     -6.81368
 6  6      8.96364      0.00000      -.23271      8.96967     -.00604     -1.48618
 6  7     15.97147      0.00000      -.22219     15.97456     -.00309      -.79688
 6  8     22.97930      0.00000      -.20551     22.98114     -.00184      -.51235
 6  9     26.91653      0.00000      -.01005     26.91653     -.00000      -.02140
 6 10     27.78316      0.00000      -.00680     27.78316     -.00000      -.01402
 6 11     28.48924      0.00000      -.00435     28.48924     -.00000      -.00875
 6 12     29.03478      0.00000      -.00219     29.03478     -.00000      -.00433

 7  1     -3.81266      0.00000      -.10131     -3.81535      .00269      1.52096
 7  2     -3.60207      0.00000      -.12974     -3.60675      .00467      2.06019
 7  3     -2.64542      0.00000     -2.84314     -4.45847     1.81305     32.52540
 7  4      -.94266      0.00000     -2.99719     -3.50536     2.56270     40.53149
 7  5       .76009      0.00000     -3.04051      3.44421    -2.68412    -41.43765
 7  6      2.46285      0.00000     -2.97308      4.44944    -1.98659    -33.75053
 7  7      4.16561      0.00000     -2.79491      5.56843    -1.40282    -26.65301
 7  8      5.86836      0.00000     -2.50599      6.79286     -.92450    -20.24981
 7  9      6.82503      0.00000      -.11594      6.82700     -.00197      -.97290
 7 10      7.03560      0.00000      -.05882      7.03609     -.00049      -.47895
 7 11       .00075      0.00000      -.00001       .00075     -.00000      -.60768
 7 12       .00076      0.00000      -.00000       .00076     -.00000      -.30101

 8  1     -9.95055      0.00000      -.09605     -9.95148      .00093       .55297
 8  2     -9.37446      0.00000      -.12042     -9.37601      .00155       .73583
 8  3     -6.75717      0.00000     -2.60329     -7.64378      .88662     18.80759
 8  4     -2.09869      0.00000     -2.73291     -3.97678     1.87810     34.49750
 8  5      2.55981      0.00000     -2.76411      4.32596    -1.76615    -32.57690
 8  6      7.21830      0.00000     -2.69690      8.11461     -.89631    -18.38425
 8  7     11.87679      0.00000     -2.53126     12.39376     -.51698    -11.54315
 8  8     16.53528      0.00000     -2.26721     16.84051     -.30523     -7.66752
 8  9     19.15257      0.00000      -.10484     19.15314     -.00057      -.31362
 8 10     19.72866      0.00000      -.05317     19.72881     -.00014      -.15443
 8 11       .00209      0.00000      -.00001       .00209     -.00000      -.19596
 8 12       .00213      0.00000      -.00000       .00213     -.00000      -.09709

 9  1    -13.45688      0.00000      -.06819    -13.45723      .00035       .29031
 9  2    -12.65344      0.00000      -.08232    -12.65398      .00054       .37273
 9  3     -9.00329      0.00000     -1.74514     -9.32972      .32643     10.59486
 9  4     -2.50641      0.00000     -1.84150     -3.48068      .97427     27.88170
 9  5      3.99047      0.00000     -1.91170      4.75849     -.76802    -21.88760
 9  6     10.48734      0.00000     -1.95574     10.84019     -.35285    -10.22706
 9  7     16.98422      0.00000     -1.97362     17.21055     -.22633     -6.54183
 9  8     23.48110      0.00000     -1.96534     23.64446     -.16336     -4.75154
 9  9     27.13126      0.00000      -.10628     27.13167     -.00042      -.22444
 9 10     27.93469      0.00000      -.10020     27.93505     -.00036      -.20552
 9 11       .00296      0.00000      -.11806       .11955     -.11659    -44.64120
 9 12       .00301      0.00000      -.05959       .06112     -.05811    -44.27672

10  1    -14.48776      0.00000      -.04118    -14.48788      .00012       .16287
10  2    -13.75122      0.00000      -.04918    -13.75139      .00018       .20490
10  3    -10.40497      0.00000     -1.03940    -10.50778      .10281      5.64916
10  4     -4.44901      0.00000     -1.10579     -4.70870      .25968     13.21589
10  5      1.50694      0.00000     -1.17475      2.14909     -.64215    -28.66216
10  6      7.46290      0.00000     -1.24627      7.66552     -.20262     -9.23442
10  7     13.41885      0.00000     -1.32035     13.54753     -.12868     -5.56651
10  8     19.37481      0.00000     -1.39700     19.47502     -.10021     -4.10297
10  9     22.72106      0.00000      -.08125     22.72135     -.00029      -.20489
10 10     23.45760      0.00000      -.09123     23.45796     -.00035      -.22282
10 11     24.05770      0.00000      -.12753     24.05835     -.00065      -.30371
10 12     24.52135      0.00000      -.06437     24.52152     -.00017      -.15041
```

```
   11  1     -15.35382       0.00000       -.02628    -15.35386       .00004       .09807
   11  2     -14.56999       0.00000       -.03231    -14.57006       .00007       .12704
   11  3     -11.00993       0.00000       -.59053    -11.05208       .04314      1.57519
   11  4      -4.67065       0.00000       -.72477     -4.78053       .10988      8.62083
   11  5       1.65764       0.00000       -.73799      1.94726      -.27762    -20.75363
   11  6       8.00593       0.00000       -.72989      8.07193      -.06600     -5.16683
   11  7      14.34421       0.00000       -.70079     14.37837      -.03415     -2.79029
   11  8      20.68250       0.00000       -.65054     20.70294      -.02044     -1.79979
   11  9      24.24356       0.00000       -.03188     24.24360      -.00004      -.07534
   11 10      25.02739       0.00000       -.02159     25.02740      -.00002      -.04942
   11 11      25.66600       0.00000       -.01382     25.66601      -.00001      -.03086
   11 12      26.15942       0.00000       -.00698     26.15942      -.00000      -.01528

   12  1     -15.70117       0.00000       -.00789    -15.70117       .00000       .02879
   12  2     -14.89940       0.00000       -.00990    -14.89941       .00001       .03808
   12  3     -11.25684       0.00000       -.21456    -11.26093       .00409      1.09154
   12  4      -4.77349       0.00000       -.22617     -4.78418       .01069      2.70660
   12  5       1.70986       0.00000       -.23099      1.74052      -.03065     -7.55953
   12  6       9.19322       0.00000       -.22901      9.19961      -.00640     -1.59980
   12  7      14.67557       0.00000       -.22024     14.67987      -.00330      -.85952
   12  8      21.15992       0.00000       -.20467     21.16190      -.00198      -.55413
   12  9      24.80249       0.00000       -.01003     24.80249      -.00000      -.02318
   12 10      25.60425       0.00000       -.00690     25.60425      -.00000      -.01521
   12 11      26.25749       0.00000       -.00435     26.25749      -.00000      -.00950
   12 12      26.76220       0.00000       -.00220     26.76220      -.00000      -.00470
    DIRECTION OF PRINCIPAL AXIS (DEG.) 1ST AND 2ND CRACK (ANG. = 999.0 IF NO CRACK)
  ELEMENT LAYER   PRINCIPAL         FIRST                     SECOND

    BEAM LAYER FAILURES
    ELEMENT  LAYER  TYPE OF FAILURE



PLOT SHOWING CRACK-CRUSH AREAS, STRESSES, NODE AND LAYER MARKERS FOR REFERENCE
(SEE USERS MANUAL FOR DETAILS)

BEAM NUMBER  1

  *                       **                       **             **             **        **         *

* 22222222222222222222222223333333333333333333333333444444444444444555555555555555555555555555555555555 *
* 22222222222222222222222223333333333333333333333333444444444444444555555555555555555555555555555555555 *
* 11111111111111111111111112222222222222222222222222333333333333333333333333333333333333333333333333333 *
* 11111111111111111111111111111111111111111111111111111111111111111222222222222222222222222222222222222 *
* AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAABBBBBBBBBBBBBBBAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA *
* AAAAAAAAAAAAAAAAAAAAAAAAABBBBBBBBBBBBBBBBBBBBBBBBBCCCCCCCCCCCCCCCBBBBBBBBBBBBBBBCCCCCCCCCCCCCCCCCCCCC *
* BBBBBBBBBBBBBBBBBBBBBBBBBDDDDDDDDDDDDDDDDDDDDDDDDDEEEEEEEEEEEEEEEDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDD *
* BBBBBBBBBBBBBBBBBBBBBBBBBEEEEEEEEEEEEEEEEEEEEEEEEEGGGGGGGGGGGGGGGFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFF *
* CCCCCCCCCCCCCCCCCCCCCCCCCFFFFFFFFFFFFFFFFFFFFFFFFFIIIIIIIIIIIIIIIGGGGGGGGGGGGGGGHHHHHHHHHHHHHHHHHHHHH *
* CCCCCCCCCCCCCCCCCCCCCCCCCGGGGGGGGGGGGGGGGGGGGGGGGGIIIIIIIIIIIIIIIHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHH *
* AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGG *
* AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGG *

  *                       **                       **             **             **        **         *


BEAM NUMBER  2

  *                       **                       **             **             **        **         *

* 22222222222222222222222223333333333333333333333333444444444444444555555555555555555555555555555555555 *
* 22222222222222222222222223333333333333333333333333444444444444444444444444444444555555555555555555555 *
* 11111111111111111111111112222222222222222222222222333333333333333333333333333333333333333333333333333 *
* 11111111111111111111111111111111111111111111111111111111111111111222222222222222222222222222222222222 *
* AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA *
* AAAAAAAAAAAAAAAAAAAAAAAAABBBBBBBBBBBBBBBBBBBBBBBBBCCCCCCCCCCCCCCCBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBB *
* AAAAAAAAAAAAAAAAAAAAAAAAACCCCCCCCCCCCCCCCCCCCCCCCCEEEEEEEEEEEEEEEDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDD *
* BBBBBBBBBBBBBBBBBBBBBBBBBDDDDDDDDDDDDDDDDDDDDDDDDDFFFFFFFFFFFFFFFEFEEFEFFFFEFFFFFEEEEEEEEEFFFFFFFFFFF *
* BBBBBBBBBBBBBBBBBBBBBBBBBFFFFFFFFFFFFFFFFFFFFFFFFFHHHHHHHHHHHHHHHGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGG *
* BBBBBBBBBBBBBBBBBBBBBBBBBFFFFFFFFFFFFFFFFFFFFFFFFFHHHHHHHHHHHHHHHGGGGGGGGGGGGGGGGGGGGGGGGHHHHHHHHHHHH *
* AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAFFFFFFFFFFFFFFFGGGGGGGGGGGGGGGGGGGGG *
* AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAFFFFFFFFFFFFFFFGGGGGGGGGGGGGGGGGGGGG *
```

```
*                        **                         **              **              **         **          *

 SLAB PLOT
      NODE J                                                                       NODE L
              ELEMENT NUMBER                      Y = NUMBER OF YIELDED LAYERS
              C = NUMBER OF CRUSHED LAYERS        T = NUMBER OF CRACKED LAYERS
      NODE I                                                                       NODE K

5BBBBBBBBBBBBBBBBBBBBBBB11BBBBBBBBBBBBBBBBBBBBBB17BBBBBBBBBBB23BBBBBBBBBBBB29BBBBBBBBBB35BBBBBBBBBBB41
*                       *                       *            *             *           *            *
*                       *                       *            *             *           *            *
*                       *                       *            *             *           *            *
*       3               *       6               *   9        *   12        *   15      *   18       *
*                       *                       *            *             *           *            *
*                       *                       *            *             *           *            *
*                       *                       *            *             *           *            *
*                       *                       *            *             *           *            *
*                       *                       *            *             *           *            *
*                       *                       *            *             *           *            *
*                       *                       *            *             *           *            *
*                       *                       *            *             *           *            *
4***********************10**********************16***********22************28**********34***********40
*                       *                       *            *             *           *            *
*                       *                       *            *             *           *            *
*                       *                       *            *             *           *            *
*       2               *       5               *   8        *   11        *   14      *   17       *
*                       *                       *            *             *           *            *
*                       *                       *            *             *           *            *
*                       *                       *            *             *           *            *
*                       *                       *            *             *           *            *
*                       *                       *            *             *           *            *
*                       *                       *            *             *           *            *
*                       *                       *            *             *           *            *
*                       *                       *            *             *           *            *
*                       *                       *            *             *           *            *
2BBBBBBBBBBBBBBBBBBBBBBB8BBBBBBBBBBBBBBBBBBBBBBB14BBBBBBBBBBB20BBBBBBBBBBBB26BBBBBBBBBB32BBBBBBBBBBB38
*                       *                       *            *             *           *            *
*                       *                       *            *             *           *            *
*                       *                       *            *             *           *            *
*                       *                       *            *             *           *            *
*       1               *       4               *   7        *   10        *   13      *   16       *
*                       *                       *            *             *           *            *
*                       *                       *            *             *           *            *
*                       *                       *            *             *           *            *
*                       *                       *            *             *           *            *
*                       *                       *            *             *           *            *
*                       *                       *            *             *           *            *
*                       *                       *            *             *           *            *
*                       *                       *            *             *           *            *
*                       *                       *            *             *           *            *
*                       *                       *            *             *           *            *
*                       *                       *            *             *           *            *
*                       *                       *            *             *           *            *
1***********************7***********************13***********19************25**********31***********37

 LOAD CYCLE =        2

 ----LOAD RATIO AT START OF CYCLE     =   .400000000E+00
 ----PRESCAN FACTOR AT START OF CYCLE =   .100000000E+01

 A TERMINATION CHECK HAS BEEN EXCEEDED IN THE PREVIOUS LOAD CYCLE.


      YES- INDICATES THAT A TERMINATION CHECK HAS BEEN EXCEEDED
      NO - INDICATES THAT THE TERMINATION CHECK HAS NOT BEEN EXCEEDED


      SLAB  -FIRST CRACK LOAD =    -999.0000 KIPS
      SLAB  -FIRST CRUSH LOAD =    -999.0000 KIPS
      SLAB  -FIRST YIELD LOAD =    -999.0000 KIPS
```

```
BEAM  -FIRST CRACK LOAD =   -999.0000 KIPS

BEAM  -FIRST CRUSH LOAD =   -999.0000 KIPS

BEAM  -FIRST YIELD LOAD =   -999.0000 KIPS



MAXIMUM DISPLACEMENT HAS BEEN EXCEEDED (NODE)  =      NO ( 41)

SPECIFIED OVERLOAD RATIO OF    .100E+21 EXCEEDED=      NO

RATIO OF TOTAL LOAD TO THE SPECIFIED OVERLOAD  =  19.761



MAX SHEAR HAS BEEN EXCEEDED(BEAM ELEMENT,LAYER)=      NO(  0, 0)



MAXIMUM SLAB CRACK WIDTH HAS BEEN EXCEEDED =      NO
     CRACK WIDTH          =  0.00000 (IN)
     ELEMENT NUMBER       =        0
     CRACK ANGLE          =    0.000 (DEGREES)
     CRACK LOCATION       =     NONE



BEAM TERMINATION CHECKS  /  MATERIAL TYPE =     1           2           3
FOR EXCEEDING LIMITS ON

     STRAIN                               =    YES         NO          NO
          ELEMENT LAYER                       9 10        0  0        0  0

     TENSILE STRESS                       =    YES         NO          NO
          ELEMENT LAYER                       9 10        0  0        0  0

     COMPRESSIVE STRESS                   =     NO         NO          NO
          ELEMENT LAYER                       0  0        0  0        0  0

     CRACKED OR YIELDED LAYERS            =     NO         NO          NO
          ELEMENT LAYER                       0  0        0  0        0  0

     CRUSHED LAYERS                       =     NO         NO          NO
          ELEMENT LAYER                       0  0        0  0        0  0


SLAB TERMINATION CHECKS  /  MATERIAL TYPE = CONCRETE/STEEL-1
FOR EXCEEDING LIMITS ON

     STRAIN                               =     NO         NO
          ELEMENT LAYER                       0  0        0  0

     TENSILE STRESS                       =     NO         NO
          ELEMENT LAYER                       0  0        0  0

     COMPRESSIVE STRESS                   =     NO         NO
          ELEMENT LAYER                       0  0        0  0

     CRACKED OR YIELDED LAYERS            =     NO         NO
          ELEMENT LAYER                       0  0        0  0

     CRUSHED LAYERS                       =     NO         NO
          ELEMENT LAYER                       0  0        0  0
```

BOTH THE SOPHISTICATED AND SIMPLIFIED VERSIONS OF THE PROGRAM EMPLOY SUBSTANTIAL DEFAULT VALUES. THE USER IS CAUTIONED TO CHECK THE DEFAULT VALUES AGAINST THE ACTUAL STRUCTURE IN ORDER TO ASSURE THE PROGRAM IS CORRECTLY MODELING THE STRUCTURE. IF SUBSTANTIAL DIFFERENCES ARE NOTED BETWEEN THE STRUCTURE AND THE MODEL, THEN THE PREDICTED BEHAVIOR MAY NOT BE REPRESENTATIVE OF THE ACTUAL BRIDGE BEHAVIOR.

IF THE USER DESIRES TO ANALYZE AN UNUSUAL OR COMPLICATED STRUCTURE, THE SOPHISTICATED VERSION OF THE PROGRAM SHOULD BE USED IN ORDER TO MORE ACCURATELY PREDICT THE BRIDGE BEHAVIOR. EXAMPLES OF STRUCTURES WHERE THE SOPHISTICATED VERSION SHOULD DEFINITELY BE USED INCLUDE BRIDGES OF UNUSUAL HYBRID CONSTRUCTION OR HAUNCHED GIRDER BRIDGES OR BRIDGES UNDER VARYING DEGREES OF DETERIORATION. THE SOPHISTICATED VERSION CAN MORE REALISTICALLY MODEL THESE TYPES OF STRUCTURES AND THEREBY AVOID GROSS SIMPLIFICATIONS AND INACCURATE RESULTS.

THIS ANALYTICAL MODEL CONSIDERS THE FLEXURAL AND INPLANE BEHAVIOR OF THE DECK SLAB AND THE FLEXURAL AND AXIAL DEFORMATIONS OF THE BEAMS. TRANSVERSE SHEAR DEFORMATION NORMAL TO THE PLANE OF THE DECK SLAB IS NOT CONSIDERED.

THE ACCURACY OF THE RESULTS DEPENDS UPON THE ACCURACY OF THE INPUT OF THE MATERIAL PROPERTIES, DEFINITION OF THE BRIDGE DESIGN PARAMETERS, AND THE CORRECT SIMULATION OF THE OVERLOAD CONFIGURATION. SUBSTANTIAL DEVIATIONS FROM ANY ONE OF THESE VALUES WILL RESULT IN A SOLUTION THAT MAY NOT BE REPRESENTATIVE OF THE ACTUAL BRIDGE BEHAVIOR.

ANY SUBSTANTIAL DEVIATION IN THE INPUT FROM THE ACTUAL STATE OF THE SUPERSTRUCTURE MAY RESULT IN AN INCORRECT SIMULATION OF THE OVERLOAD RESPONSE OF THE BRIDGE.

CRACK WIDTHS IN THE CONCRETE SLAB ARE COMPUTED FROM FORMULAE THAT ARE BASED ON EMPIRICALLY DERIVED RELATIONSHIPS AND ARE THEREFORE CONSIDERED TO BE APPPROXIMATE.

THE ANALYSIS IS CARRIED OUT FOR THE LANE LOCATION OF THE OVERLOAD VEHICLE THAT IS DEFINED BY THE USER OF THE PROGRAM. ANY DEVIATION FROM THIS INPUT LOADING IN THE ACTUAL OVERLOADING OF THE BRIDGE MAY RESULT IN A RESPONSE DIFFERENT FROM THAT PREDICTED BY THE PROGRAM.

THE ANALYSIS IS CARRIED OUT FOR THE GIVEN LOADING SPECIFIED BY THE USER. IF DURING THE ACTUAL LOADING OF THE BRIDGE OTHER VEHICLES OF QUESTIONABLE WEIGHT ARE PRESENT IN ADDITION TO THE GIVEN LOADING, THEN THE ACTUAL BRIDGE RESPONSE MAY BE DIFFERENT AS COMPARED TO THAT PREDICTED BY THE PROGRAM.

THE COMPUTER PROGRAM ASSUMES THAT DYNAMIC EFFECTS ARE PRESENT. THE ACTUAL VEHICULAR LOAD SHOULD BE INPUT AND THE PROGRAM WILL APPLY AN IMPACT FACTOR IN ACCORDANCE WITH THE STANDARD SPECIFICATIONS

FOR HIGHWAY BRIDGES (TWELFTH ED., 1977, AASHTO).

IF THE VEHICULAR SPEED SHOULD BE REDUCED TO A CRAWL SPEED (I.E. A MAXIMUM OF 5 MPH) DURING THE TRAVEL ACROSS THE BRIDGE, NO IMPACT FACTOR SHOULD BE APPLIED TO THE INPUT LOAD. THE INPUT LOAD SHOULD BE DIVIDED BY THE COMPUTED IMPACT FACTOR. THIS IS VALID ONLY IF THE TRAVERSE OF THE VEHICLE IS CONTROLLED BY AN ESCORT VEHICLE AND THE SPEED OF THE VEHICLE IS NO GREATER THAN THE CRAWL SPEED.

SUBSTANTIAL RESIDUAL STRESSES EXIST IN BOTH ROLLED AND BUILT-UP GIRDERS AT THE VICINITY OF THE FLANGE-TO-WEB CONNECTION AREA. THE MAGNITUDE OF THE RESIDUAL STRESSES VARIES DEPENDING UPON THE ROLLING PROCESS OR THE CUTTING AND WELDING SCHEME EMPLOYED. THEREFORE THE ACCURATE ASSESSMENT OF THESE RESIDUAL STRESSES IS EXTREMELY DEMANDING AND USUALLY UNKNOWN. IF RESIDUAL STRESSES ARE INPUTTED (SOPHISTICATED VERSION ONLY), THE ACCURACY OF THE RESULTS OBTAINED BY THE PROGRAM ARE CONTROLLED BY THE ACCURACY OF THE INPUT.

THE SIMPLIFIED VERSION ASSUMES THE RESIDUAL STRESSES ARE ZERO AND ARE THEREBY NEGLECTED IN THE ANALYSIS. THIS ASSUMPTION PRODUCES RESULTS WHICH UNDER ESTIMATE THE MAXIMUM TENSILE STRESSES IN THE ACTUAL STRUCTURE AT THE COVER PLATES AND THE TENSION FLANGE. UNDER THESE CIRCUMSTANCES THE ENGINEER SHOULD APPLY PRUDENT CONSERVATISM IN THE PERMIT OPERATIONS. HOWEVER, IF THE USER ONLY ALLOWS A MAXIMUM ALLOWABLE TENSILE STRESS EQUAL TO 75 PER CENT OF THE YIELD STRESS (AS PERMITTED IN THE AASHTO MANUAL FOR MAINTENANCE INSPECTION OF BRIDGES, 1978), THEN SUFFICIENT CONSERVATISM MAY EXIST TO ACCOUNT FOR THE NEGLECTED RESIDUAL STRESSES.

BASED ON THEORY AND AVAILABLE LIMITED TEST RESULTS, IT IS FOUND THAT THE PROGRAM ACCURATELY PREDICTS THE STRUCTURAL BEHAVIOR OF FULLY COMPOSITE CONSTRUCTION.

IN NONCOMPOSITE CONSTRUCTION THERE EXISTS SUBSTANTIAL FRICTION FORCES BETWEEN THE SLAB AND THE TOP FLANGE OR COVER PLATE OF THE GIRDERS. AT THIS TIME (1982) THESE FORCES HAVE NOT BEEN QUANTIFIED. THE PROGRAM APPROXIMATES THE BEHAVIOR OF NONCOMPOSITE CONSTRUCTION. HOWEVER, DEPENDING UPON THE CONSTRUCTION PRACTICES AND THE CONDITION OF THE BRIDGE, THE OBTAINED RESULTS MAY NOT BE TRULY REPRESENTATIVE OF THE ACTUAL BEHAVIOR OF THE STRUCTURE. THUS ENGINEERING JUDGMENT SHOULD BE APPLIED IN THE INTERPRETATION OF NONCOMPOSITE BRIDGES.

AT THIS TIME (1982) NO DEFINITE REFERENCES CAN BE CITED TO ASSIST IN THE QUANTIFICATION OF THE FRICTION FORCES IN PARTIAL COMPOSITE STRUCTURES. THUS THE ACCURACY OF THE RESULTS IS DEPENDENT UPON THE FORMULATION SELECTED FOR THE PROGRAM. BASED ON LIMITED STUDIES THE USE OF FULLY COMPOSITE CONSTRUCTION COULD BE CONSIDERED IN LIEU OF PARTIAL COMPOSITE CONSTRUCTION.

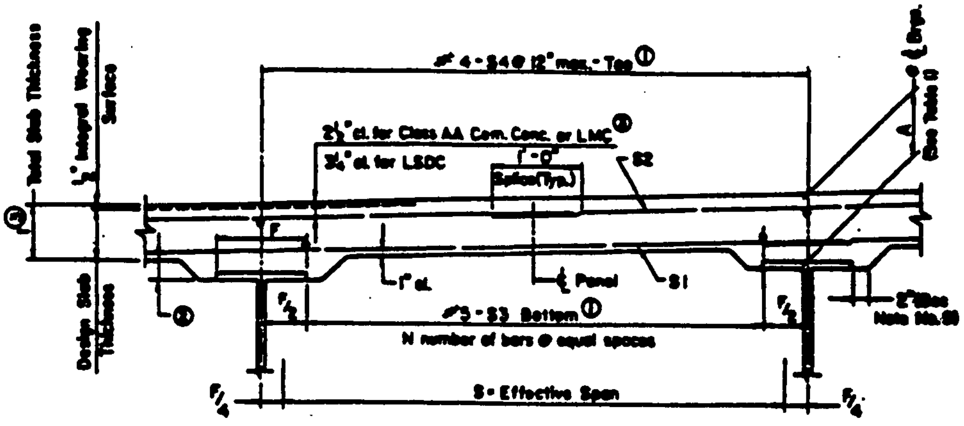


Fig. 1A: Typical Slab Panel (Simple Span Bridges)
(Taken from Ref.10)

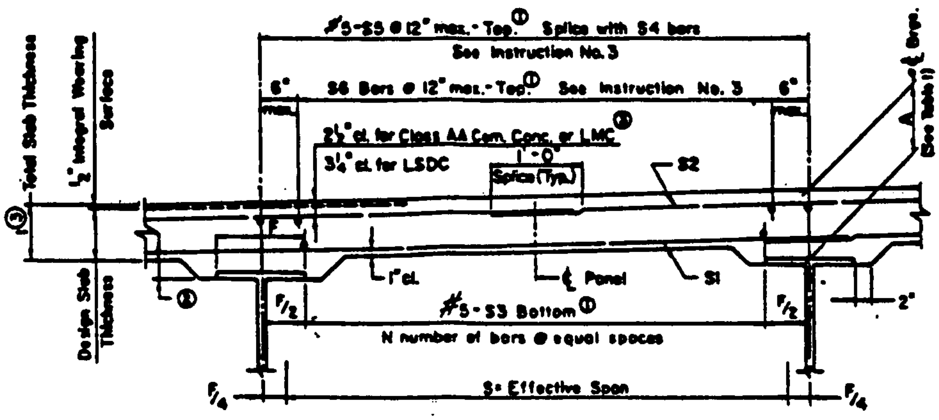


Fig. 1B: Typical Slab Panel
(Continuous Composite and Noncomposite
Bridges; taken from Ref. 10)

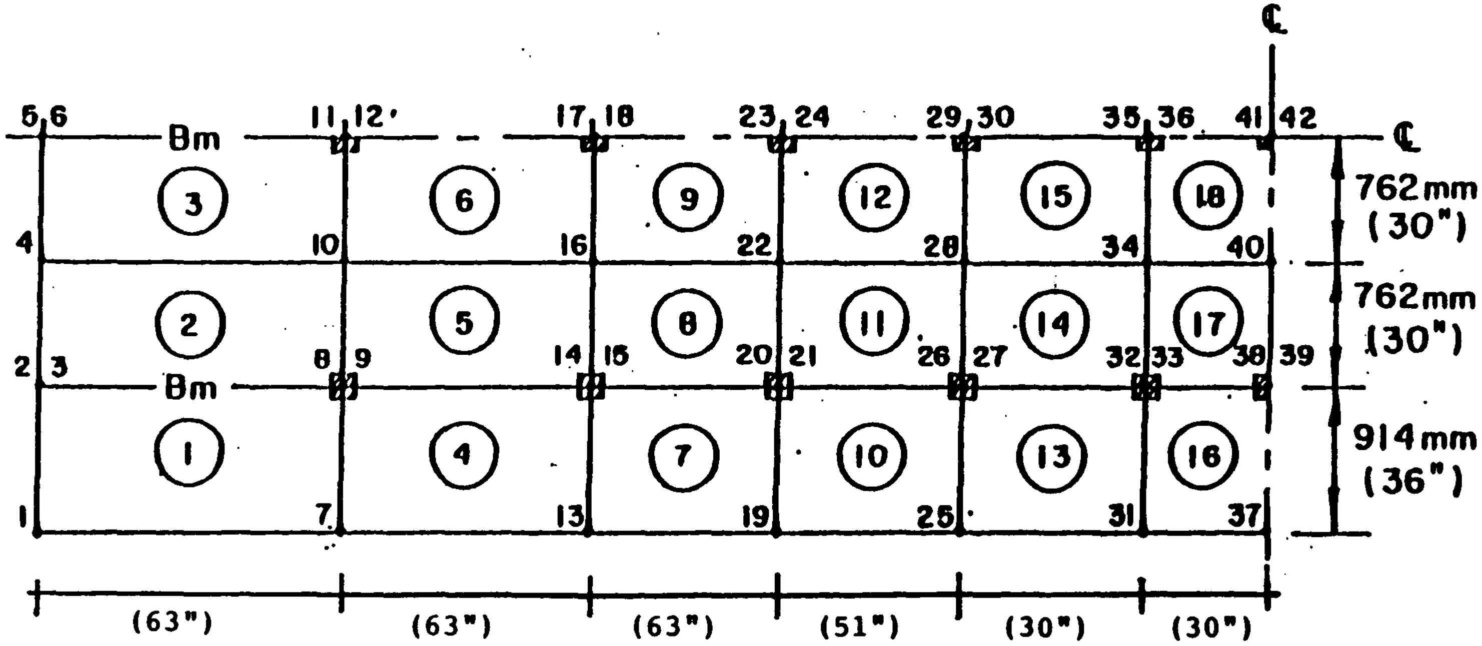


Fig. 2 : Example No.1 (AASHTO - Bridge 3B) - Finite Element Discretization

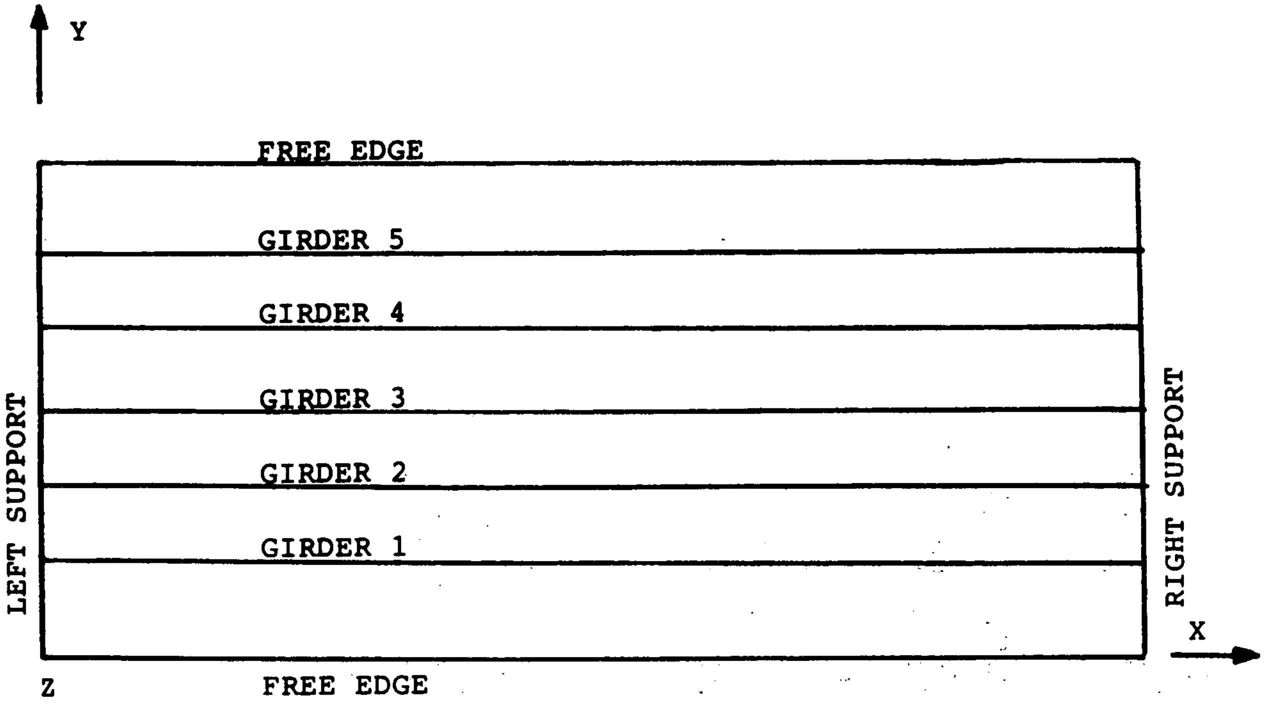


Fig. 3 Coordinate System

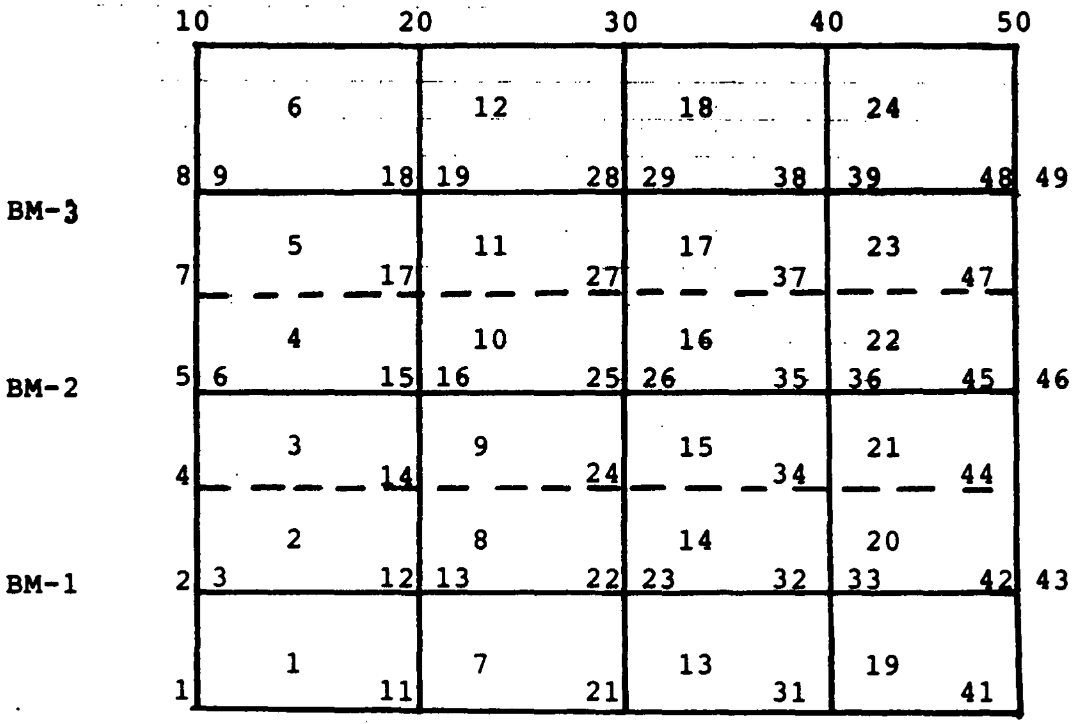


Fig. 4 Nodal Point and Plate Element Numbering Scheme

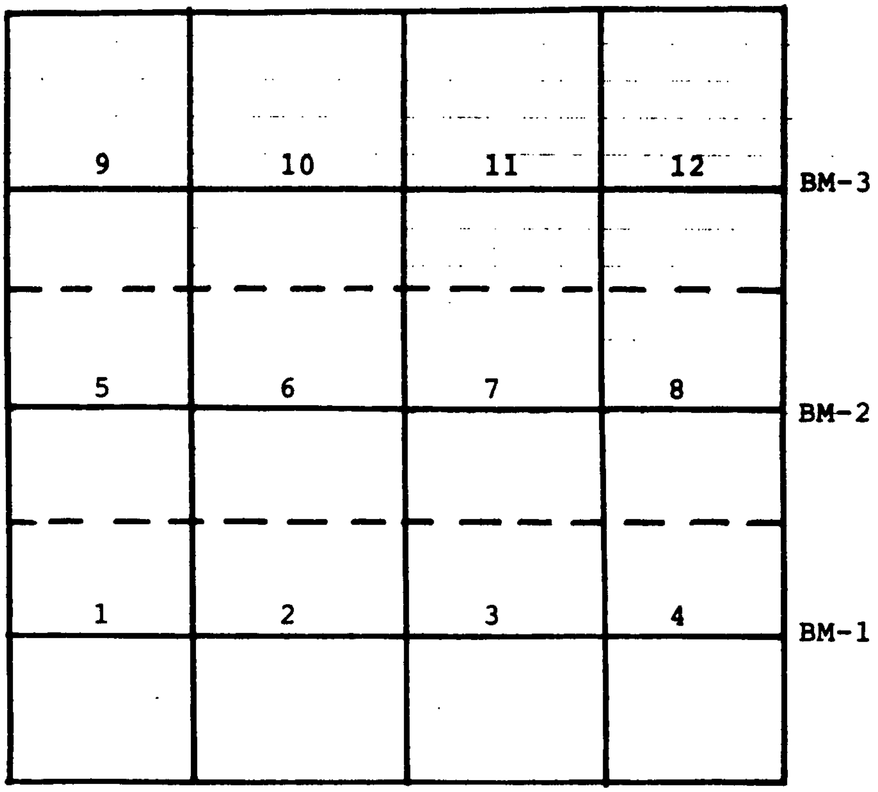


Fig. 5 Beam Element Numbering Scheme

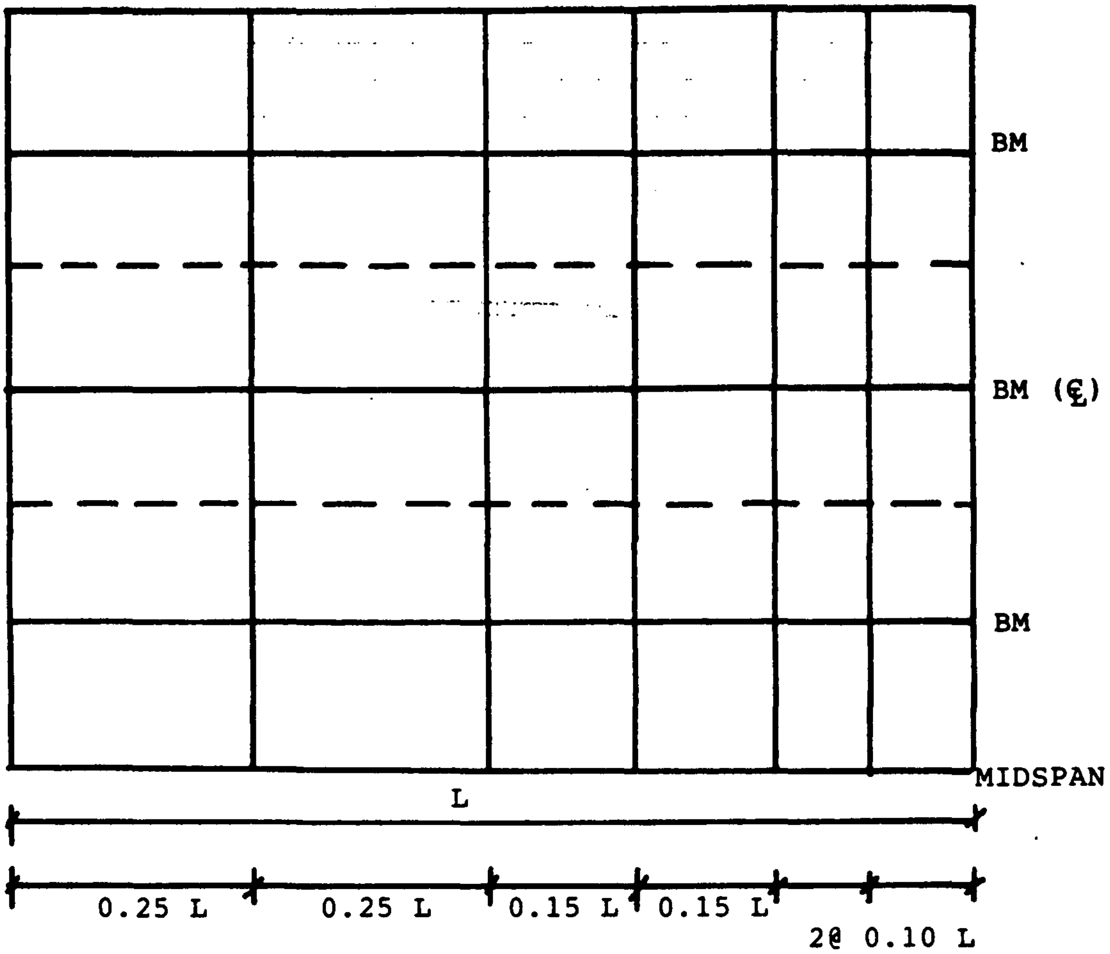


Fig. 6 Automatic Discretization - Simple Span
(Half-Transverse Symmetry)

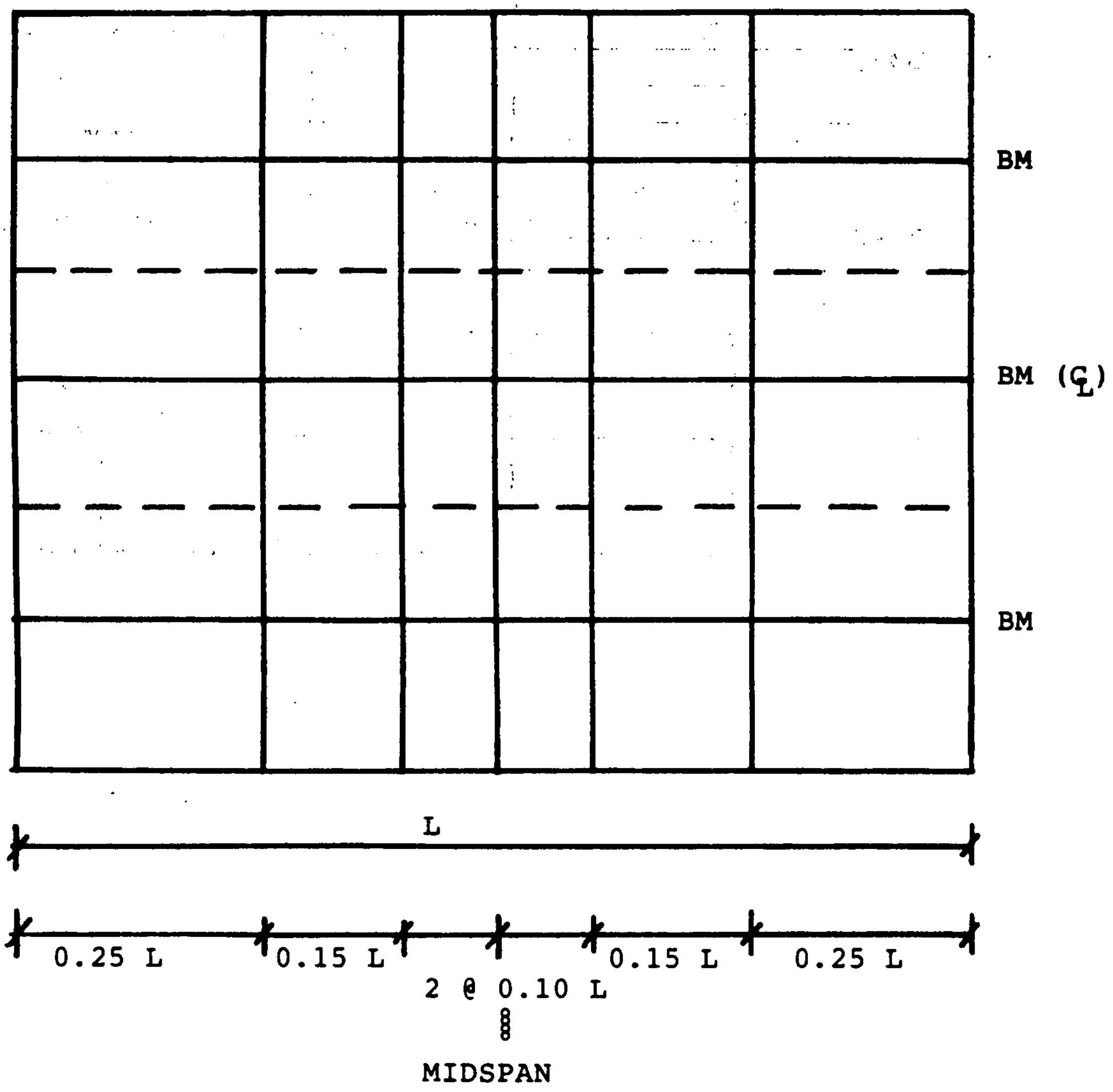


Fig. 7 Automatic Discretization - Simple Span (Full Symmetry)

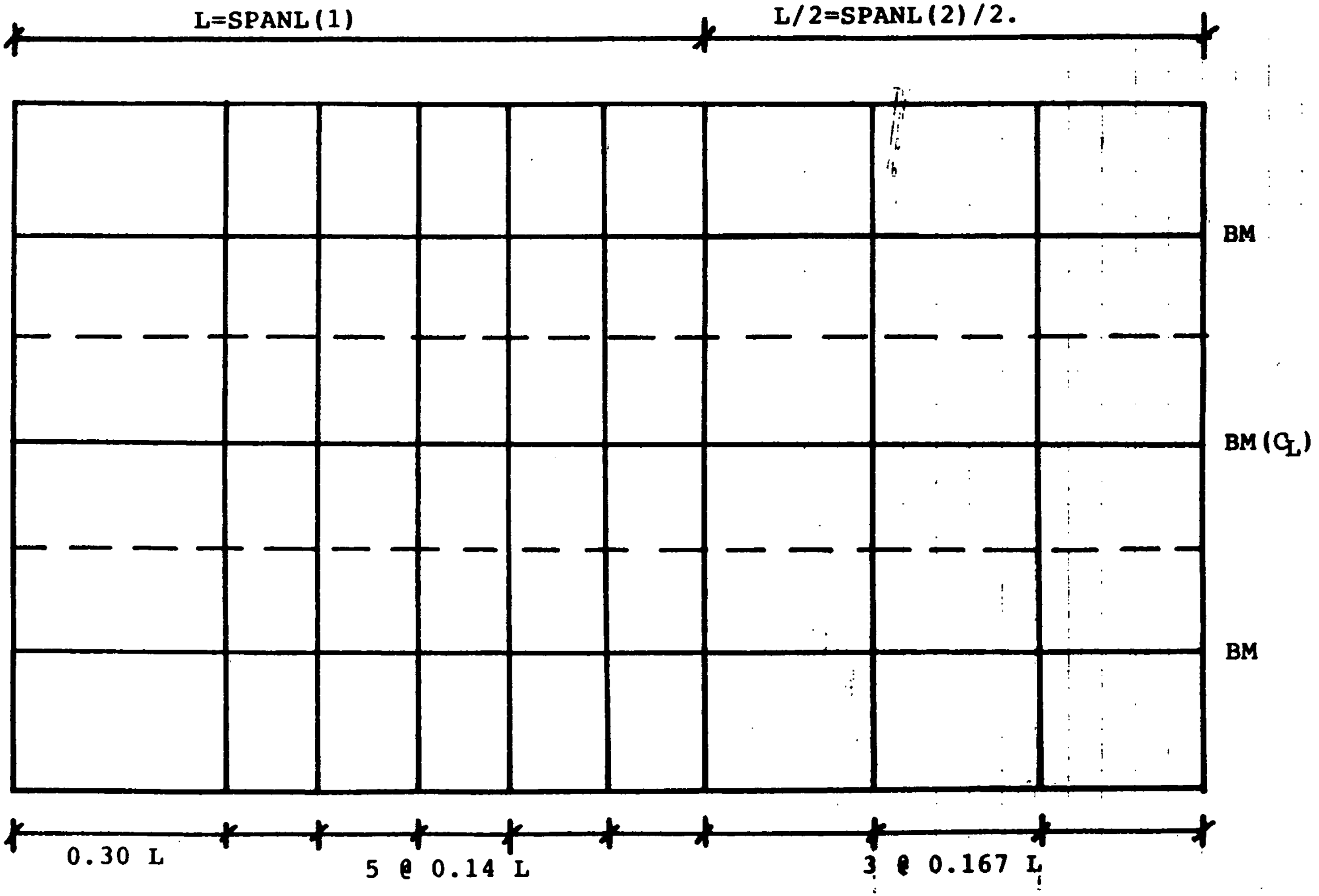


Fig. 8 Automatic Discretization - Three Span Half-Transverse Symmetry

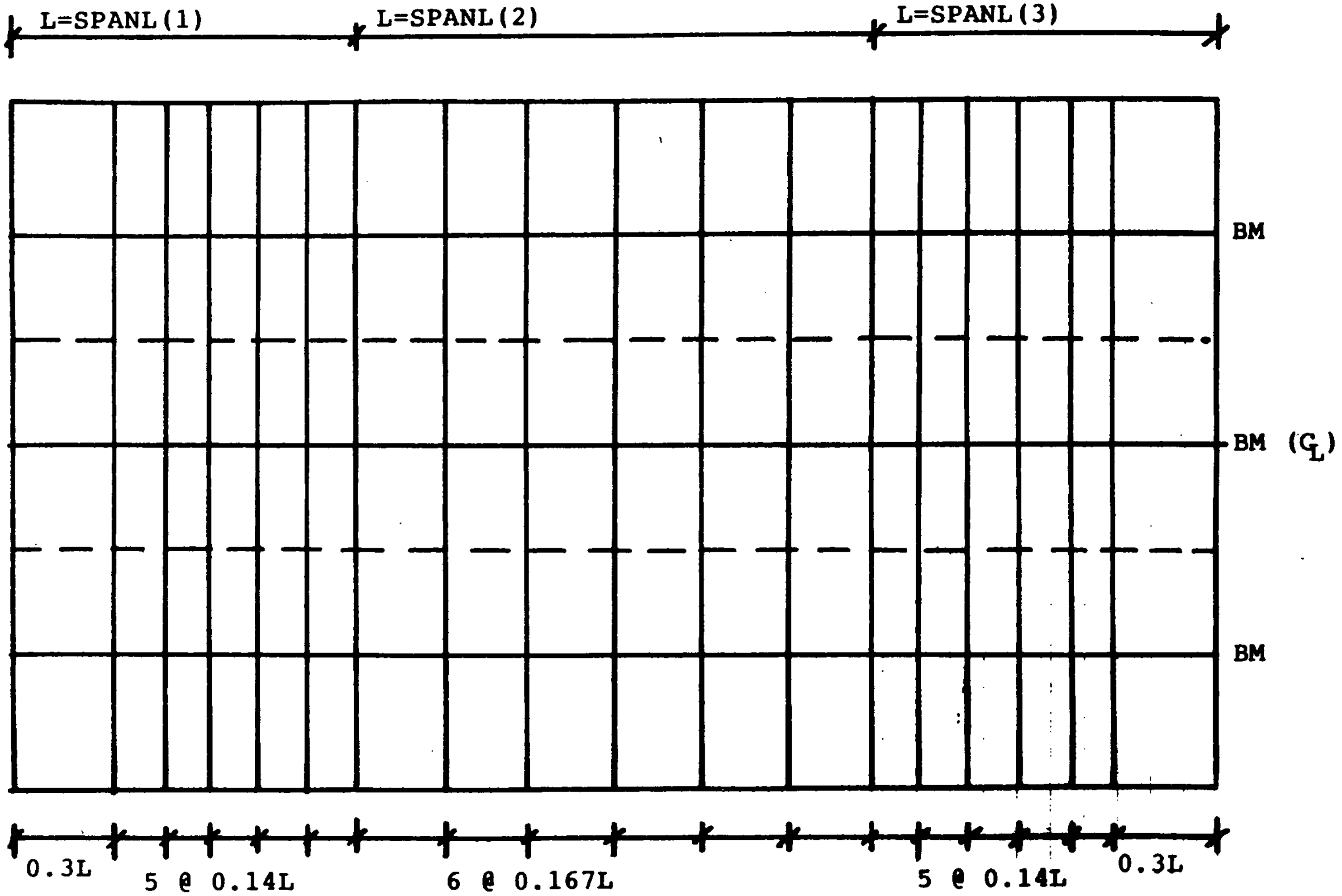


Fig. 9 Automatic Discretization - <u>Three Span Full Symmetry</u>

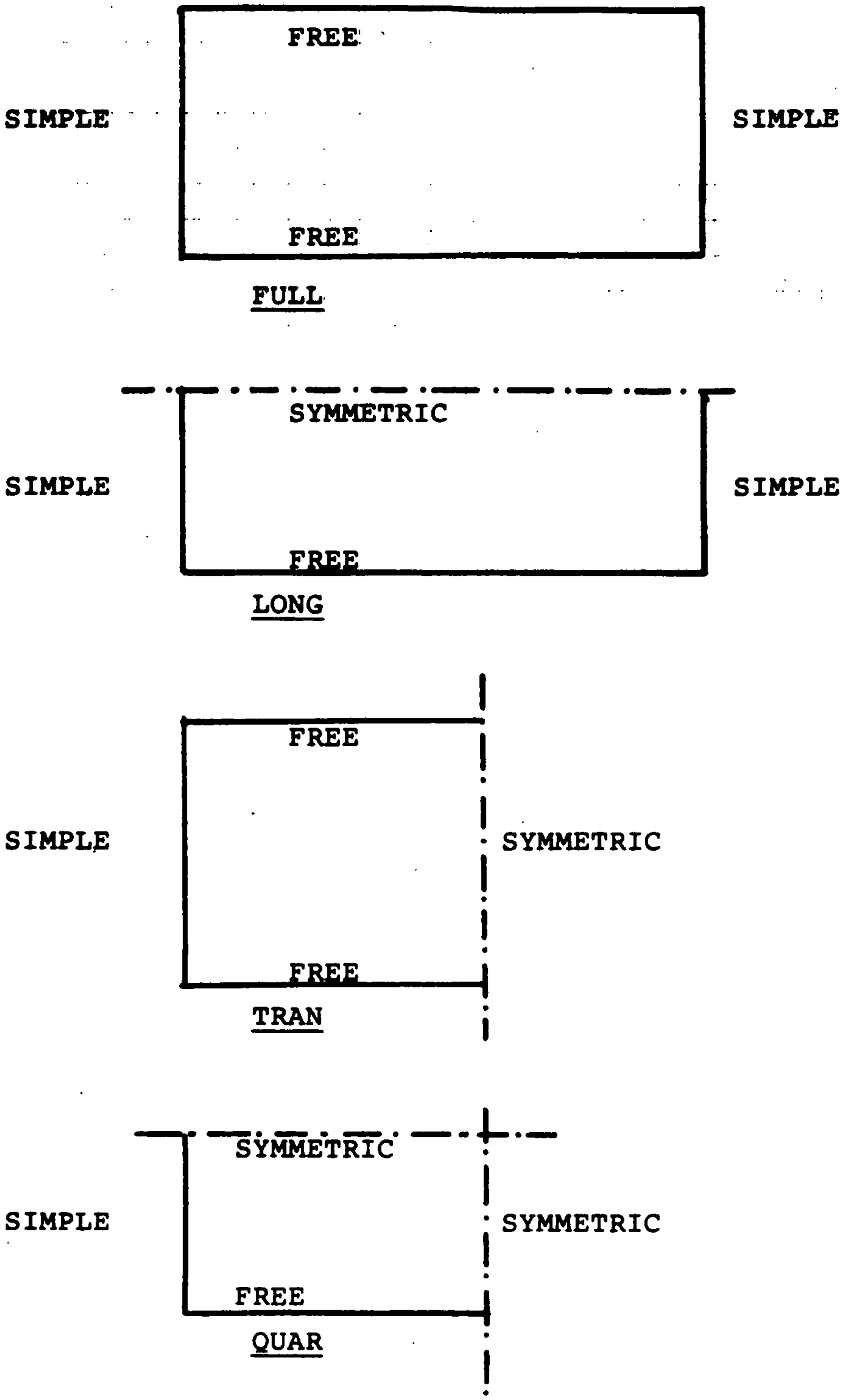


Fig. 10 Boundary Conditions

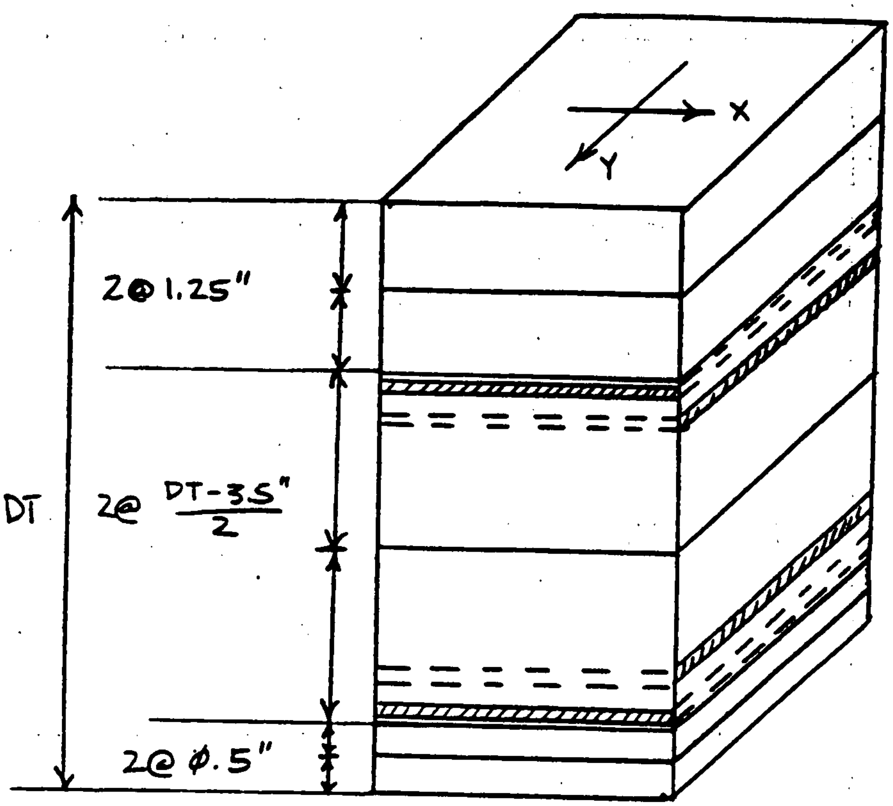


Fig. 11 Slab Layering

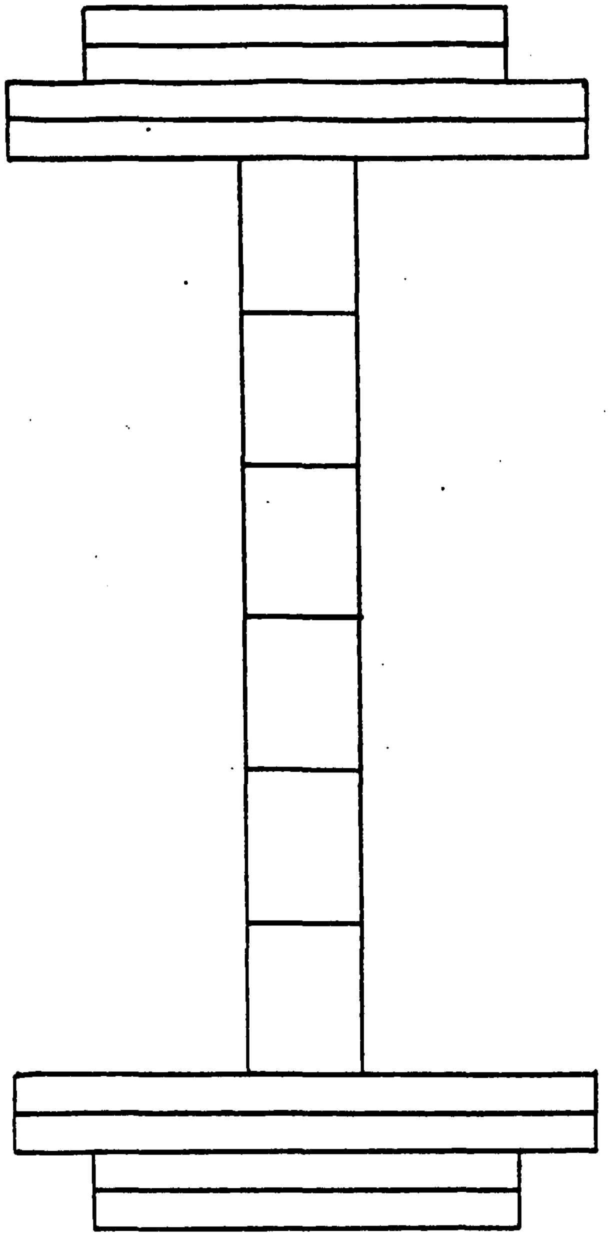


Fig. 12 Girder Layering

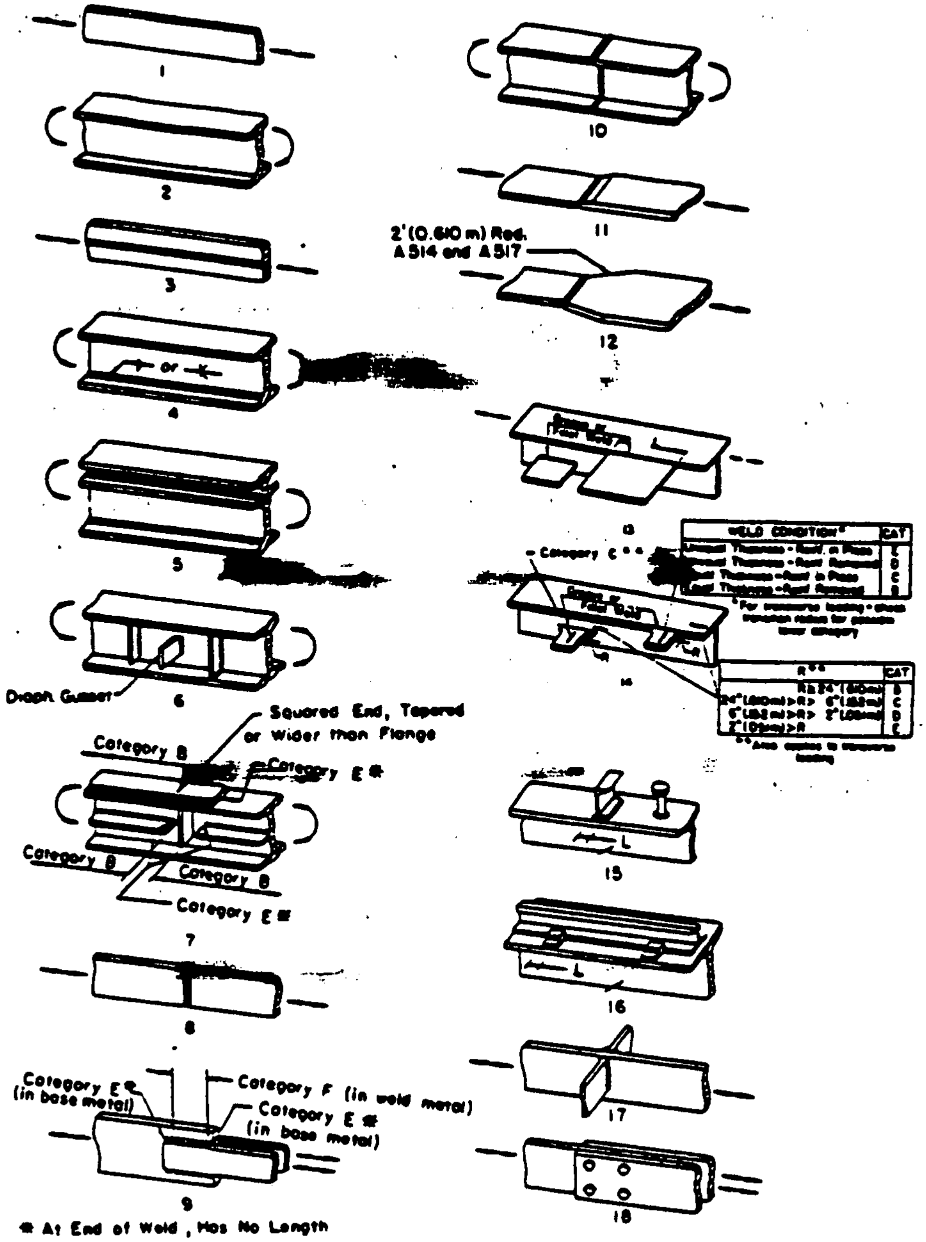


Fig. 13 Illustrative Examples on Classification of Connection Details for Fatigue
(Taken from AASHTO Standard Specifications for Highway Bridges, 1978)

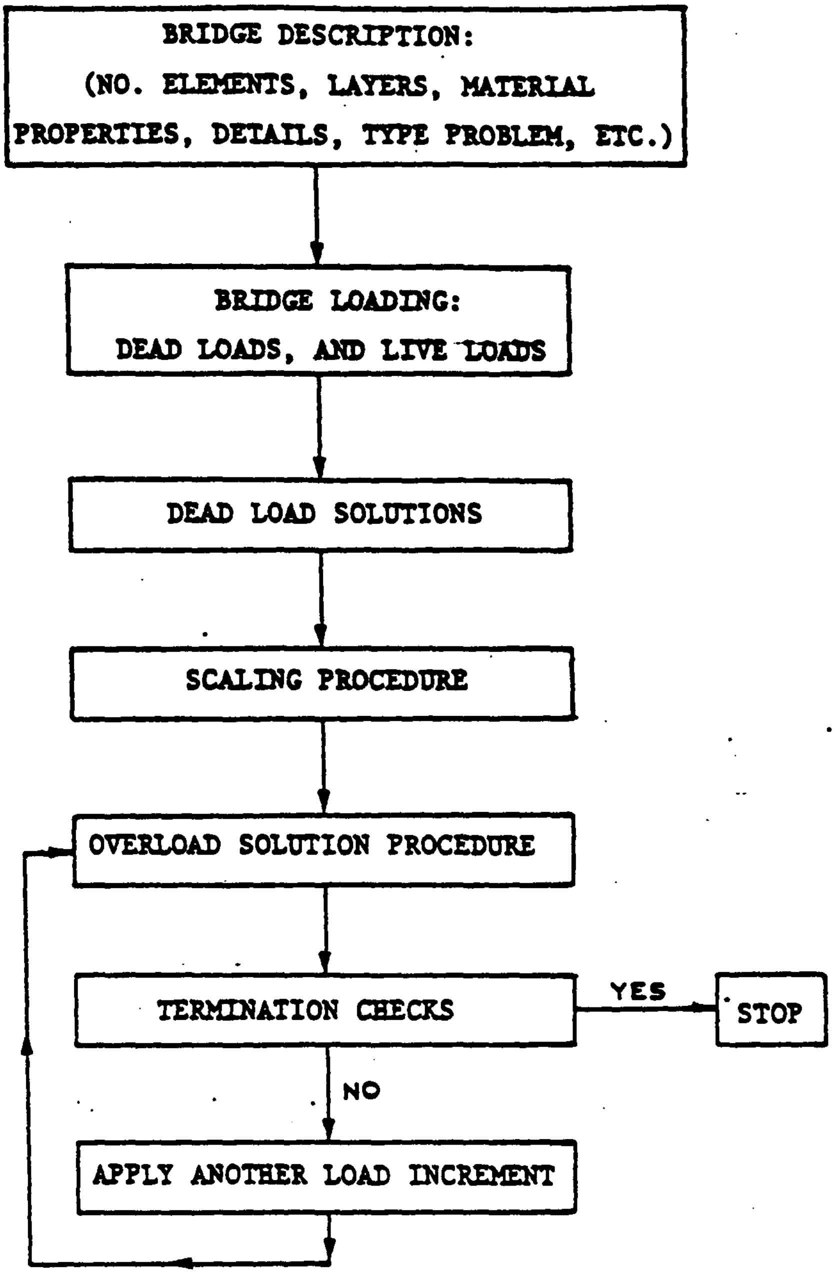


Fig. 14 Flow Chart BOVAS Solution Scheme

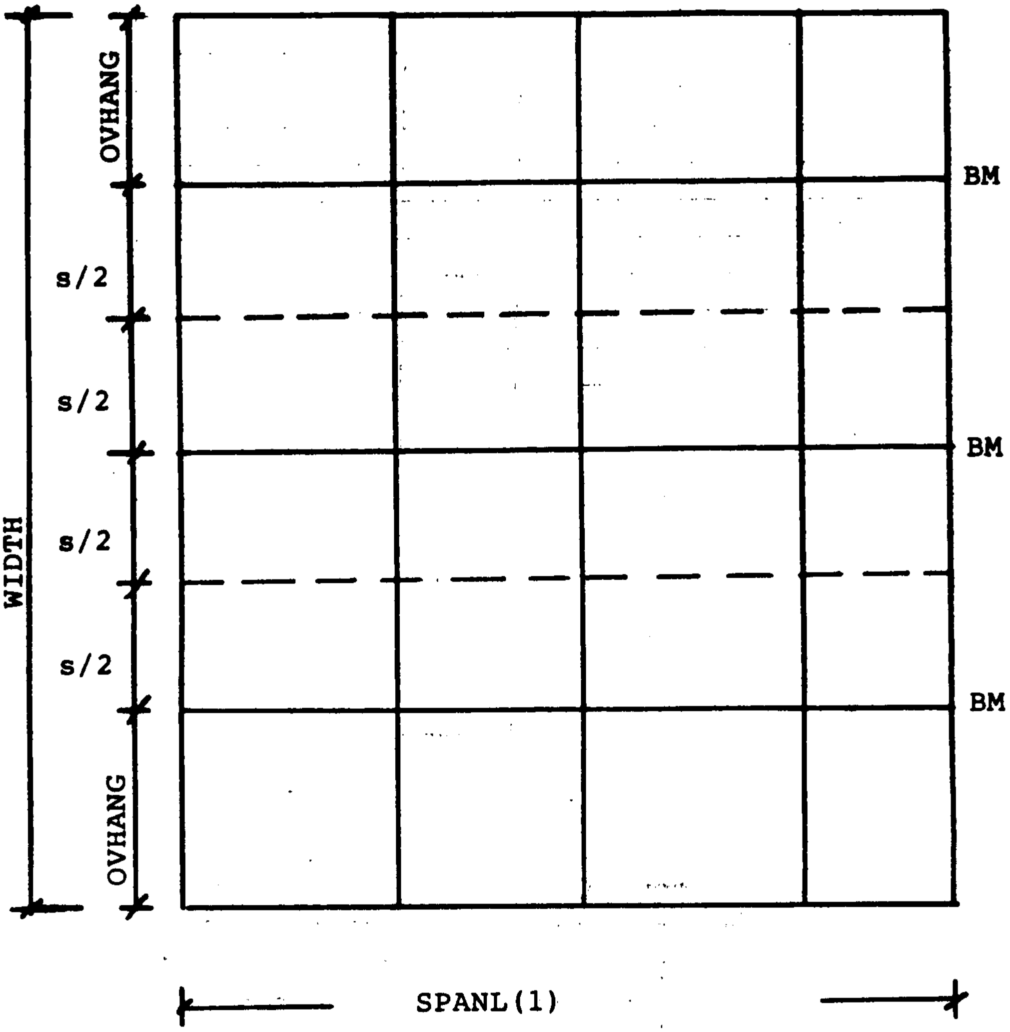


Fig. 15 Simple Span With Needed Dimensions

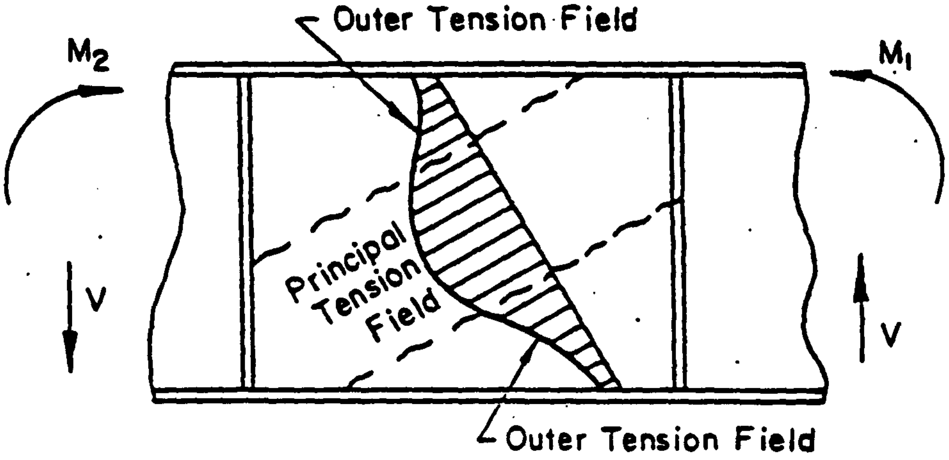


Fig. 16 Typical Transversely Stiffened Plate Girder Web Plate Under Combined Moment and Shear

(NOTE: Counterclockwise Shear will be noted as PHICO(I)=0.0)

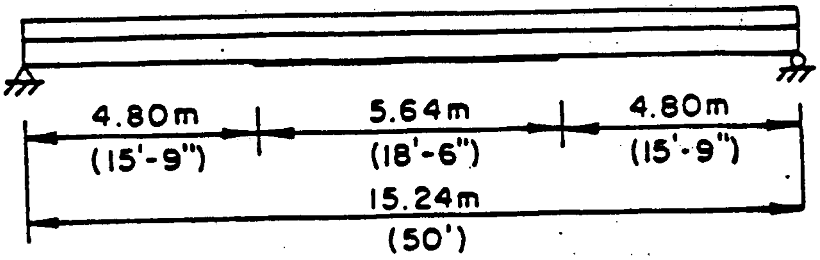


Fig. 17 Example No.1 - Bridge 3B - Elevation

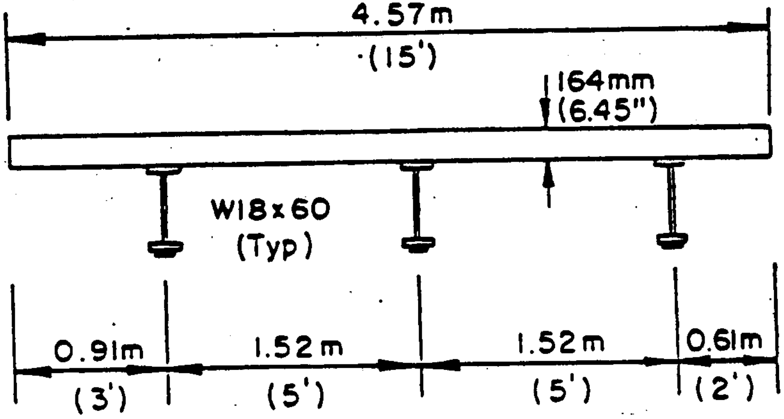


Fig. 18 Example No.1 - Bridge 3B - Cross Section

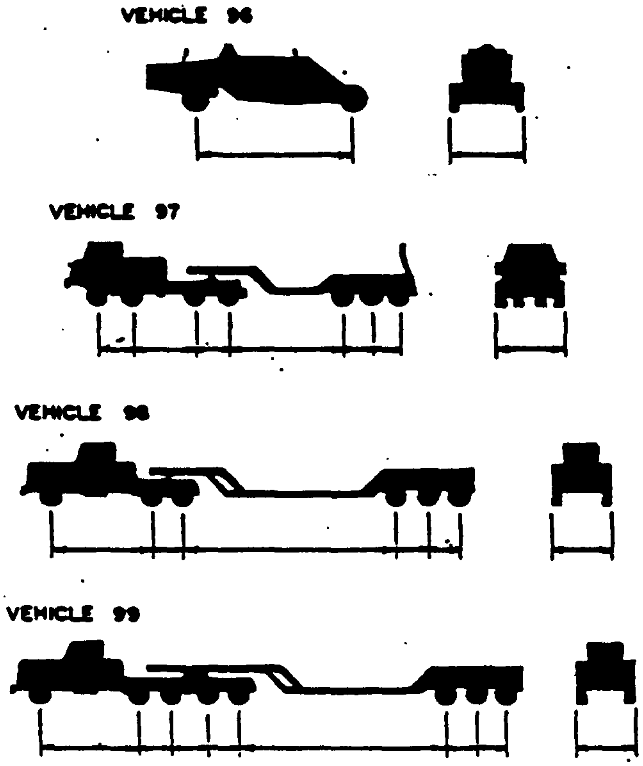


Fig. 19 Overloaded Test Vehicles
Example No.1 -AASHTO Bridge 3B

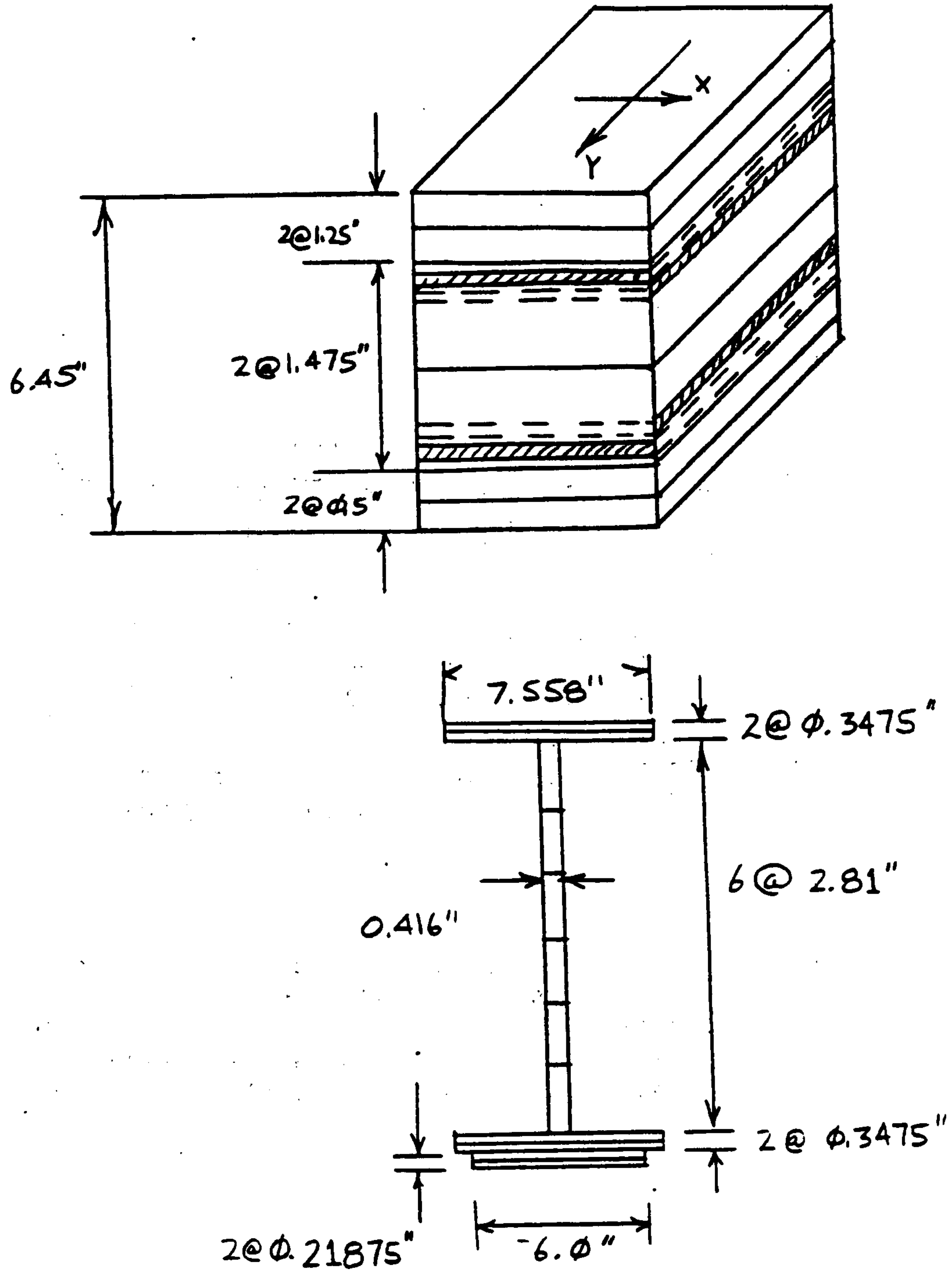


Fig. 20 Example Problem 1 and 2 (AASHTO Bridge 3B), Slab and Girder Layering

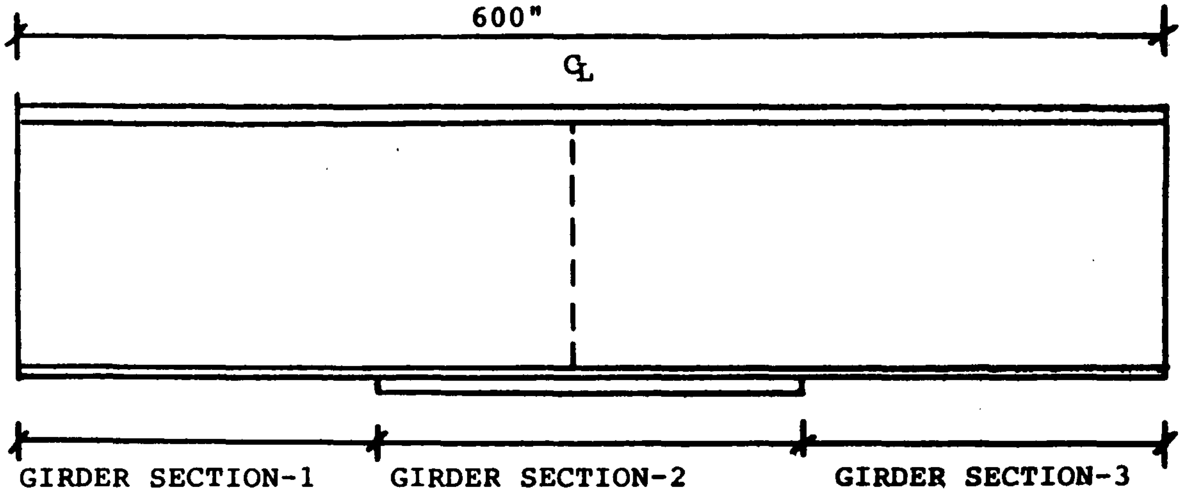


Fig. 21 AASHTO 3B Bridge, Girder Elevation

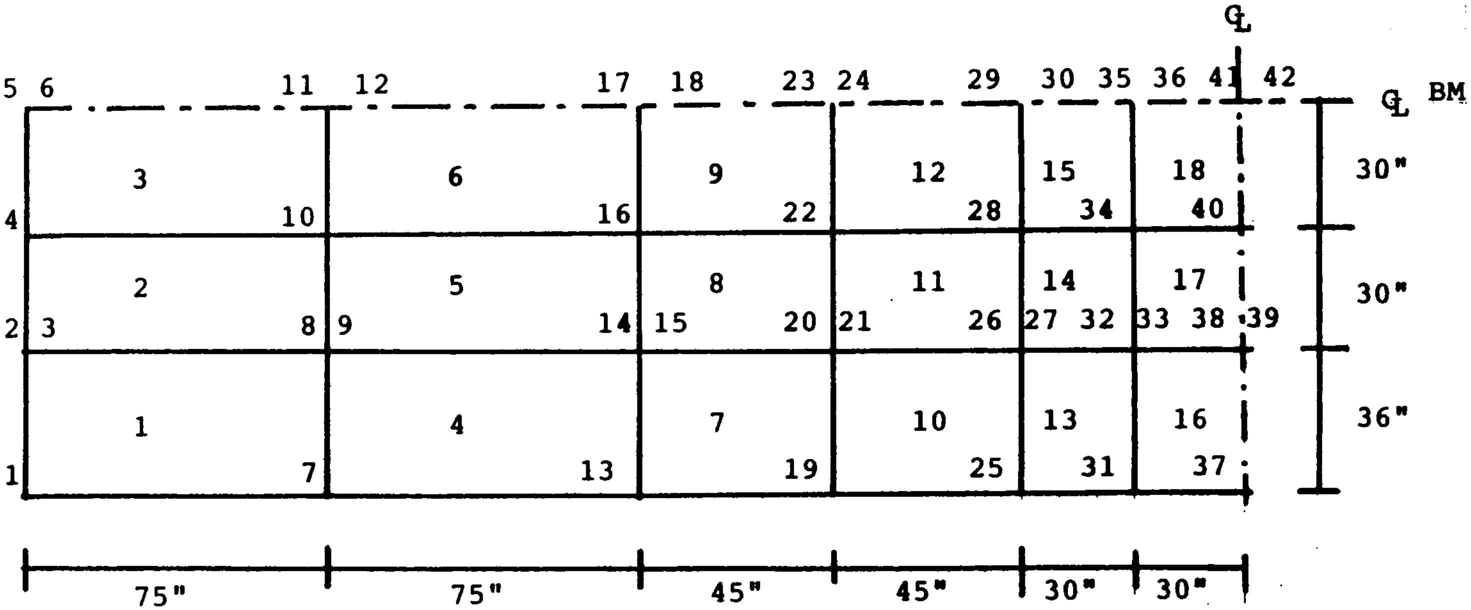


Fig. 22 Example No.2 (AASHTO Bridge 3B), Finite Element Discretization

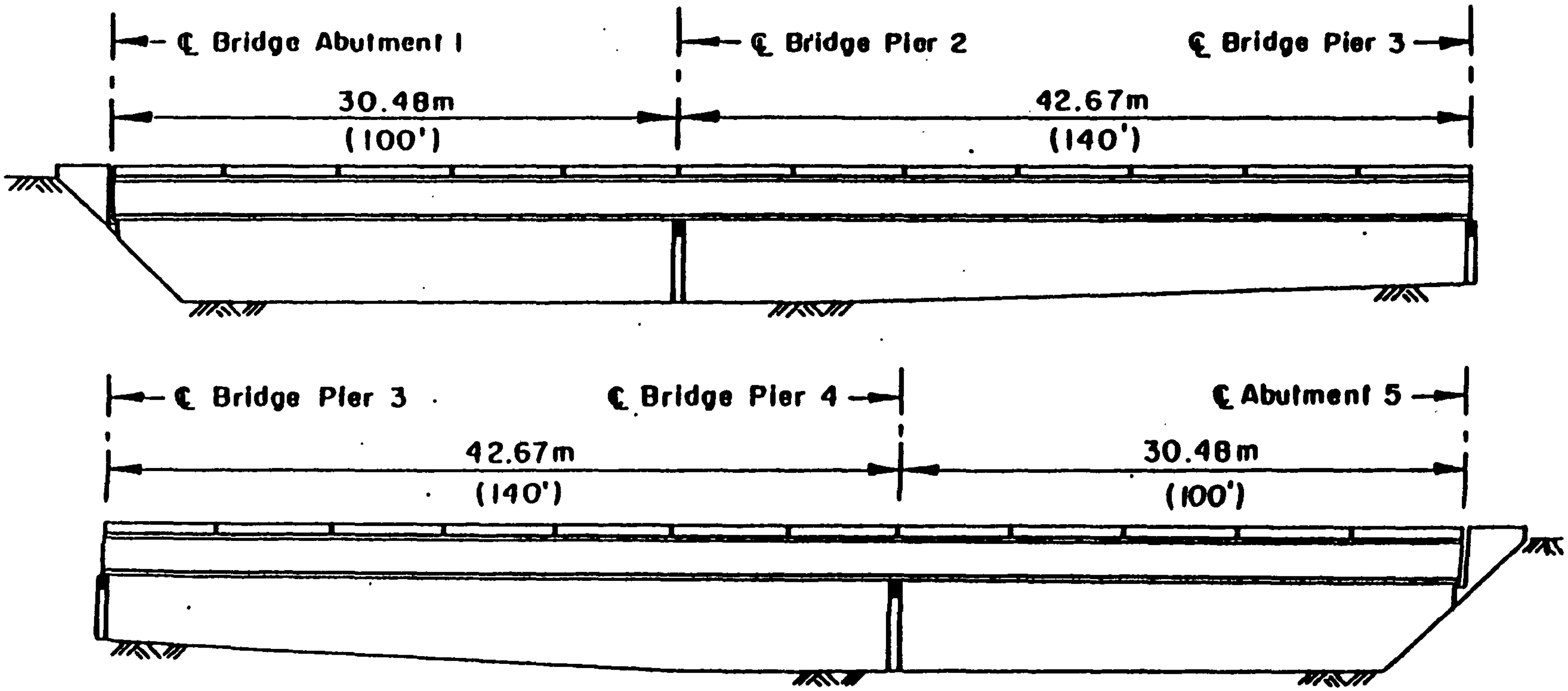


Fig. 23 FHWA Four-Span Continuous Plate Girder Bridge - Elevation

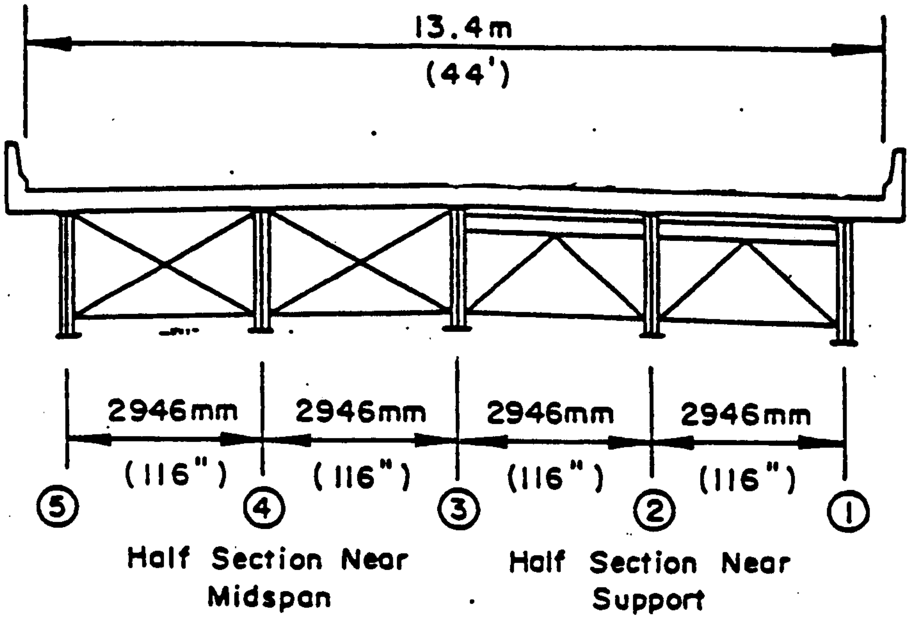


Fig. 24 FHWA Four-Span Cross-Section

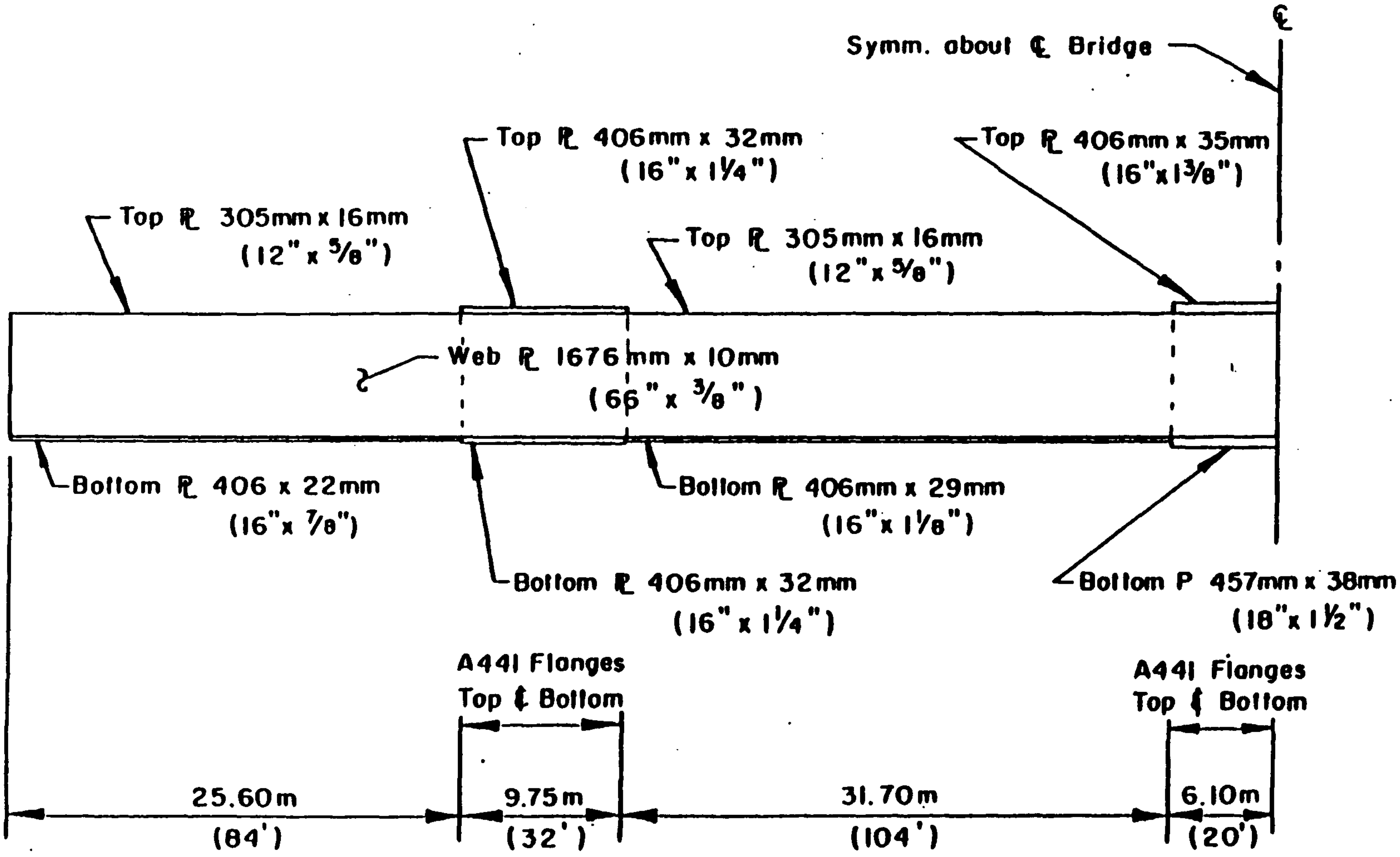


Fig. 25 FHWA Four-Span Plate Girder - Elevation

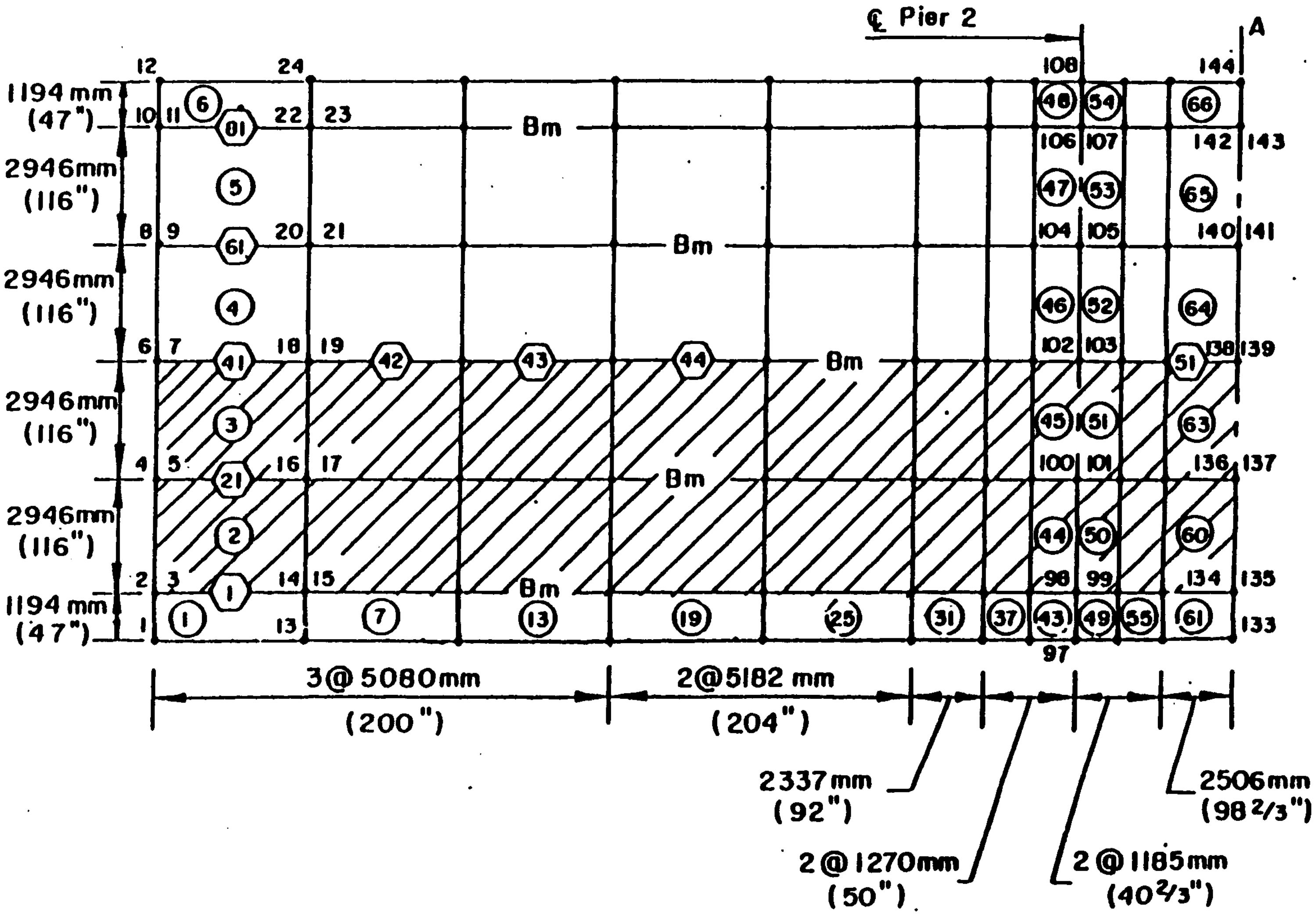


Fig. 26(a) FHWA Four-Span - Finite Element Discretization

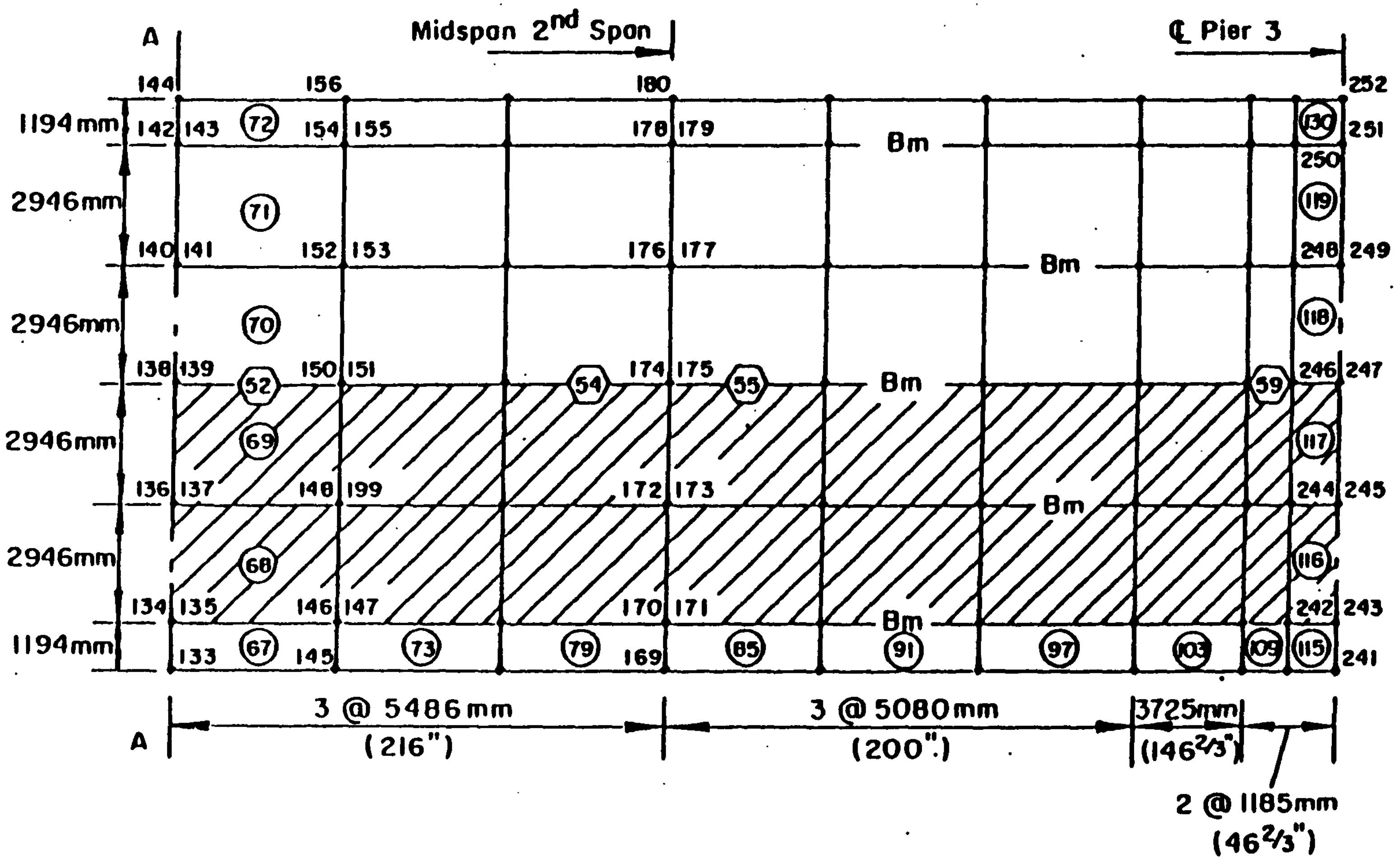


Fig. 26(b) FHWA Four-Span -Finite Element Discretization (Continued)

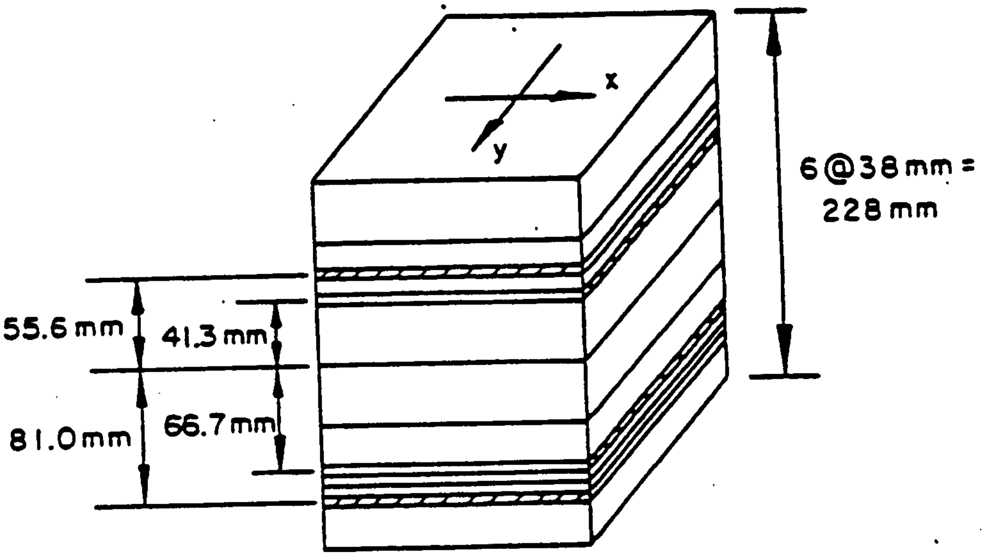


Fig. 27 FHWA Four-Span - Slab Layering

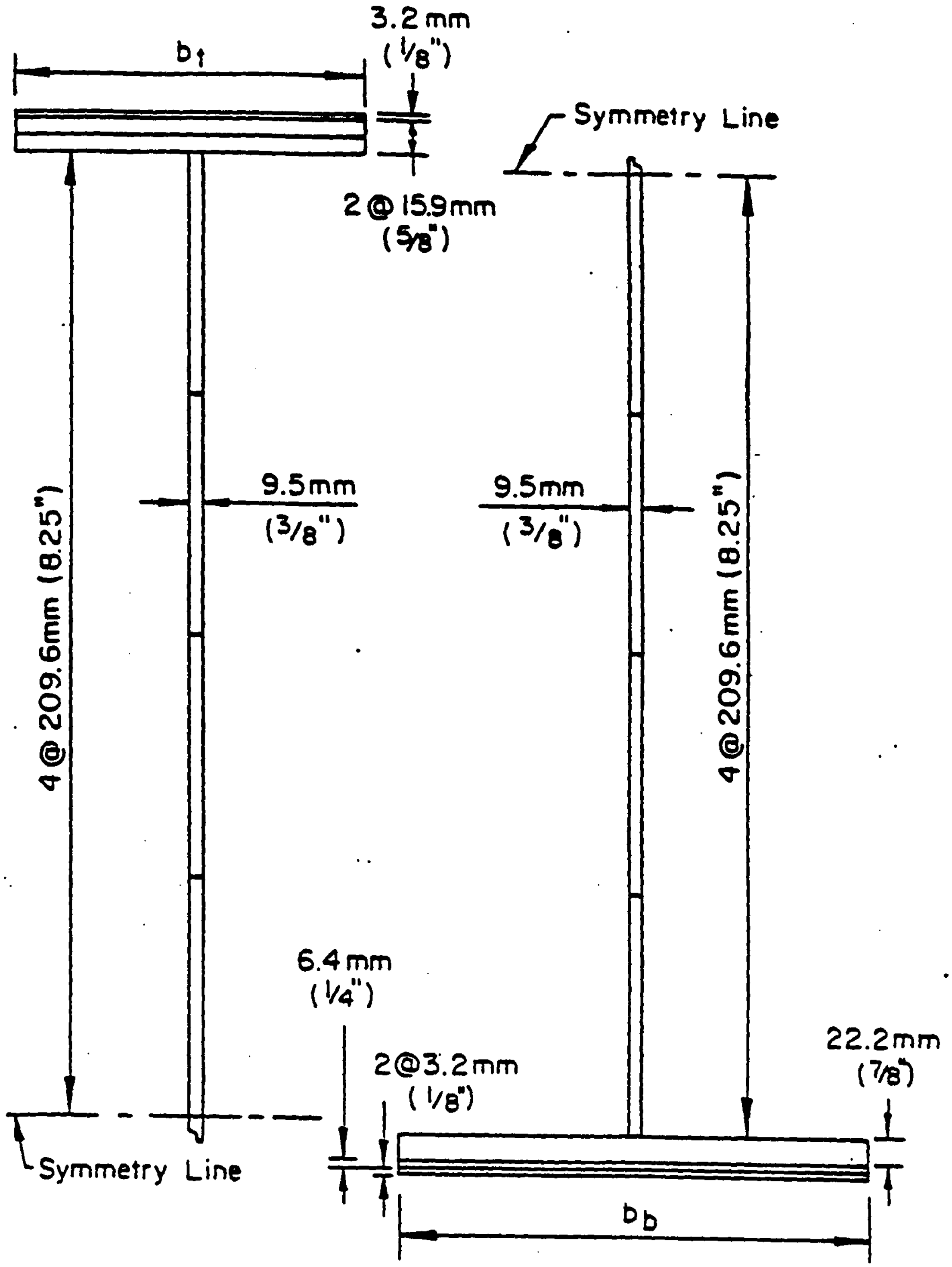


Fig. 28 FHWA Four-Span - Girder Layering

TABLE 1
BRIDGE DECK REINFORCEMENT
(from PennDOT BD 101A)

t	BARS S1 & S2		BARS S3		S6	S
	LSDC	LMC	N	MAX.SPC.		
8 1/4"	7 1/2"	#5 @ 8" = 0.47	4	12"	#5	3'-7"
8 1/4"	7 1/2"	#5 @ 7 1/2" = 0.53	5	10"	#5	3'-10"
8 1/4"	7 1/2"	#5 & 6" = 0.62	6	9"	#5	4'-1"
8 1/4"	7 1/2"	#5 @ 5 1/2" = 0.68	7	8"	#5	4'-3"
8 1/4"	7 1/2"	#5 @ 5" = 0.74	7	7.5"	#5	4'-5"
8 3/4"	8"	#5 @ 7 1/2" = 0.5	5	11"	#5	4'-6"
8 3/4"	8"	#5 @ 7" = 0.53	6	10"	#5	4'-8"
8 3/4"	8"	#5 @ 6" = 0.62	7	9"	#5	5'-0"
8 3/4"	8"	#5 @ 5 1/2 = 0.68	8	8"	#5	5'-3"
8 3/4"	8"	#5 @ 5" = 0.74	9	7.5"	#5	5'-5"
9 1/4"	8 1/2"	#5 @ 7 1/2" = 0.5	6	11"	#5	5'-5"
9 1/4"	8 1/2"	#5 @ 6 1/2" = 0.57	7	9.5"	#5	5'-9"
9 1/4"	8 1/2"	#5 @ 6" = 0.62	8	9"	#5	5'-11"
9 1/4"	8 1/2"	#5 @ 5 1/2" = 0.68	9	8"	#5	6'-2"
9 1/4"	8 1/2"	#5 @ 5" = 0.74	10	7.5"	#5	6'-4"
9 3/4"	9"	#5 @ 7" = 0.53	8	10"	#6	6'-5"
9 3/4"	9"	#5 & 6 1/2" = 0.57	9	9.5"	#6	6'-8"
9 3/4"	9"	#5 @ 6" = 0.62	10	9"	#6	6'-10"
9 3/4"	9"	#5 @ 5 1/2" = 0.68	11	8"	#6	7'-1"
9 3/4"	9"	#5 @ 5" = 0.74	12	7.5"	#6	7'-4"
10 1/4"	9 1/2"	#5 @ 6 1/2" = 0.57	10	9.5"	#6	7'-5"
10 1/4"	9 1/2"	#5 @ 6" = 0.62	11	9"	#6	7'-9"
10 1/4"	9 1/2"	#5 @ 5 1/2" = 0.68	12	8"	#6	8'-0"

TABLE 2

SIGX(I) - AUTOMATIC MESH GENERATION FOR SINGLE SPAN BRIDGES

X	QUAR	TRAN	LONG	FULL
1	0.25 L	0.25 L	0.25 L	0.25 L
2	0.25 L	0.25 L	0.15 L	0.15 L
3	0.15 L	0.15 L	0.10 L	0.10 L
4	0.15 L	0.15 L	0.10 L	0.10 L
5	0.10 L	0.10 L	0.15 L	0.15 L
6	0.10 L	0.10 L	0.25 L	0.25 L

Note: "L" is the length of the finite element model. For QUAR and TRAN L is one-half the L of LONG and FULL.

TABLE 3

SIG(X) - AUTOMATIC MESH GENERATION, TWO SPAN BRIDGES

X	QUAR	TRAN	LONG	FULL	Notes:
1	0.30 L	0.30 L	0.30 L	0.30 L	L = SPANL(1)
2	0.14 L	0.14 L	0.14 L	0.14 L	
3	0.14 L	0.14 L	0.14 L	0.14 L	
4	0.14 L	0.14 L	0.14 L	0.14 L	
5	0.14 L	0.14 L	0.14 L	0.14 L	
6	0.14 L	0.14 L	0.14 L	0.14 L	
7	--	--	0.14 L	0.14 L	L = SPANL (2)
8	--	--	0.14 L	0.14 L	
9	--	--	0.14 L	0.14 L	
10	--	--	0.14 L	0.14 L	
11	--	--	0.14 L	0.14 L	
12	--	--	0.30 L	0.30 L	

Table 4
SIG(X) - AUTOMATIC MESH GENERATION, THREE SPAN BRIDGES

X	QUAR	TRAN	LONG	FULL	Notes:
1	0.30 L	0.30 L	0.30 L	0.30 L	L = SPANL(1)
2	0.14 L	0.14 L	0.14 L	0.14 L	
3	0.14 L	0.14 L	0.14 L	0.14 L	
4	0.14 L	0.14 L	0.14 L	0.14 L	
5	0.14 L	0.14 L	0.14 L	0.14 L	
6	0.14 L	0.14 L	0.14 L	0.14 L	
7	0.167 L	0.167 L	0.167 L	0.167 L	L = SPANL(2)
8	0.167 L	0.167 L	0.167 L	0.167 L	
9	0.167 L	0.167 L	0.167 L	0.167 L	
10	--	--	0.167 L	0.167 L	
11	--	--	0.167 L	0.167 L	
12	--	--	0.167 L	0.167 L	
13	--	--	0.14 L	0.14 L	L = SPANL(3)
14	--	--	0.14 L	0.14 L	
15	--	--	0.14 L	0.14 L	
16	--	--	0.14 L	0.14 L	
17	--	--	0.14 L	0.14 L	
18	--	--	0.30 L	0.30 L	

Table 5
SIGX(I) - AUTOMATIC MESH GENERATION, FOUR SPAN BRIDGES

X	QUAR	TRAN	LONG	FULL	Notes:
1	0.30 L	0.30 L	0.30 L	0.30 L	L = SPANL(1)
2	0.14 L	0.14 L	0.14 L	0.14 L	
3	0.14 L	0.14 L	0.14 L	0.14 L	
4	0.14 L	0.14 L	0.14 L	0.14 L	
5	0.14 L	0.14 L	0.14 L	0.14 L	
6	0.14 L	0.14 L	0.14 L	0.14 L	
7	0.167 L	0.167 L	0.167 L	0.167 L	L = SPANL(2)
8	0.167 L	0.167 L	0.167 L	0.167 L	
9	0.167 L	0.167 L	0.167 L	0.167 L	
10	0.167 L	0.167 L	0.167 L	0.167 L	
11	0.167 L	0.167 L	0.167 L	0.167 L	
12	0.167 L	0.167 L	0.167 L	0.167 L	
13	--	--	0.167 L	0.167 L	L = SPANL(3)
14	--	--	0.167 L	0.167 L	
15	--	--	0.167 L	0.167 L	
16	--	--	0.167 L	0.167 L	
17	--	--	0.167 L	0.167 L	
18	--	--	0.167 L	0.167 L	
19	--	--	0.14 L	0.14 L	L = SPANL(4)
20	--	--	0.14 L	0.14 L	
21	--	--	0.14 L	0.14 L	
22	--	--	0.14 L	0.14 L	
23	--	--	0.14 L	0.14 L	
24	--	--	0.30 L	0.30 L	

TABLE 6

ALLOWABLE RANGES OF STRESS

(Copied from "AASHTO Standard Specifications
for Highway Bridges, 1978)

NON REDUNDANT LOAD PATH STRUCTURES (2)

Category	Allowable Range of Stress F_{sr} (ksi) (MPa)			
	For 100,000 Cycles	For 500,000 Cycles	For 2,000,000 Cycles	For over 2,000,000 Cycles
A	36 (248.21)	24 (165.47)	24 (165.47)	24 (165.47)
B	27.5 (189.60)	18 (124.10)	16 (110.31)	16 (110.31)
C	19 (131.00)	13 (89.63)	10, (68.95) 12* (82.74)	9, (62.05) 11* (75.84)
D	16 (110.31)	10 (68.95)	7 (48.26)	5 (34.47)
E	12.5 (86.18)	8 (55.16)	5 (34.47)	2.5 (17.24)
F	12 (82.74)	9 (62.05)	8 (55.16)	7 (48.26)

*For transverse stiffener welds on girder webs or flanges.

(1) Structure types with multi-load paths where a single fracture in a member cannot lead to the collapse. For example, a simply supported single span multi-beam bridge or a multi-element eye bar truss member has redundant load paths.

(2) Structure types with a single load path where a single fracture can lead to a catastrophic collapse. For example, flange and web plates in one or two girder bridges, main one-element truss members, hanger plates, caps at single or two column bents have non-redundant load paths.

TABLE 7

CLASSIFICATION OF STRESS CATEGORIES

(Copied from "AASHTO Standard Specifications for Highway Bridges, 1978)

General Condition	Situation	Kind of Stress	Stress Category	Illustrative Example
Plain Material	Base metal with rolled or cleaned surfaces. Flame cut edges with ASA smoothness of 1000 or less	T or Rev.	A	1,2
Built-up Members	Base metal and weld metal in members without attachments, built-up of plates, or shapes connected by continuous full or partial penetration groove welds or by continuous fillet welds parallel to the direction of applied stress	T or Rev.	B	3,4,5,7
	Calculated flexural stress at toe of transverse stiffener welds on girder webs or flanges	T or Rev.	C	6

TABLE 7 (Continued)

General Condition	Situation	Kind of Stress	Stress Category	Illustrative Example
	Base metal at end of partial length welded cover plates having square or tapered ends, with or without welds across the ends	T or Rev.	E	7
Groove Welds	Base metal and weld metal at full penetration groove welded splices of rolled and welded sections having similar profiles when welds are ground flush and weld soundness established by nondestructive inspection.	T or Rev.	B	8,10,14
	Base metal and weld metal in or adjacent to full penetration groove welded splices at transitions in width or thickness, with welds ground to provide slopes no steeper than 1 to 2 1/2, with grinding in the direction of applied stress, and weld soundness established by nondestructive inspection.	T or Rev.	B	11,12
	Base metal and weld metal in or adjacent to full penetration groove welded splices, with or without transitions having slopes no greater than 1 to 2 1/2 when reinforcement is not removed and weld soundness is established by nondestructive inspection	T or Rev.	C	8,10,11,12,14
	Base metal at details attached by groove welds subject to longitudinal loading when the detail length, L, parallel to the line of stress is between 2 in. (50.8 mm) and 12 times the plate thicknesses, but less than 4 in. (101.6 mm)	T or Rev.	D	13

TABLE 7 (Continued)

General Condition	Situation	Kind of Stress	Stress Category	Illustrative Example
	Base metal at details attached by groove welds subject to longitudinal loading when the detail length, L, is greater than 12 times the plate thickness or greater than 4 in. (101.6 mm) long	T or Rev.	E	13
	Base metal at details attached by groove welds subjected to transverse and/or longitudinal loading regardless of detail length when weld soundness transverse to the direction of stress is established by nondestructive inspection			
	(a) When provided with transition radius equal to or greater than 24 in. (.610 m) and weld end ground smooth	T or R	C	14
	(b) When provided with transition radius less than 24 in. (.610 m) but not less than 6 in. (.152 m) and weld end ground smooth	T or R	C	14
	(c) When provided with transition radius less than 6 in. (.152 m) but not less than 2 in. (.051 m) and weld end ground smooth	T or R	D	14
	(d) When provided with transition radius between 0 in. and 2 in. (0 and .051 m)	T or R	E	14

TABLE 7 (Continued)

General Condition	Situation	Kind of Stress	Stress Category	Illustrative Example
Fillet Welded Connections	Base metal at intermittent fillet welds	T or Rev.	E	
	Base metal adjacent to fillet welded attachments with length, L, in direction of stress less than 2 in. (50.8 mm) and stud-type shear connectors	T or Rev.	C	13,15,16,17
	Base metal at details attached by fillet welds with detail length, L, in direction of stress between 2 in. (50.8 mm) and 12 times the plate thickness but less than 4 in. (101.6 mm)	T or Rev.	D	13,15,16
	Base metal at attachment—details with detail length, L, in direction of stress (length of fillet weld) greater than 12 times the plate thickness or greater than 4 in. (101.6 mm)	T or Rev.	E	7,9,13,16
	Base metal at details attached by fillet welds regardless of length in direction of stress (shear stress on the throat of fillet welds governed by stress category F)			
	(a) When provided with transition radius equal to or greater than 24 in. (.610 m) and weld end ground smooth	T or R	B	14
	(b) When provided with transition radius less than 24 in. (.610 m) but not less than 6 in. (.152 m) and weld end ground smooth	T or R	C	14

TABLE 7 (Continued)

General Condition	Situation	Kind of Stress	Stress Category	Illustrative Example
	(c) When provided with transition radius less than 6 in. (.152 m) but not less than 2 in. (.051 m) and weld end ground smooth	T or R	D	14
	(d) When provided with transition radius between 0 in. and 2 in. (0 and .051 m)	T or R	E	14
Mechanically Fastened Connections	Base metal at gross section of high-strength bolted slip resistant connections, except axially loaded joints which induce out-of-plane bending in connected material	T or Rev.	B	18
	Base metal at net section of high-strength bolted bearing type connections	T or Rev.	B	18
	Base metal at net section of riveted connections	T or Rev.	D	18
Fillet Welds	Shear stress on throat of fillet welds	Shear	F	9

TABLE 8

STRESS CYCLES

(Copied from "AASHTO Standard Specifications for Highway Bridges, 1978)

Main (Longitudinal) Load Carrying Members

Type of Road	Case	ADTT*	Truck Loading	Lane Loading†
Freeways, Expressways, Major Highways and Streets	I	2500 or more	2,000,000**	500,000
	II	less than 2500	500,000	100,000
Other Highways and Streets not included in Case I or II	III		100,000	100,000

Transverse Members and Details Subjected to Wheel Loads

Type of Road	Case	ADTT*	Truck Loading
Freeways, Expressways, Major Highways and Streets	I	2500 or more	over 2,000,000
	II	less than 2500	2,000,000
Other Highways and Streets	III	...	500,000

*Average Daily Truck Traffic (one direction).

†Longitudinal members should also be checked for truck loading.

**Members shall also be investigated for "over 2 million" stress cycles produced by placing a single truck on the bridge distributed to the girders as designated in Article 1.3.1(B) for one traffic lane loading.

Table 9
ASTM REINFORCING BARS

BAR SIZE	WEIGHT (LBS/FT)	DIAMETER IN.	CROSS-SECTIONAL AREA (SQ.IN)
# 3	0.376	0.375	0.11
# 4	0.668	0.500	0.20
# 5	1.043	0.625	0.31
# 6	1.502	0.750	0.44
# 7	2.044	0.875	0.60
# 8	2.670	1.000	0.79
# 9	3.400	1.128	1.00
#10	4.303	1.270	1.27
#11	5.313	1.410	1.56

Table 10
ASTM STEEL TYPE MATERIAL PROPERTIES

ASTM STEEL GRADE	YIELD STRENGTH (KSI)	ULTIMATE STRENGTH (KSI)
A7	33	60
A8	55	90
A36	36	58
A94	50	75
A242	50	70
A440	50	70
A441	50	70
A514	100	115
A517	100	115
A529	42	60
A572(*)	65 or 45	80 or 60
A588	50	70

(*) Refer to Reference 1.

Table 11
SLAB REINFORCEMENT AND ORIENTATION
EXAMPLE PROBLEMS 1 AND 2 (AASHO 3B)

LAYER	BAR SIZE AND SPACING	THICKNESS (IN)	CENTROID (IN)	ANGLE (DEG)
1	#5 @ 6"	0.05167	-0.4125	-90
2	#4 @ 12"	0.01667	0.1500	0
3	#5 @ 8.74"	0.0547	1.2875	0
4	#5 @ 6"	0.05167	1.9125	-90

Table 12
MATERIAL PROPERTIES
EXAMPLE PROBLEMS 1 AND 2 (AASHO 3B)

SLAB	FC(*)	5.74	5.74	5.74
CONCRETE	FT(**)	--	0.459	0.459
	EC(#)	5200	4365.	4365.
REINF.	FT(##)	61.2	61.2	61.2
STEEL	Ei(+)	28800.	29000.	29000.
GIRDER	FY(##) (flange)	35.1	35.1	35.1
STEEL	FY(##) (web)	39.9	39.9	42.
(++)	FY(##) (coverplate)	38.4	38.4	42.
	Ei(+)	30000.	30000.	29000.

(*) Concrete compressive cylinder strength.
(**) Concrete tensile strength.
(#) Initial modulus of elasticity of concrete.
(##) Yield stress of the steel.
(+) Initial modulus of elasticity of the steel.
(++) No other girder properties, e.g. modulus of elasticity at strain hardening, are reported herein, since they were not employed in this analysis. The 75% Fy termination criterion will not permit the steel to strain-harden, or attain values that are beyond the yield stress point.

Table 13
MATERIAL PROPERTIES
EXAMPLE PROBLEM - 3 (FHWA FOUR SPAN BRIDGE)

MATERIAL	PROPERTY (Stresses and Elas. Moduli in KSI, Strains in IN/IN.)			
SLAB CONCRETE	FC(*)	5.5		
	FT(**)	0.44		
	EC(+)	4273		
REINFORCING STEEL	FY(++)	40.		
	EI(#)	29000.		
GIRDER STEEL		A36	A441	FICTITIOUS(%)
	FY(++)	36	50	36
	EI(#)	29000	29000	3
	EST(##)	900	700	0.08
	EPSST(@)	0.014	0.0215	140
	FU(@@)	58	70	58.5
	EPSU(%%)	0.12	0.12	1200

(*) Concrete compressive cylinder strength.

(**) Concrete tensile strength.

(+) Initial modulus of elasticity of concrete.

(++) Yield stress of the steel.

(#) Initial modulus of elasticity of the steel.

(##) Modulus of elasticity of the steel at strain hardening range.

(@) Strain at steel at the inception of the strain hardening

(@@) Stress at the ultimate strength point of the stress strain curve of the steel

(%) In the layered finite element model, the number of layers must remain constant; however, since the width and thickness of the flanges change from section to section, certain layers (Table 15) are given fictitious material properties to model the "non-existence" of material for this section.

(%%) Strain at steel at ultimate strength stress point.

Table 14
SLAB REINFORCEMENT AND ORIENTATION
EXAMPLE PROBLEM - 3 (FHWA FOUR SPAN BRIDGE)

LAYER	BAR SIZE AND SPACING	THICKNESS (IN.)	CENTROID (IN.)	ANGLE (DEG.)
1	#5 @ 5.5"	0.05636	-1.6875	-90
2	#5 @ 12.89"	0.02405	-1.0625	0
2	#6 @ 12.5"	0.03520	-1.0625	0
3	#5 @ 8"	0.03875	2.5625	0
4	#5 @ 5.5"	0.05636	3.1875	-90

Table 15
TOP AND BOTTOM FLANGE CROSS-SECTIONS
EXAMPLE PROBLEM - 3 (FHWA FOUR SPAN BRIDGE)

TOP FLANGE	CROSS-SECTIONS		
SECTION	LAYER	WIDTH (IN)	MATERIAL
1	1	12	Fictitious
1	2	12	Fictitious
1	3	12	A36
2	1	16	Fictitious
2	2	16	A441
2	3	16	A441
3	1	12	Fictitious
3	2	12	Fictitious
3	3	12	A36
4	1	16	A441
4	2	16	A441
4	3	16	A441

BOTTOM FLANGE	CROSS-SECTIONS		
SECTION	LAYER	WIDTH(IN)	MATERIAL
1	12	16	A36
1	13	16	Fictitious
1	14	16	Fictitious
1	15	16	Fictitious
2	12	16	A441
2	13	16	A441
2	14	16	A441
2	15	16	Fictitious
3	12	16	A36
3	13	16	A36
3	14	16	Fictitious
3	15	16	Fictitious
4	12	18	A441
4	13	18	A441
4	14	18	A441
4	15	18	A441

APPENDIX - 1

INPUT UNIT SUMMARY

This summary indicates what and where the specific variables are located in the input stream. Chapter III gives a detailed explanation of each variable.

UNIT 1 - INITIAL INPUT PARAMETERS

A. Title Card, (ITITLE)

B. Number of Spans, Number of Girders, and Type of Symmetry, (NSPANS, NOMB, TSYM(I))

C. Superstructure Width, Bridge Overhang, and Span Length(s), (WIDTH, OVHANG, SPANL(I))

D. Output Option, (IPRINT)

E. Number of Element Divisions in the Longitudinal or X-Direction, (NELX)

F. Number of Girder Layers, Girder Sections, and Fatigue Checks, (NULAYB, NBS, NFATG)

G. Number of Plate Girder Web Panel Checks, (NPNL)

H. Element Lengths in the Longitudinal or X-Direction, (SIGX(I))

> NOTE: Section-H is read only if the input value in Section -E is greater than zero.

I. Slab Thickness, (DT)

J. Girder Depth, Top Coverplate Thickness, and Bottom Coverplate Thickness, (BDEPTH, TCP, BCP)

K. Flange Width and Thickness, and Web Thickness, (BF, TF, TW)

L. Geometry of Plate Girder Web Panel Checks, (NBM(I), SDIST(I), PHICO(I), USLEN(I))

> NOTE: Section-L is read only if the input value of Section-G is greater than zero.

M. Web Panel Support Conditions, (IBODRY)

> NOTE: Section-M is read only if the input value of Section-G is greater than zero.

UNIT 2 - SLAB PROPERTIES AND MATERIALS

A. Concrete Compressive Cylinder Strength, (FC)

B. Steel Reinforcement Yield Strength (SIGMAP)

C. Steel Reinforcement Material Number, (NSRM)

D. Steel Reinforcement Pattern Geometry, (ISIZE(I), SPACE(I), SZC(I), SPHI(I))

> NOTE: Section-D is read only if the input value of Section-C is defined to be one.

UNIT 3 - GIRDER PROPERTIES AND MATERIALS

A. Number of Steel Materials, (NSM)

B. Steel Type, (CLASS(I))

C. Steel Material Properties, (SYB(I), EB(I), ROM(I), RON(I), ESHB(I), STRAN(I), SBU(I), STBU(I))

> NOTE: Section-C is read only after a user defined option is specified in Section-B.

D. Identical or Different Girders, (ISAME)

E. Distances to New Girder Cross-Sections, (DNBS(I))

> NOTE: Section-E is read only after Section-D is defined to be zero.

F. Identical or Different Girder Cross-Sections, (IX)

> NOTE: Section-F is read only after Section-D is defined to be zero.

G. Definition of Girder Cross-Section by Layers, (I,J), B(I,J), SIR(I,J), TY(I,J))

> NOTE: Section-G is read only after Section-F is defined to be zero.

H. Fatigue Cycles, (IFATCYC(I))

> NOTE: Section-H is read only if the input value for Unit-1, Section-F, Entry 3 is greater than zero.

I. Geometry and Type of Fatigue Detail, (NBEAM(I), LDIST(I), VDIST(I), TDETAIL(I))

NOTE: Section-I is read only if the input value for Unit-1, Section-F, Entry-3 is greater than zero.

J. Type of Composite Action, (ICOMP(I))

UNIT 4 - STRUCTURAL LOADINGS

A. Number of Area Loads - Dead Load Beam Solution, (NC)

B. Area Load Cards, (Q, X, Y, XLL, YLL)

A. Number of Area Loads - Dead Load Structure Solution, (NC)

B. Area Load Cards, (Q, X, Y, XLL, YLL)

A. Number of Area Loads - Live Load Solution, (NC)

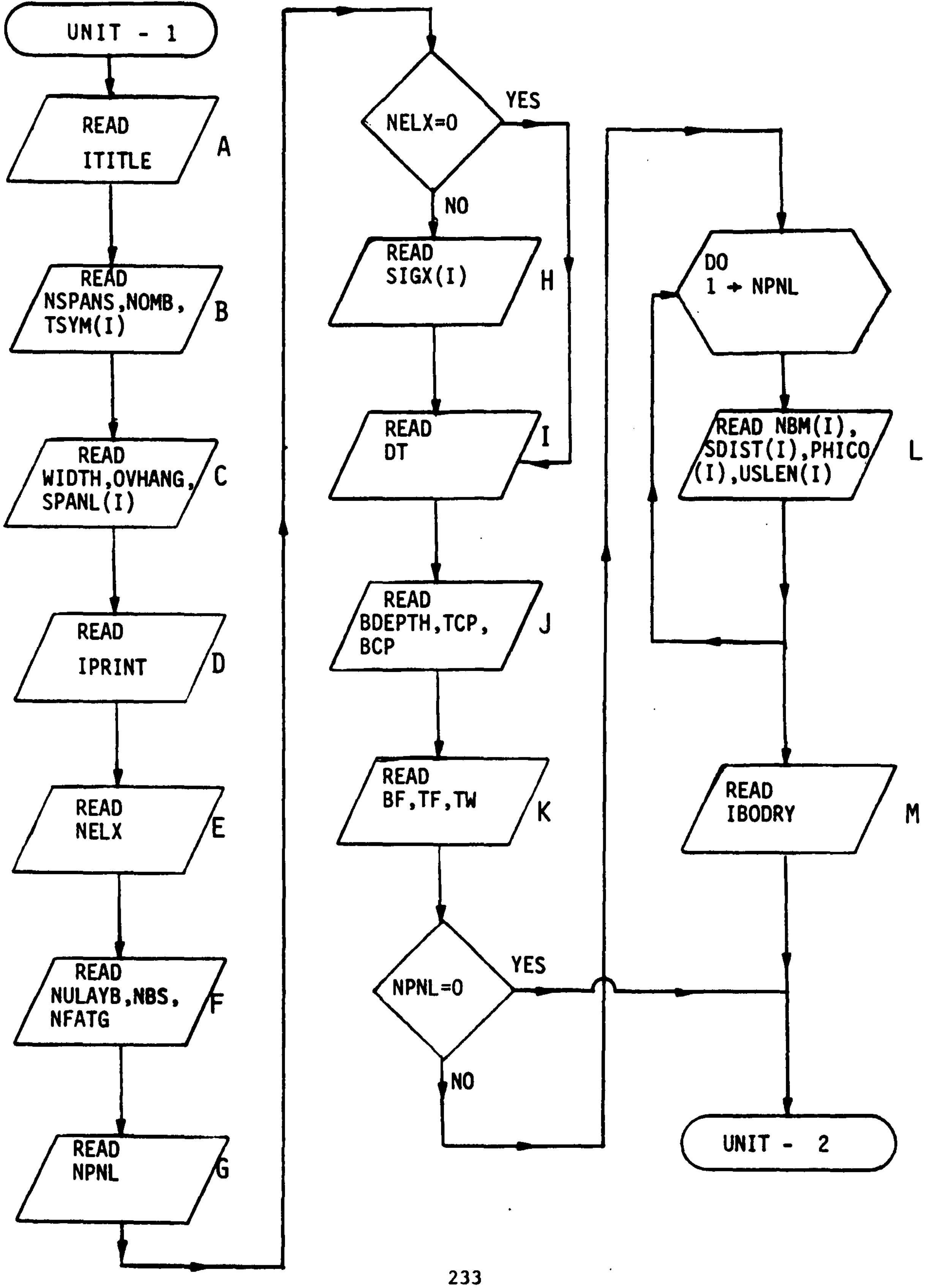
B. Area Load Cards, (Q, X, Y, XLL< YLL)

END OF INPUT

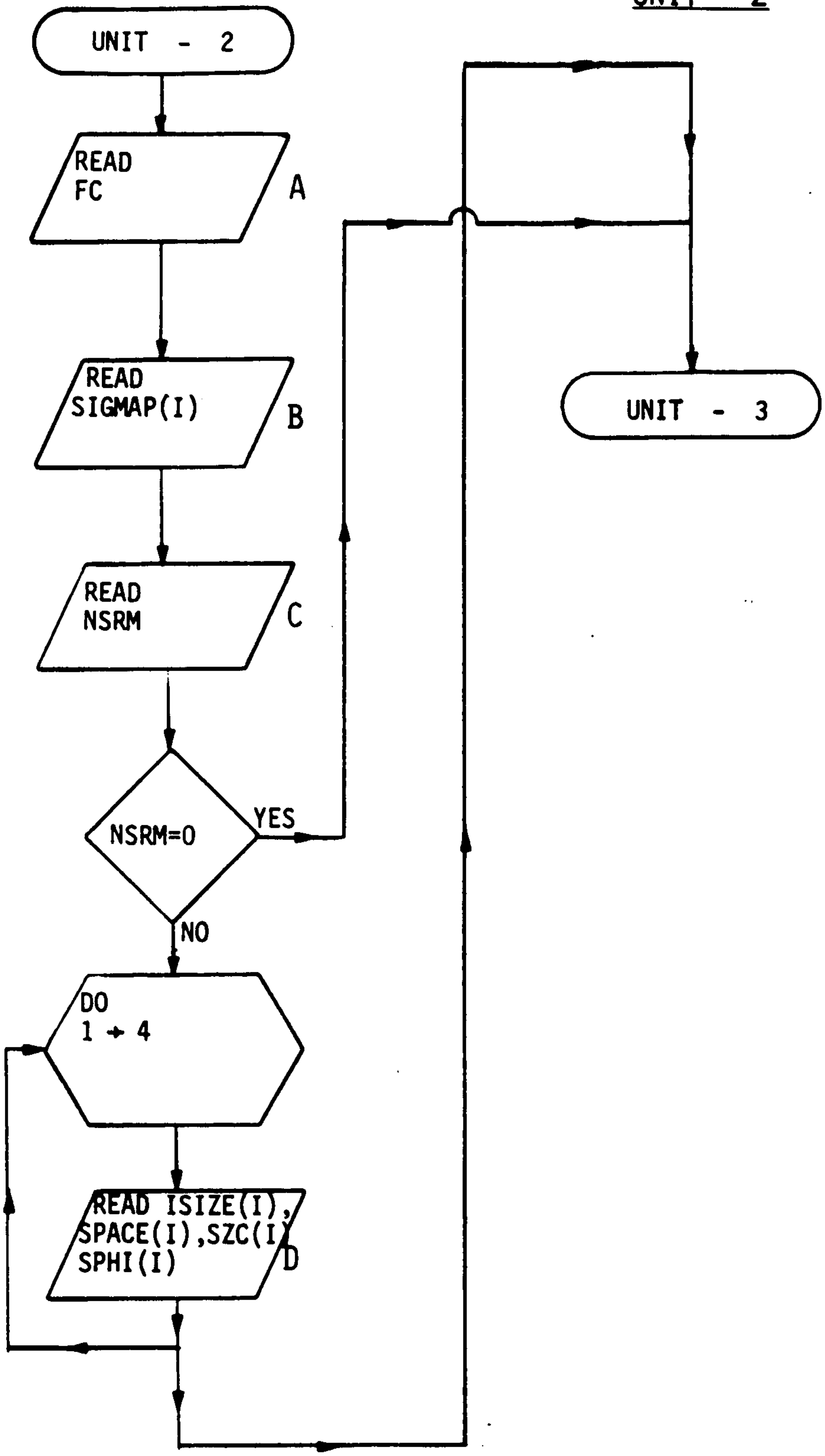
APPENDIX 2

FLOW CHART FOR THE DATA INPUT

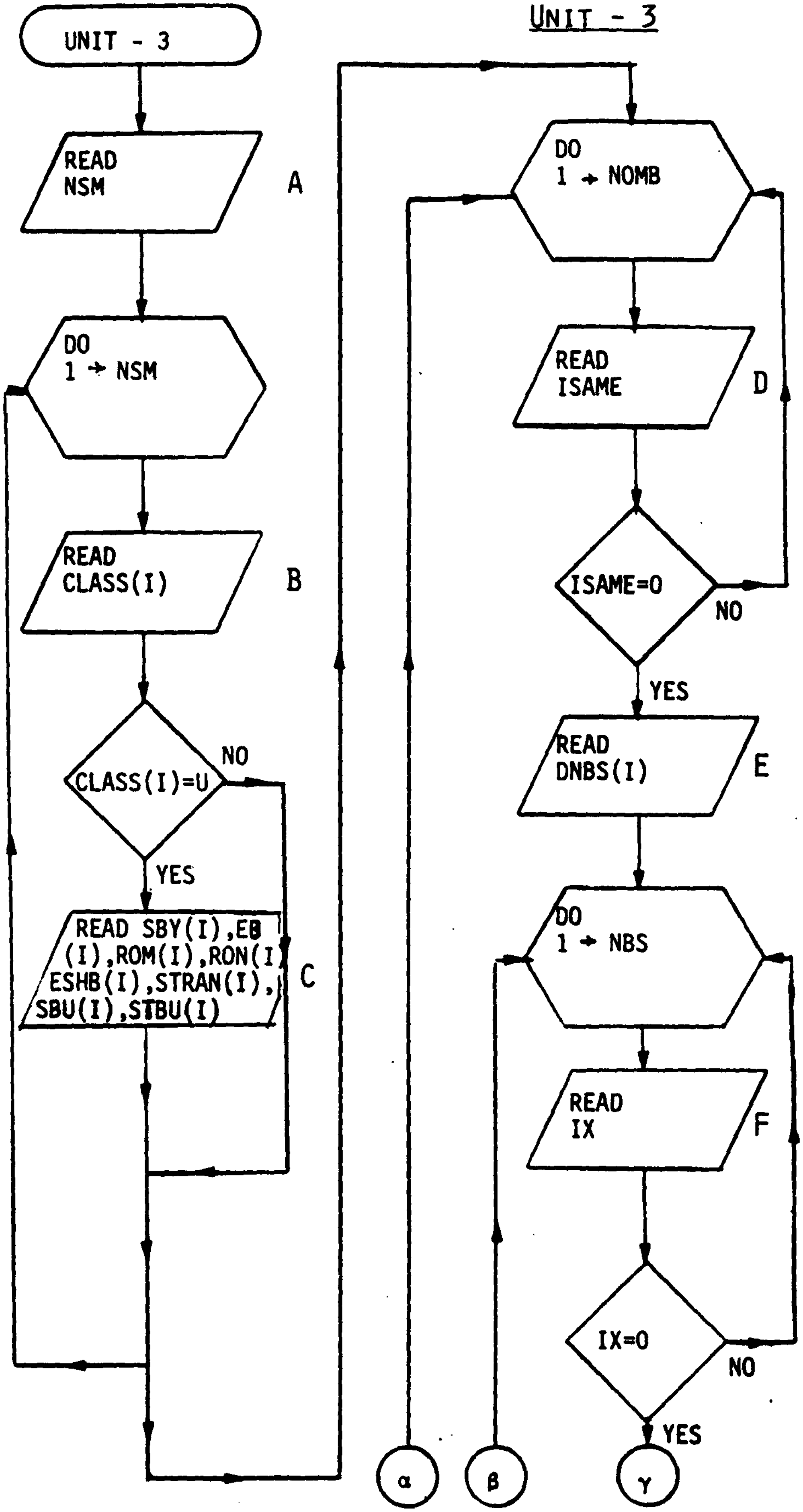
UNIT - 1


UNIT - 1
READ ITITLE
A
READ NSPANS,NOMB, TSYM(I)
B
READ WIDTH,OVHANG, SPANL(I)
C
READ IPRINT
D
READ NELX
E
READ NULAYB,NBS, NFATG
F
READ NPNL
G
NELX=0
YES
NO
READ SIGX(I)
H
READ DT
I
READ BDEPTH,TCP, BCP
J
READ BF,TF,TW
K
NPNL=0
YES
NO
DO 1 → NPNL
READ NBM(I), SDIST(I),PHICO (I),USLEN(I)
L
READ IBODRY
M
UNIT - 2

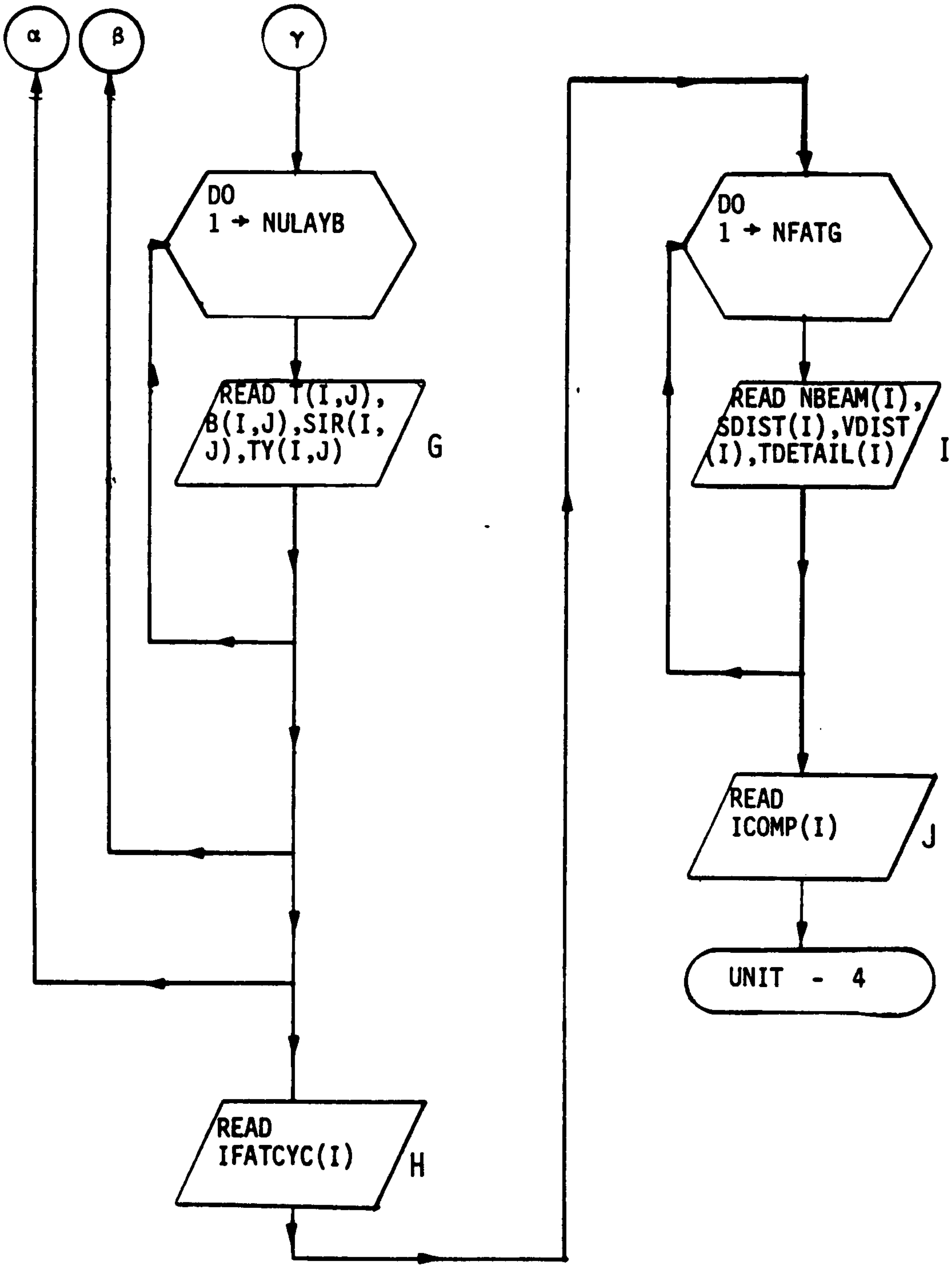
UNIT - 2


UNIT - 2
READ
FC
A
READ
SIGMAP(I)
B
READ
NSRM
C
NSRM=0
YES
NO
DO
1 → 4
READ ISIZE(I),
SPACE(I),SZC(I),
SPHI(I)
D
UNIT - 3

UNIT - 3

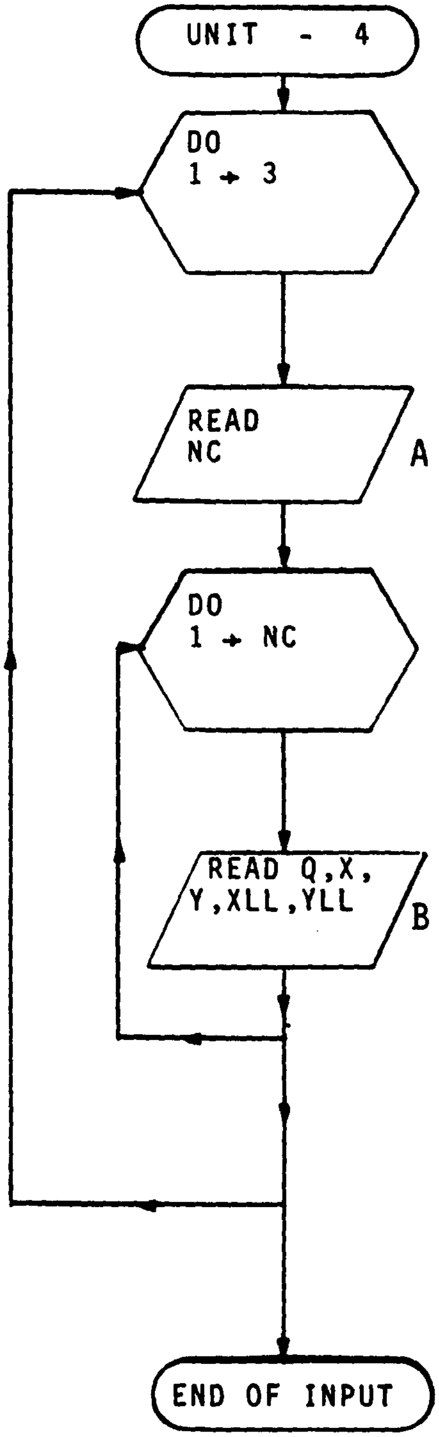

UNIT - 3
READ NSM
A
DO 1 → NSM
READ CLASS(I)
B
CLASS(I)=U
NO
YES
READ SBY(I),EB(I),ROM(I),RON(I) ESHB(I),STRAN(I), SBU(I),STBU(I)
C
DO 1 → NOMB
READ ISAME
D
ISAME=0
NO
YES
READ DNBS(I)
E
DO 1 → NBS
READ IX
F
IX=0
NO
YES
α
β
γ

UNIT - 3 (CONT.)



α
β
γ
DO
1 → NULAYB
READ T(I,J),
B(I,J),SIR(I,
J),TY(I,J)
G
READ
IFATCYC(I)
H
DO
1 → NFATG
READ NBEAM(I),
SDIST(I),VDIST
(I),TDETAIL(I)
I
READ
ICOMP(I)
J
UNIT - 4

UNIT - 4



APPENDIX-3

COMMENTS ON FORMAT FIELD SPECIFICATIONS

I. COMMENTS ON FIXED-FIELD INPUT IN FORTRAN IV

This appendix is designed to familiarize the user of program BOVAS with the basic field specifications used in the input of data. A detailed treatment of the subject matter can be found in any FORTRAN reference manual of the computer system that the user will employ or in any textbook on introductory computer programming.

The four format specifications, i.e. the form in which certain alphabetical or numerical information needs to be entered, required for the program are real (F-format), integer (I-format), alphanumeric (A-format), and skip (X-format). These formats can be briefly described as:

1. **F-Format:** This is the type used to input the numerical values with decimal fractions. For example, if format is (F10.0), and the value to be entered is 3.1416, then the value should be entered as (in the first ten columns, remainder being blank)

```
COLUMN NUMBERS:
         1111111111222222222233333333334444444444
1234567890123456789012345678901234567890 ETC.

3.1416
               OR

   3.1416

               OR

 3.1416
```

If the number to be entered is 31416. and if the format is still (F10.0) the number should be entered as (in the first ten columns, remainder being blank)

```
COLUMN NUMBERS;
         1111111111222222222233333333334444444444
1234567890123456789012345678901234567890 ETC.
31416.
               OR
   31416.
               OR
 31416.
```

Two salient points that the user can observe: In F-format the decimal point must be entered, as far as the scope of this manual is concerned, and the number to be punched can occupy any space within the specified number of columns. In the above example F10.0 indicates that the number is allocated 10 columns. (The number immediately following the letter F indicates the number of columns allocated.)

2. **I-Format:** I-field specification is used to define integer variables (or numbers). For example, if the format calls for (2I5), it indicates that two integer values are to be entered in the particular line of entry. The first value will employ the first through fifth column, and the second value will employ sixth through tenth columns. It should be remembered that in inputting integer values no decimal points are to be entered and the number to be entered must be placed at the outermost right side of the allocated number of columns. If the number to be entered is 12 and if the format is (I5) then the number could be entered only in the following manner:

```
COLUMN NUMBERS;
         1111111111222222222233333333334444444444
12345678901234567890123456789012345678901234567890 ETC.
        12
```

In the above example if the numbers would have been entered in columns 8 and 9, instead of columns 9 and 10, the computer would have assumed the value of 120 for this input. Such a mis-keying can either be rejected by the program, resulting in "abortion" of the job, or much worse, it could proceed with the analysis using this incorrect data. If a solution is obtained with this incorrect data, it will have no resemblance whatsoever to the solution of the problem attempted.

As can be noted in the above discussion, both F-format and I-format can be repeated using an appropriate integer before letter designation. For example, FORMAT(I5,I5) is the same as FORMAT(2I5). Similarly, FORMAT(I5, I5, F10.0, F10.0, I5) serves the same purpose as FORMAT(2I5, 2F10.0, I5). In the latter example the first through fifth columns are allocated for the first integer number, sixth through tenth are allocated for the second integer number, 11th through 20th are allocated for the first real number, 21st through 30th are allocated for the second real number, and the 31st through 35th columns are allocated for the third integer number.

3. **A-Field Specification:** A-field specification is used to transmit alphanumeric values, usually names and acronyms. The variable name can be composed of alphabetic and numeric characters. The cards must be entered, within the given field length (that is the number of columns allocated) in such a manner that the "name" will start in the left most column. For example, if

the format is (A5) and the "value" is HIG, then the value should be keyed in as (for the first five columns, remainder blank):

```
COLUMN NUMBERS:

          11111111112222222223
123456789012345678901234567890 etc.
HIG
```

4. **X-Field Specifications:** X-field specification is used to skip a certain number of columns. Any value punched in these columns corresponding to this field length (number of columns representing the said field length) will be ignored. For example, if the format is (A5,I3,2X,F10.0) and if the values to be keyed in are LOW, 2, and 3.1416 then the entry should be (for the first 20 columns, remainder being blank):

```
COLUMN NUMBERS;
          1111111112
12345678901234567890 ETC.
Low    2  3.1416
```

II. COMMENTS ON FORTRAN 77 VIA CRT TERMINALS

Both FORTRAN IV and fixed field formatting are becoming obsolete. It is prudent to expect that by late 1980's the changes from FORTRAN IV to FORTRAN 77 will take place and will essentially make the contents of this Appendix partially obsolete.

Any changes that will be made to "run" program BOVAS to migrate from FORTRAN IV to FORTRAN 77 environment should be transparent to the user. This migration will be accomplished by the system programming support personnel of the computer where BOVAS is being maintained.

The rigid formatting in FORTRAN IV will be far more lenient under FORTRAN 77 environment. Following is one of many examples that can be given:

The format specification used is (A3, F10.0, I10) and the values to be inputted via this format specification are MED, 3.14, and 74. In the case of FORTRAN IV the data entry should look like:

```
COLUMN NUMBERS;
          1111111111222222222233333333334444444445
12345678901234567890123456789012345678901234567890 ETC.
MED 3.14            74
```

whereas the input in FORTRAN 77 should be:

```
MED,3.14,74
```

In some other systems the following is also acceptable:

```
MED 3.14 74
```

In view of substantial differences between FORTRAN IV and FORTRAN 77, as far as the input operations are concerned, it is imperative that the users should consult with the computer support personnel for the options available to them. If working versions of BOVAS, both in FORTRAN IV and FORTRAN 77 are available, the preference must be given to the latter.

APPENDIX-4

PREDEFINED CONTROL PARAMETERS

Several control parameters, which were at one time part of the input data, have been assigned values internally by the computer program. Also in some cases the user can opt to input their own value rather than defaulting to the "preset" internally defined values. An asterisk is used to indicate those parameters which can be manually inputted or internally defined. The internally defined parameters, which can only be changed by reprogramming, are listed below:

UNIT 1 - INITIAL INPUT PARAMETERS

1. Number of concrete layers in the deck slab.

NULAY = 6

The program assumes two equal layers above the top reinforcement bars, two equal layers below the bottom reinforcement bars, and two equal layers between reinforcing bars (See Fig. 11). The program also assumes a concrete cover of 2.5 inches on the top and 1.0 inch on the bottom in accordance with Reference 10.

2. Number of reinforcing bar layers in the deck slab.

NSLAYR = 4

Both the top and bottom reinforcement are composed of two bar layers each - one transverse and one longitudinal. Although the continuous spans are shown to have five layers, the two top longitudinal layers are consolidated into one steel layer.

3. Number of sections in the longitudinal direction at which different slab reinforcement patterns are specified.

NDRS = 1

The program assumes a constant reinforcement pattern is used throughout the deck slab.

4. Scaling of the solution.

ISCALE = YES

The first solution will be scaled within a certain percentage of the first failure of any form.

5. Dead load solution on the composite structure.

IDEAD = YES

A dead load solution on the composite superstructure will be performed. Therefore, loads must be input for this solution.

6. Type of analysis for the solution.

MODES = YES

An incremental-iterative solution scheme will be employed. The other option, which user can not activate, but the program maintenance personnel can by reprogramming, is NO; in which case, an incremental solution could have been performed (See Ref. 12).

7. Is this a restart run?

ICARDS = NO

The restart capability has been eliminated. If ICARD would have been YES, this would have been a restart run and data from the previous run would have been read from Tape-28. If ICARD = NO, as it is set in the current version of the program, the program assumes that this is an "initial run."

8. Should end data file be written?

ECARDS = NO

The restart capability has been eliminated. If ECARDS would have been YES, the data would have been saved at the end of the run on Tape-23 and would have been "cataloged" for future runs. By setting ECARDS to NO, no end file will be cataloged; therefore, restart runs will not be possible.

9. Allowable central processing unit time in seconds.

ETIME = 50,000.

By presetting this value to a very high number, this control parameter has essentially been eliminated. After substantial testing, the programming personnel in-charge of the maintenance of this program may wish to reset this parameter to another value. This resetting can be accomplished by changing the numerical value in one of the statements of the program.

10. Node point number at which the vertical force is to be monitored.

NSIGF = Internally computed.

NSIGF is internally computed as the first non-zero nodal point in the force vector. NSIGF and the corresponding force at this specific node are used to monitor the force increments during the overload solution.

11. Node point number at which the vertical displacement is to be monitored.

NSIGD = Internally computed.

NSIGD is internally computed as the center nodal point of the bridge deck on the left most span. This nodal point usually corresponds to the point of maximum displacement in most simple span bridges and some continuous bridges.

12. Maximum vertical displacement allowed for nodal point NSIGD in inches.

DSPMAX = Internally computed.

DSPMAX is internally computed as ten percent of the maximum span length. For example, a two span continuous bridge with span lengths of 480. inches and 960 inches would have a DSPMAX equal to 96. inches.

13. Maximum weight to overload vehicle to weight ratio.

OLOAD = 1.0

No "factor of safety" has been included in the analysis.

14. Maximum value of the total vehicular load in kips applied before the termination of the execution of the program.

PMAX = 1.0 E+20

By presetting PMAX to this high value, the maximum load check has been eliminated.

15. Force increment multiplier.

QAPA = 0.4

The practical range of this parameter is between 0.2 and 0.8. This factor is applied to the scaled force vector if ISCALE = YES (it does for the reported version of the program, see No. 4 above) or to the inputted force vector if ISCALE = NO.

16. Print mode control parameter for displacements.

RDPR = Internally defined.

The program defined RDPR = 0.0 for the long printout option and RDPR = 0.03 for the short printout option. If the change in displacement of node NSIGD (see No. 11 above) is greater than RDPR multiplied by the first solution displacement of node NSIGD, then the detailed print option is automatically selected for the next load step. If not, then only a short output mode is selected with only reference point information being printed.

17. Print mode control parameter for forces.

RFPR = Internally defined.

The program defined RFPR = 0.0 for the long printout and RFPR = 0.03 for the short printout option. If the change in force of node NSIGF (see No. 10 above) is greater than RFPR multiplied by the first solution force of node NSIGF, then the detailed print option is automatically selected for the next load step. If not, then only a short output mode is selected with only reference point information being printed.

18. Maximum allowable number of load increments.

LCYCLE = 300

As long as the 75% yield criterion is imposed on the steel girders, the program will probably never reach this value. Therefore the effect of this control parameter on the program is eliminated.

19. Dead load on the beam solution.

IDEADB = YES

If YES, a dead load on the beam solution will be performed. The loads should include the weight of the steel girders and the "wet" concrete.

20. Definition of the mathematical model to compute the stresses at the bridge deck slab finite elements.

ISRT = NODE

If ISRT is set to NODE, stresses will be computed conservatively via node - dominant formulation. See Reference 13 for other allowable options of this parameter.

* 21. Finite element lengths in the longitudinal or x-direction.

SIGX(I) = Internally computed or manually inputted.

If the automatic mesh generation option was selected (NELX = 0), values for SIGX(I) will be computed internally based on the number of spans and the type of symmetry. If the manual mesh discretization is selected (NELX > 0), the user should input NELX values for SIGX(I). See Section 2.3.2 and Chapter III for more details on this parameter.

22. Finite element lengths in the transverse or y-directin in inches.

SIGY(I) = Internally computed.

This option is always internally computed. Two equal strings of plate bending elements will be placed between the girders and one string of plate bending elements will be used to model any bridge overhang. See Section 2.3.2 for more details on this parameter.

23. Distance from the midheight of the slab to the reference plane for girder in inches.

ZBAR = Internally computed.

ZBAR is computed to be the distance between the neutral axis of the slab and the neutral axis of the girder.

24. Distance from the midheight of the slab to the top of the top most layer of the girder in inches.

ZBARTF = Internally computed.

ZBARTF is assumed to be one-half the slab thickness. The program does not allow for embedment of the steel girder or coverplate in the slab.

25. Starting nodal point numbers for the girders.

NPBST(I) = Internally computed.

There are NOMB values of NPBST(I).

26. Number of 'beam elements" used to model the "web panel."

NEPNL(I) = 1

One beam element will be used to model each of the NPNL values of web panel checks.

27. Beam element number which defines the first element of the "web panel."

NEPNLS(I) = Internally computed.

NEPNLS is computed based on the inputted values of NBM(I) and SDIST(I).

28. Direction of the degree of freedom which is to be constrained.

DIR = Internally computed.

All constraints are internally set by the program.

29. Node number which is to be constrained or the starting number of a string of nodes that will have the same type of constraints.

NODE = Internally computed.

All constraints are internally set by the program.

30. Node number increment.

K = Internally computed.

All constraints are internally set by the program. This option is only used when constraints are generated via strings.

31. Last node number of the string when generating via the automatic approach.

IE = Internally computed.

All constraints are internally set by the program.

UNIT 2 - SLAB PROPERTIES AND MATERIALS

1. Concrete tensile strength in ksi.

FT = Internally computed.

FT is internally computed as a function of the input of concrete compressive cylinder strength in accordance with the ACI 318 - 77 provisions.

2. Initial modulus of elasticity for concrete in ksi.

EC = Internally computed.

EC is internally computed as a function of the input concrete compressive cylinder strength in accordance with the ACI 318 - 77 provisions.

3. Unloading modulus for concrete in compression in ksi.

EDOWNC = 1000.

This is the internationally accepted Kostem-Kulicki unloading curve.

4. Unloading modulus for concrete in tension in ksi.

EDOWNT = 800.

This is the internationally accepted Kostem-Kulicki unloading curve.

5. Number of different steel reinforcement materials in the deck slab.

NSMAT = 1

Only one type of steel reinforcement will be permitted in the deck slab.

6. Modulus of elasticity of the reinforcement steel in ksi.

SEMOD(I) = 29,000.

SEMOD(I) is defined in accordance with AASHTO provisions and PennDOT's recommendations.

7. Ramberg-Osgood m-parameter for the reinforcement steel

SPROM(I) = 0.7

8. Ramberg-Osgood n-parameter for the reinforcement steel

SPRON(I) = 300.

9. Starting slab element number for reinforcement pattern-I.

NES(I) = 1

Since a constant reinforcement pattern is assumed in the deck slab (NDRS=1, see Unit-1, No. 3), NES(I) will always be one.

10. Ending slab element number for reinforcement pattern-I.

NEE(I) = Internally computed.

Since a constant reinforcement pattern is assumed in the deck slab (NDRS=1, Unit-1, No. 3), NEE(I) will always be computed to equal the numbers of plate elements in the model.

* 11. Steel reinforcement bar size.

ISIZE(I) = Internally computed or manually inputted.

If the automatic reinforcement generation option was selected (NSRM = 0), values for ISIZE(I) will be computed internally in accordance with Reference 10. If the manual reinforcement generation option was selected (NSRM = 1), the user should input the necessary reinforcement data (See Chapter III).

* 12. Spacing of reinforcing bars in inches.

SPACE(I) = Internally computed or manually inputted.

If the automatic reinforcement generation option was selected (NSRM=0), values for SPACE(I) will be computed internally in accordance with Reference 10. If the manual reinforcement option was selected (NSRM = 1), the user should input the necessary reinforcement data (See Chapter III).

* 13. Distance for the given layer between the centroid of the reinforcing bars and the mid-plane of the slab in inches.

SZC(I) = Internally computed or manually inputted.

If the automatic reinforcement generation option was selected (NSRM = 0), values for SZC(I) will be computed internally in accordance with Reference 10. If the manual reinforcement generation option was selected (NSRM = 1), the user should input the necessary reinforcement data (See Chapter III).

* 14. Orientation of the reinforcing bars in the slab.

SPHI(I) = Internally computed or manually inputted.

If the automatic reinforcement generation option was selected (NSRM = 0), values for SPHI(I) will be computed internally in accordance with Reference 10. If the manual reinforcement option was selected (NSRM = 1), the user should input the necessary reinforcement data (See Chapter III).

15. Number of slab termination checks.

NC = 2

NC has been internally defined to be two - the total number of slab materials (one for concrete and one for steel reinforcement material).

16. Maximum allowable strain in percent for slab material (I+1)

STRAMS(I+1) = Internally defined.

For the concrete, STRAMS(1)=0.0025 and for steel reinforcement, STRAMS(2) = SIGMAP / (SPRON(No. 8 above) x SEMOD(No. 6 above)).

17. Maximum allowable tensile stress for slab material (I+1) in ski.

STTEMS(I+1) = Internally defined.

For concrete, STTEMS(1) is defined as a function of FC. and for steel reinforcement, STTEMS(2) = SIGMAP.

18. Maximum allowable compressive stress for slab material (I+1) is ksi.

STCEMS(I+1) = Internally defined.

For the concrete, STCEMS(1) = 0.8 x FC, and for steel reinforcement, STCEMS(2) = SIGMAP.

19. Maximum number of cracked or yielded layers for slab material (I+1).

NKS(I+1) = Internally defined.

For the concrete, NKS(1) = 3 and for the steel reinforcement, NKS(2) = 1.

20. Maximum number of crushed layers for slab material (I+1).

NHS(I+1) = Internally defined.

For concrete, NHS(1) = 1 and for the steel reinforcement, NHS(2) = 0.

21. Spacing of the bars closest to the appropriate surface in inches.

ACR(I) = Internally defined.

ACR for the top surface has been set to the spacing of the top transverse layer (SPACE(1)), while ACR for the bottom surface has been set to the spacing of the bottom transverse layer (SPACE(4)).

22. Minimum concrete cover for the appropriate surface in inches.

CMIN(I) = Internally defined.

CMIN for the top surface has been set to 2.5 inches, while CMIN for the bottom surface has been set to 1.0 inch. Both values are in accordance with Reference 10.

23. Maximum allowable crack width for the appropriate surface in inches.

VCMAX(I) = 0.004

The same value is used for both the top and bottom surfaces.

UNIT 3 = GIRDER PROPERTIES AND MATERIALS

* 1. Yield stress of the girder steel in ksi.

SBY(I) = Internally defined or manually inputted.

If the user defined option was selected for CLASS(I), the user should input the yield stress of the girder layer. Otherwise the program will internally define the value based on the input for CLASS(I) (See Chapter III).

* 2. Initial modulus of elasticity for the girder in ksi.

EB(I) = Internally defined or manually inputted.

If the user defined option was selected for CLASS(I), the user should input the modulus of elasticity. Otherwise the program internally defines EB = 29000. in accordance with the AASHTO Specifications and PennDOT's recommendations.

* 3. Ramberg-Osgood m-parameter for girder steel.

ROM(I) = Internally defined or manually defined.

If the user defined option was selected for CLASS(I), the user should input Ramberg-Osgood m-parameter. Otherwise the program internally defines ROM=0.67

* 4. Ramberg-Osgood n-parameter for the girder steel.

RON(I) = Internally defined or manually inputted.

If the user defined option was selected for CLASS(I), the user should input the Ramberg-Osgood n-parameter. Otherwise the program internally defines RON=400.

* 5. Initial strain hardening modulus for the girder steel in ksi.

ESHB(I) = Internally defined or manually inputted.

If the user defined option was selected for CLASS(I), the user should input the value for ESHB. Otherwise the program will internally define the value based on the input for CLASS(I) (See Chapter III).

* 6. Strain at the initiation of strain hardening for the girder steel.

STRAN(I) = Internally defined or manually inputted.

If the user defined option was selected for CLASS(I), the user should input the value for STRAN. Otherwise the program will internally define the value based on the input for CLASS(I) (See Chapter III).

* 7. Ultimate strength of the girder steel in ksi.

SBU(I) = Internally defined or manually inputted.

If the user defined option was selected for CLASS(I), the user should input the ultimate strength of the girder steel. Otherwise the program will internally define the value based on the input for CLASS(I) (See Chapter III).

* 8. Strain at ultimate stress for girder steel.

STBU(I) = Internally defined or manually inputted.

If the user defined option was selected for CLASS(I), the user should input the value for STRAN. Otherwise the program will internally define the value based on the input for CLASS(I).

9. Distance between girders in inches.

YDIST = Internally computed.

YDIST is internally computed based on the number of girders, bridge width, and overhang width. The spacing between girders is assumed constant for bridge.

10. Shear connector stiffness.

KSC(I) = Internally computed.

YDIST is internally computed at present, but the option exists to input values at a later date when more "reliable" curves or formulae are available.

11. Girder element number which contains the layer to be checked for fatigue.

NELFAT(I,1) = Internally computed.

NELFAT(I,1) is computed based on the inputted girder number and the longitudinal distance from the left support to the detail location.

12. Girder element layer which contains the detail to be checked for fatigue.

NELFAT(I,2) = Internally computed.

NELFAT(I,2) is computed based on the inputted vertical distance from the mid-plane of the slab to the detail location (positive downward).

13. Allowable fatigue stress range in ksi.

FTGSTR(I,2) = Internally defined.

FTGSTR is internally defined from a program library based on the inputted detail type and the relative number of load cycles in accordance with the AASHTO Specifications (See Chapter III).

14. Number of girder termination checks.

NC = Internally defined.

NC is defined to equal the inputted value of NSM+1.

15. Maximum allowable strain in percent for the girder steel.

STRAMX(I) = Internally computed.

STRAMX is computed to be the strain at 75% of the yield stress level in accordance with the AASHTO provisions. Fictitious steel layers are set to a very high value.

16. **Maximum** allowable tensile stress for the girder steel in ksi.

STTEMX(I) = Internally computed.

STTEMX is computed to be the stress at 75% of the yield stress level in accordance with the AASHTO provisions. Fictitious steel layers are reset to a very high value.

17. Maximum allowable compressive stress for the girder steel in ksi.

STCEMX(I) = Internally computed.

STCEMX is computed to be the stress at 75% of the yield stress level in accordance with the AASHTO provisions. Fictitious steel layers are set to a very high value.

18. Maximum number of yielded layers in the girder steel.

NK(I) = Internally defined.

NK is defined to be zero for the girder steel in accordance with the AASHTO provisions. Fictitious steel layers are set to a very high value.

19. Maximum number of layers to reach strain hardening levels in the girder steel.

NH(I) = Internally defined.

NH is defined to be zero for the girder steel in accordance with the AASHTO provisions. Fictitious steel layers are set to a very high value.

20. Effective shear width of layer-I at location-J.

ASH(I,J) = Internally defined.

ASH is defined to be 0.001 inches for all flange and coverplate layers, while ASH is defined to be equal to the web thickness for all web layers.

21. Half Section properties.

Y = Internally computed.

Y is defined to be 1.0 if the full girder is included in the finite element model. Y is defined to be 2.0 if only one-half the girder is included in the finite element model (a centerline exists along the length of the girder).

UNIT 4 - STRUCTURAL LOADINGS

The following types of input loads have been "looped over" the present version of the program. They can easily be included in the analysis by simple reprogramming.

1. Nodal point loads.
2. Uniform line loads.
3. Uniformly distributed loads.
4. Concentrated vertical loads.

REFERENCES

1. American Association of State Highway and Transportation Officials, MANUAL FOR MAINTENANCE INSPECTION OF BRIDGES, Washington, D.C., 1978.

2. American Association of State Highway and Transportation Officials, STANDARD SPECIFICATIONS FOR HIGHWAY BRIDGES, Washington, D.C., 1977.

3. American Institute of Steel Construction, MANUAL OF STEEL CONSTRUCTION, Chicago, Illinois, 1980.

4. Control Data Corporation, FORTRAN REFERENCE MANUAL, Sunnyvale, California, 1976.

5. Hall, J. C. and Kostem, C. N., INELASTIC OVERLOAD ANALYSIS OF CONTINUOUS STEEL MULTIGIRDER HIGHWAY BRIDGES BY THE FINITE ELEMENT METHOD, Fritz Engineering Laboratory Report No. 432.6, Lehigh University, Bethlehem, Pennsylvania, June 1981.

6. Hall, J. C. and Kostem, C. N., INELASTIC ANALYSIS OF STEEL MULTIGIRDER HIGHWAY BRIDGES, Fritz Engineering Laboratory Report No. 435.1, Lehigh University, Bethlehem, Pennsylvania, August 1980.

7. Kostem, C. N., FURTHER STUDIES ON THE INELASTIC OVERLOAD RESPONSE OF STEEL MULTIGIRDER BRIDGES, Fritz Engineering Laboratory Report No. 435.2, Lehigh University, Bethlehem, Pennsylvania, 1984.

8. Highway Research Board, THE AASHO ROAD TEST, REPORT - 2, MATERIALS AND CONSTRUCTION, Special Report 61B, 1962.

9. Highway Research Board, THE AASHO ROAD TEST, REPORT - 4, BRIDGE RESEARCH, Special Report 61D, 1962.

10. Pennsylvania Department of Transportation, STANDARDS FOR BRIDGE DESIGN, BD-101, Harrisburg, Pennsylvania, 197_.

11. Peterson, W. S., Kostem, C. N. and Kulicki, J. M., THE INELASTIC ANALYSIS OF REINFORCED CONCRETE SLABS, Fritz Engineering Laboratory Report No. 378B.3, Lehigh University, Bethlehem, Pennsylvania, May 1974.

12. Peterson, W. S. and Kostem, C. N., THE INELASTIC ANALYSIS OF BEAM-SLAB HIGHWAY BRIDGE SUPERSTRUCTURES, Fritz Engineering Laboratory Report No. 378B.5, Lehigh University, Bethlehem, Pennsylvania, March 1975.

13. Peterson, W. S. and Kostem, C. N., USER'S MANUAL FOR PROGRAM

BOVA, Fritz Engineering Laboratory Report No. 378B.6A, Lehigh University, Bethlehem, Pennsylvania, March 1975.

14. Peterson, W. S. and Kostem, C. N., THE INELASTIC ANALYSIS OF BEAM-SLAB BRIDGES, Fritz Engineering Laboratory Report No. 400.20, Lehigh University, Bethlehem, Pennsylvania, July 1975.

15. Ramberg, W. and Osgood, W. R., DESCRIPTION OF STRESS-STRAIN CURVES BY THREE PARAMETERS, NACA, TN 902, July 1943.

16. Ruhl, G. and Kostem, C. N., USER'S MANUAL FOR PROGRAM BOVAC, Fritz Engineering Laboratory Report No. 434.1, Lehigh University, Bethlehem, Pennsylvania, April 1980.

17. Tall, L. (Editor), STRUCTURAL STEEL DESIGN, The Ronald Press Company, New York, New York, 1964.

18. Tumminelli, S. C. and Kostem, C. N., FINITE ELEMENTS FOR THE ELASTIC ANALYSIS OF COMPOSITE BEAMS AND BRIDGES, Fritz Engineering Laboratory Report No. 432.3, Lehigh University, Bethlehem, Pennsylvania, March 1978.

19. U. S. Department of Transportation, Federal Highway Administration, STANDARD PLANS FOR HIGHWAY BRIDGES, Vol. IV A, Typical Continuous Bridges, Load Factor Design, Washington, D.C., June 1973.

20. Wegmuller, A. W. and Kostem, C. N., FINITE ELEMENT ANALYSIS OF PLATES AND ECCENTRICALLY STIFFENED PLATES, Fritz Engineering Laboratory Report No. 378A.3, Lehigh University, Bethlehem, Pennsylvania, February 1973.

21. Wegmuller, A. W. and Kostem, C. N., FINITE ELEMENT ANALYSIS OF ELASTIC-PLASTIC PLATES AND ECCENTRICALLY STIFFENED PLATES, Fritz Engineering Laboratory Report No. 378A.4, Lehigh University, Bethlehem, Pennsylvania, February 1973.

22. Kostem, C. N., OVERLOADING BEHAVIOR OF BEAM-SLAB TYPE HIGHWAY BRIDGES, Proposal for Initiation of Research Project Submitted to the Pennsylvania Department of Transportation, The Office of Research, Lehigh University, Bethlehem, Pennsylvania, September 1971.

ACKNOWLEDGMENTS

The reported investigation was conducted in the Department of Civil Engineering and Fritz Engineering Laboratory, under the auspices of the Lehigh University Office of Research, as a part of the research investigation sponsored by the Pennsylvania Department of Transportation and Federal Highway Administration.

The basic planning for the developed software, and the organization and coordination of activities were in cooperation with the following individuals representing Pennsylvania Department of Transportation: Mr. H. P. Koretzky, who continually provided valuable technical guidance, Mr. S. Davis, who was directly instrumental in completion of the reported activity, and Messrs. J. Breon and H. Lathia, who provided suggestions on the programming aspects. Messrs. B. Kotalik and K. Heilman, both of whom were previously employed by Pennsylvania Department of Transportation, provided very valuable assistance in the initial phases of the reported research.

Drs. S. C. Tumminelli and J. C. Hall were the co-developers of program BOVAS. Mr. C. Heishman made numerous improvements to the computer program, and also developed the first draft of this report. Maj. T. A. Lenox over the course of three years, tested every aspect of the program, and executed numerous test cases to validate the accuracy of the results.

At Lehigh University Drs. J. W. Fisher, I. J. Kugelman, J. Goldstein, D. Bolle, and especially Mr. J. Cheezum provided continued encouragement in the execution of the reported research and in the preparation of this report.

Finally, Mrs. K. Michele Kostem reviewed, edited, and re-entered the manuscript of this report to a new wordprocessor during one single weekend. Without the assistance of the individuals listed above the completion of this research and report would not have been possible.