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RATING AND ANALYSIS OF CONTINUOUS GIRDER BRIDGES

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(The opinions, findings, and conclusions expressed in this report are those of the authors and not necessarily those of the sponsoring agencies.)

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SUMMARY

Federal regulations prompted as a result of bridge failures require the rating of bridge structures for which federal funds will be utilized for rehabilitation and replacement. The large number of bridges in Virginia subject to being rated makes such a task time consuming and difficult to fulfill if manual procedures are to be used. Consequently, a study was initiated to investigate the possibility of developing an automated capability for the rating of continuous girder bridges.

A review of existing computer programs capable of rating bridges was conducted. The best candidate program, BRASS, which is a widely used general purpose rating and analysis program, was modified for convenient use by bridge engineers. Because the cost of running this program was found to be very high, a second program, BRRAT, was investigated. BRRAT was found to cost much less than BRASS, but not to be as versatile.

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PROBLEM STATEMENT

Under the Highway Safety Act of 1968, highway officials throughout the United States are required to inspect and rate the bridges in their jurisdictions. This interest in bridge safety resulted from the collapse of the Silver Bridge across the Ohio River at Point Pleasant, West Virginia, in December 1967. Subsequently, on April 27, 1971, the National Bridge Inspection Standards were presented to all states. These standards require a bridge rating to determine the safe load-carrying capacity for each bridge on the federal-aid system. In addition, it is necessary to determine a structural rating for each bridge that, in many cases, requires a detailed analysis of the bridge structure. While these regulations require periodic ratings and analyses for only those structures on the federal-aid system, recent legislation, has extended that requirement to all off-system bridges as well, if states are to qualify for federal money to be applied to the rehabilitation and replacement of off-system bridges.

With approximately 35,000 bridges in Virginia, this rating and analysis requirement places a tremendous demand on the manpower resources of the Bridge Division of the Virginia Department of Highways and Transportation. The analysis of data and establishment of bridge ratings by traditional manual procedures are time consuming and inefficient. Further, because bridge ratings are so important in terms of safety and maintenance requirements, extreme care and accuracy are demanded in their determination. Consequently, this study was undertaken to develop an efficient and reliable, computer-based procedure capable of handling the immense volume of work now required in the analysis of data to establish the rating of bridges.

RESEARCH APPROACH

Three alternatives for developing an automated bridge rating procedure were available. The first was to develop an entirely new computer program comprising a number of modular elements each designed to achieve a particular objective of the bridge rating and analysis. Because the development of a totally new computer package that did not utilize previously developed software would be very time consuming, extremely inefficient, and certainly not cost-effective, this alternative was given little consideration.

A second alternative was to use one of the large-scale programs that had been developed by another state agency or a private firm. This approach necessarily imposes certain constraints on the user in terms of the amount of input required and the volume of output provided. This alternative was, in fact, the one adopted initially by the Department. After careful review, the Department had chosen the BRASS program developed by the state of Wyoming. However, the input required to obtain the rating of a simple continuous girder bridge was found to be excessive and complicated and, accordingly, use of the program was limited.

A third alternative was to adopt an existing large-scale computer code having the capability for analysis and rating of various types of bridge configurations and modify it to meet the needs for the rating of a particular bridge within the Virginia system. This approach was adopted in this study.

OBJECTIVE AND SCOPE

The broad objective of the study was to develop an automated capability for the rating of continuous girder bridges of the type typically found in Virginia.

To achieve the study objective, it was decided it would be necessary to —

1. review existing computer programs, such as BRASS, that have the capability of performing a variety of bridge rating and analyses;
2. select the best candidate program and identify the modifications necessary to render it useful to engineers within the Bridge Division;

3. develop the modifications of this program and the software necessary to make the modified program usable;

4. demonstrate and document the use of the modified program on a typical example problem;

5. review its performance with engineers in the Bridge Division to ascertain possible improvements in subsequent similar work.

CONDUCT OF STUDY

The five activities pursued in achieving the study objective are described under the succeeding subheadings.

Review of Existing Programs

A number of reviews of existing programs have been compiled and published(1, 2), and only brief descriptions of the programs considered for use in Virginia will be given here.

One of the earliest and most widely used computer programs for bridge rating is the BRASS program previously referred to.(3) This program has the capability for the design, review, or load rating of a variety of bridge types, including the deck and various portions of the superstructures. It will handle steel girders, concrete girders, concrete slabs, timber beams, and composite concrete steel girders. However, even though the system is capable of performing a variety of functions, the input necessary to define the particular features of a specific problem is excessive and complicated. In addition, because various components of this program were developed in the early 1960's, a number of the procedures used in the analysis modules are obsolete.

The Control Data Corporation developed a program called BARS for the rating of bridges. According to the corporation, the system can establish the inventory and operating rating required by the AASHTO specifications and the posting, rating, and special permit analysis required by various states using working stress methods.

Another program, BRRAT, was developed by the Pennsylvania Department of Transportation specifically to compute load ratings and determine load limits on bridges. Its capabilities and the relatively simple input required for this program made it an attractive candidate, along with BRASS, for use in the present study. BRRAT will determine the inventory and operating, and safe load capacity ratings for the following types of bridges: (1) single-span, reinforced slab; (2) single-span, reinforced concrete T-beam; (3) simple and continuous span multi-girder steel girder; (4) simple and continuous span with a girder-floor beam-stringer system; and (5) simple and continuous span truss.

Four other bridge rating programs — namely OVLOAD, developed by the New Mexico State Highway Department; MARYLAND, developed by the Maryland State Highway Department; VERMONT, developed by the Vermont State Highway Department; and OKLAHOMA, developed by the Oklahoma State Highway Department — have been developed for bridge rating and some are seeing limited use. However, these four programs have more restrictions than the three initially discussed and, after preliminary review, were not given further consideration.

Program Selection and Identification of Needed Modifications

Program Selection

After a review of programs having the desired capabilities, it was determined that the BRASS program would be the most logical candidate for modification. At the same time, the review had indicated that the BRRAT program developed by the Pennsylvania Department of Transportation might also be worthy of further consideration, since it was inherently a simpler program than BRASS in terms of input preparation. Accordingly, at this particular stage of the investigation, a dual approach was decided upon: (1) BRASS would be investigated with the idea of either modifying it internally or modifying just the input and output to provide the necessary automated capability for rating; and (2) a limited amount of study would be given to the BRRAT program in the event that some backup program might be necessary.

BRASS was selected as the primary candidate because of its ready availability, its long period of use (approximately ten years), and its widespread use. Accordingly, it was felt that the BRASS output was reliable and well checked for analysis and the rating of continuous girder bridges. Many of the other programs, such as BRRAT, had been used by relatively few states and thus their reliability and validity were considered low relative to those of the BRASS program.

Needed Modifications

In the initial stages of the project, it was planned to affect the modification to BRASS by reviewing the internal modular components of the total program, removing those components that pertained directly to a continuous girder bridge, and reassembling the program with appropriate modifications of the software. The modified program would thus be simpler, more streamlined than the original, and would not only have simplified input requirements and limited output but would also be more efficient in terms of operation. Accordingly, a significant amount of time was allocated to gaining familiarity with the internal workings of the BRASS program and identifying those parts necessary for the analysis and rating of continuous girder bridges.

The input for the BRASS program was not only unnecessarily extensive, it was confusing and at times difficult to interpret. For the analysis and rating of typical highway bridges, this program can be thought of as consisting of four major components: the structural analysis component, the structural loading component, the girder section design and review component, and the deck design and review component. Each of these components has separate distinct input which must be generated and developed separately.

The deck design component calculates actual stresses, allowable stresses, and load factors for concrete and timber decks. If this type of information is desired, the input requires all details associated with the slab itself and includes such items as thickness of the slab, percentage of tensile and compressive steel, location of the reinforcing steel, strength of the concrete and steel, and geometric details on such appurtenances as curbs and parapets. In addition, it requires a number of input items relating to the loading and the allowable stresses within the steel and concrete. The bridge engineers responsible for the rating of continuous girder bridges indicated that the deck rating was of little concern and, accordingly, this feature was deleted from the capability of the modified program. This was accomplished within the preprocessor that will be described subsequently.

The structural analysis component of the program performs all of the analysis computations required to analyze and determine stresses throughout the bridge configuration. The input for this component includes information concerning the geometry of the structure and detailed descriptions of the girder configuration, the locations at which specific analyses are to be conducted, specific structural properties for each of the girders, and, finally, the specific type and format of output desired.

The structural loading component generates the actual loading to be used for the final rating and uses as input influence lines generated by the structural analysis component. The loading component generates both dead load and live load magnitudes, depending on the geometry of the structure and on the specific vehicle loading prescribed by the user. Input for this component includes the wheel loadings of the trucks to be used, any superimposed dead loads not included by the bridge definition prescribed earlier, and other special information or unusual loading configurations.

The girder section design review and rating component simply performs the design and rating of steel, concrete, timber, and composite sections.

If the BRASS program were to be used without modification, it is obvious that extensive input would be required to provide the information necessary for the operation of each of the above components. However, for continuous girder bridges, in which the primary concerns are with the capacity of the girders, it is obvious the desired results could be achieved with significantly less input data. It is precisely this objective that is the purpose of the preprocessor described in the following section.

Development Of Preprocessor

Subsequent to the review of the modular components of the BRASS program, two factors served to significantly change the direction of the research effort. One was that it became apparent that the task of disassembling and reassembling the component parts of the program into an efficient smaller program would be extremely difficult in view of the time and budgetary constraints on the project. More importantly, however, personnel in the Automatic Data Processing (ADP) Division of the Department, who are responsible for the upkeep and maintenance of large systems programs, did not wish the BRASS program to be modified in any way. They suggested that a preferable alternate direction would be to simply develop a preprocessor for BRASS which would accept input that would be simple and easily developed by bridge engineers but which would then generate the large amount of input data required by the BRASS program. This would permit BRASS to be operated in an unmodified state while at the same time providing for simplified input from the user's point of view.

The only drawback to this approach was that while the input and output could be simplified, the operation of the program would remain unmodified and inefficient and hence the program would still likely be rather expensive to use.

After extensive discussions with personnel in the ADP Division, it was decided to reorient the objective of the project to the development of a preprocessor for BRASS that would enable the bridge engineer to input only those data necessary for the analysis and rating of continuous girder bridges and that would generate the remaining information required by the input portion of the BRASS program. Such a development would still meet the overall objective of the study; namely, the development of a relatively simple automated capability for the rating of continuous girder bridges.

Input Requirements

As noted earlier, the input requirements for the BRASS program are exceedingly lengthy and even confusing in terms of what is required for a particular problem. For example, the input data sheets that must be completed for a problem analysis by BRASS are shown in Appendix A. It may be seen that the input is separated into four groups, each group being identified by a particular data code control card. All input cards associated with data code 001 pertain to the structural analysis component. The input data required under data code 002 are those items of information needed to completely define the structural loading. Data code 005 refers to that input information used in the girder section design and review component; and, finally, data code 006 is input information associated with the deck design and review components.

In all, these input components require a total of over 700 individual pieces of input information. However, for a particular type of bridge and for a particular function, such as an analysis or rating, all of this information is not required. Nevertheless, it is extremely cumbersome and time consuming for a bridge engineer to identify precisely the minimum information necessary to adequately define a problem.

In this study the concern was limited to the rating of continuous girder bridges. Although a rating of this particular type of bridge using the BRASS program requires input under each of the four input components, the number of input items is considerably reduced. In fact, the most complete description of any type of continuous girder bridge, for which only a rating is required requires approximately 300 items of input. Much of this information is necessary to define the type of bridge being considered and to provide information that, for the most part, is constant for steel girder bridges.

In this phase of the investigation, the major effort was devoted to identifying the minimum input considered essential by bridge engineers for defining the characteristics of a continuous girder bridge for rating under the BRASS program. The relative simplicity of the new input preparation developed under this project can be better understood by comparing the new input with the input required for rating a continuous girder bridge under the unmodified BRASS system. This latter input is provided in Appendix B, in which over 3 1/2 pages of input, numbering over 300 individual items, are required.

After reviewing and evaluating the input defined by the BRASS program, and after discussions with bridge engineers in Richmond, it was determined that an automated rating of a typical continuous girder bridge that would provide the minimum information needed by the bridge engineer could be accomplished by defining only 81 pieces of input data. A form for the preparation of these data and the identification of the individual items is given in Appendix C.

The development of the preprocessor was based on the simple logic following the input data flow as indicated in the BRASS User's Manual and in the sample problem for a plate girder shown in Appendix B. Each sequential operation in the preprocessor was then defined to either read the data that would form a part of the preprocessor input, or simply define the data that would automatically be prescribed to the BRASS program. A listing of the preprocessor subroutine is shown in Appendix D. A brief description of the logic in the preprocessor will be provided by following through the first two or three data cards which are typical of all those that follow.

Input Definition

The input to the preprocessor consists of data contained on 11 data cards as illustrated by the table in Appendix C. The first input card, which contains the integers 100 in columns 1-3, is a title card in which any alphanumeric information contained in columns 4-80 is simply reproduced by the preprocessor program. The remaining 10 cards contain data required by the BRASS input routine and input as eight pieces of data per card, each contained in a 10-column block. The last data card contains only one block of information. Thus a total of 73 items of input data are to be provided by the engineer.

Referring to the listing of the preprocessor in Appendix D, all the input is read in by one READ statement and is identified in the program as a vector V dimensioned as V(80). This information is then redefined in the preprocessor as a variable vector OP dimensioned as OP(8). The elements of the output vector OP consist of either the input variables V or constants. When each of the eight elements of OP have been defined in the preprocessor, they are output on a file that forms the input file for BRASS. Thus the preprocessor essentially consists of the following operations: (1) read and output title card; (2) read all input data as a vector V; and (3) from the input data and design parameters, which are constants, generate a series of 8-element vectors OP which are, in turn, output to a file that forms the input to BRASS.

The BRASS input requires data cards containing 8 pieces of information. As may be noted by referring to the typical BRASS input format in Appendix B, the first 2 of these define a data code and work code and the remaining 6 blocks define actual parameters for the program. For example, on the sample input for the plate girder bridge shown in Appendix B, the first card has a work code DC, a data code 006, which defines the information that follows to be associated with that deck design component, and then 6 numerical entries. The first entry in columns 6 and 7 are the integers 1 1, which defines the desired output to be a rating. The second entry in column 16 is the integer 8, which defines the problem as a continuous slab over steel girders. Entry 3, the integer 2, defines the steel girders, and entry 4 is the integer 20, which specifies that cantilever spans are not involved. Entry 5 is used only if the deck is timber; and, finally, entry 6 is an impact factor that is usually taken to be 0.3. Since the entries in the first card will be the same for the rating of all continuous girder bridges, these were directly defined in the preprocessor to be fixed values.

The second card, which has a data code of 11 in columns 4 and 5 for the BRASS input, is similar to the first in that most of the entries are also constants for the rating of a continuous girder bridge. The only exceptions are entry 2 and entry 6. In the sample program, entry 2 has a value of 0.75 which is the area of the tensile steel in the positive moment region of the slab. In the preprocessor this entry is the variable OP(4), which is set equal to the input parameter V(1). As may be seen from Appendix C, V(1) is defined as the required area of steel. Entry 6 in the BRASS input sample problem has a value of 1.38. This is essentially the thickness of the concrete cover measured from the bottom of the deck. Since this value may vary, it is designated as a variable V(2) in the preprocessor input. In the preprocessor program, the parameter OP(8) is thus set equal to V(2).

The remainder of the preprocessor is developed in the same manner. Thus by simply reading in 73 pieces of information it is possible, to generate an output file that is used as input to the BRASS program and that contains approximately 300 pieces of information. This reduction in data preparation can be accomplished only because most of the data required by the BRASS program consist of constant values for a particular type of bridge.

It is appropriate, now, to review the restrictions in the scope of this modified BRASS program and preprocessor to define the type of bridge and the characteristics of the bridge that can be handled under this rating program.

Scope of Preprocessor

As noted earlier, the primary objective of this study was to ascertain whether or not an automated capability based on an existing program for bridge rating could be conveniently and efficiently provided for the Bridge Division. The scope was limited to consideration of continuous girder bridges of the type commonly found on a large number of on-system bridges in Virginia. Accordingly, in the development of the preprocessor, which would ultimately assemble data for the BRASS program, it was convenient to incorporate certain limitations on the number and type of parameters that would be accepted by this program. Later, any of these limitations not desired by the Bridge Division could be easily removed and as much generality as desired could be included in the preprocessor.

As suggested by engineers within the Bridge Division, the primary concern for rating continuous girder bridges was the analysis and capacity rating of the girders themselves rather than the slab. Accordingly, the rating of the slab was not included in the program. Only that slab data necessary to enable the BRASS program to operate was included in the preprocessor.

On Input Card No. 3 of the preprocessor input (Appendix C), the number of typical cross sections refers to the cross-sectional configurations within a given span. Based on discussions with bridge engineers and a review of a number of bridge types in use, it was decided to arbitrarily limit this number to three. This would account for the existence of cover plates within a span and should be adequate to handle most of the bridges to be studied. Also on Input Card No. 3, the number of each span is specified. It was decided to limit the number of spans to five. If desired in the future, the number of spans can easily be extended.

Input Card No. 8 contains, in columns 21 through 50, a description of three cross-section types. These refer to the total number of distinct cross-sectional configurations throughout all of the spans. In this study, it was decided to limit the number of cross-section types to three. Again, this limitation can easily be removed with a minimum of program modification. Finally, referring to the last two input data cards, the loading permitted under this modified program is somewhat more limited than that in the original BRASS program. This preprocessor program is limited to two types of loading. One is an HS-20 truck loading specified in terms of total weight on Input Card No. 10

and by axle spacing and wheel loads specified as constants within the preprocessor. The other, the only input item in Input Card 11, is the superimposed dead load, which refers to a uniform load on all spans and may be used in addition to or in lieu of the HS-20 truck loading. These two loadings were felt to be adequate to represent the majority of bridge loadings necessary for rating continuous girder bridges. This input restriction also can easily be removed and loadings can be modified to include up to three truck configurations with varying wheel loads, axle spacings, and uniform loads on different spans.

Demonstration and Documentation

BRASS Sample Problem

Volume 2 of the BRASS User's Manual contains a number of example problems that were run on the original BRASS system including full input.(4) One of the sample problems, identified as Sample Problem No. 2 in the Manual, used a five-span, welded plate girder bridge similar in detail and configuration to the type of bridge desired to be rated using the program developed in this study. Details of the bridge, including dimensions and cross-sectional properties, may be found in Figure 1. The input necessary for the rating and analysis of this bridge, as previously described, is provided in Appendix B. This same input information, with only a slight modification to account for a single load rather than three trucks in the sample problem, was punched following the format shown in the BRASS Manual. This problem was then run on the IBM computer in Richmond to obtain a rating for this bridge.

The same bridge was rated using the modified BRASS program by preparing input for the preprocessor consistent with the table shown in Appendix C and the corresponding input data shown in Appendix D. This problem was then run using the modified BRASS program in which the simplified input generated an input file subsequently used as input to the regular BRASS program. The input to the BRASS program should have been the same for both example runs. The purpose of this sample application was simply to verify that the preprocessor did, in fact, operate as it should by comparing results from the modified BRASS run with those from the original full-scale run. The outputs from the programs were identical and the information reproduced from the computer sheets are provided in Appendix E.

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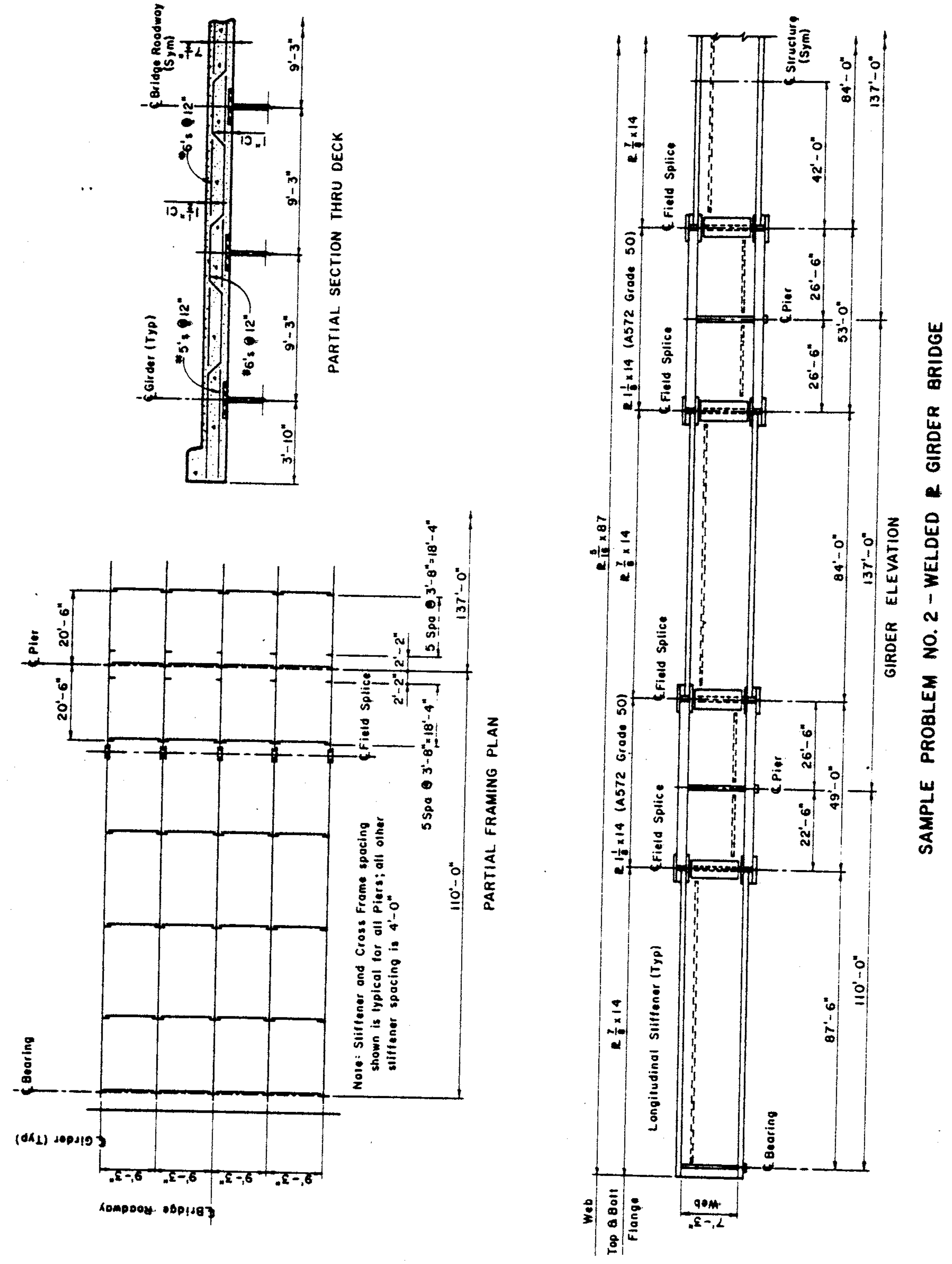

Figure 1. Sample Problem: five-span, welded plate girder bridge.(4)

BRRAT Sample Problem

The original objective of the project, namely the modification of the BRASS program to accept considerably simplified input preparation, was successfully completed and was found to yield results identical to those obtained from the full-scale input. As a point of comparison, and because of the high cost of BRASS noted during this study it was felt appropriate to extend the study to review at least one other program. The BRRAT program developed by the Pennsylvania Department of Transportation was selected.

As described earlier, the BRRAT program is of relatively recent vintage and is not widely used. It appears to have been developed primarily as a research tool. Nevertheless, the apparent simplicity of the program makes it appealing.

It should be noted that the purpose of this limited consideration of BRRAT was simply to provide a point of comparison with the modified BRASS program to see whether or not any further consideration of BRRAT would be warranted. The input required for this program is simpler than that required for BRASS and a comparison can best be made by comparing the inputs for the sample problem run previously. As noted earlier, the input for the full BRASS program is shown in Appendix B and the input for the modified BRASS program (input to the preprocessor) is shown in Appendix C. For comparison, the input for the same sample problem for the BRRAT program is shown in Appendix F. Clearly the input is much simpler, partly because much of the information required for the BRASS program is either assumed or neglected in the BRRAT program. For example, only one modulus of elasticity corresponding to a single grade of steel is permitted in the BRRAT program, whereas composite girders may be handled in the BRASS program.

Nevertheless, it is instructive to compare the outputs from the two programs. The output for the BRRAT program is shown in Appendix G. A comparison of this output with that from the BRASS program indicates clearly that the amount of output from the BRRAT program is considerably less, although it would appear that the basic information is still available; namely, the location of the critical section and the specific values for the inventory rating, operating rating, and safe load capacity.

In comparing the two, it is noted that the inventory rating from the BRASS program identified the critical point as the midpoint of span No. 3 when the inventory rating was 1.13. Correspondingly, from the BRRAT program it is observed that the location of the critical section was identified to be "137.0 feet from the left end of span 3". In the BRRAT rating output it may be seen that the values for the inventory rating, operating rating, and safe load capacity are 1.27, 2.08, and 2.18, respectively. In the BRASS rating output, the inventory rating at mid-span was found to be 1.13, but at the right support the rating was 1.26. The minimum value of the operating rating was 1.76, and no corresponding figure for safe load capacity was given, although, in BRASS the inventory load rating is prescribed to be 40.71 tons.

Although these runs were for the same problem, there are only minor differences in values for the minimum inventory and operating ratings, even though the critical sections were identified to be at different locations in the same span. These relatively small differences in rating values and locations can be ascribed to a number of factors. First, the BRASS rating was obtained for girders whose modulus for the web and flange were different, a capability which was not present in the BRRAT program. Differences also can be ascribed to the fact that the two programs used different techniques for defining the precise load on the girders and for analyzing the bridge. Nevertheless, the very close agreement between the values of the ratings obtained would seem to indicate that either program could be used reasonably effectively. The best check might be to rate a given bridge using both programs and a manual procedure.

Evaluation

The final evaluation of the modified BRASS program, must be made by users of the program in the Bridge Division. Nevertheless, a comparison of the ratings obtained with the original BRASS program, the modified program, and the BRRAT program, indicates that the modified program is successful. While the program developed can provide a BRASS rating with input sufficiently simple to be attractive to potential users, the cost, appears unreasonably high. The BRRAT program is a relatively new program that has seen little field application and its reliability has not been fully evaluated. In spite of this, it does provide easy input and although the output is limited, the key features of the output such as the identification of the critical section and the corresponding values of inventory and operating rating were found to be close to those obtained from the BRASS program. A far more important consideration in judging which program to use, however, is cost.

The costs of running BRASS and BRRAT for the same sample problem were compared and the cost differences were found to be dramatic. The average cost for a BRASS run was in excess of \$450 for the rating of a 5-span, continuous girder bridge. The cost of a rating of the same bridge, admittedly in a more limited context, using the BRRAT program was less than \$11. Based only on this information, it would seem worthwhile for bridge engineers to at least pursue additional comparisons of BRASS and BRRAT. Unless the BRASS program can be made more economical to run, even the provision for simplified input would not make it attractive for use compared to the less costly BRRAT program. In this regard, it has recently been learned that a new release of BRASS is now available and this may prove to be more economical than the old one.

RECOMMENDATIONS

It is recommended that the BRRAT program be given consideration as at least a candidate for checking bridge ratings as currently conducted by the Bridge Division.

It is also recommended that a rating of a continuous girder bridge structure be determined manually and the results compared with the output obtained from the BRRAT and the modified BRASS programs.

Consideration should also be given to obtaining bridge ratings with the BRASS program recently made available to determine their costs.

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APPENDIX A

Components of the BRASS Program

Table A-1

Structural analysis component.
Input data sheets necessary for a problem analysis by BRASS(4)

COL.	Card 1	Card 2	Card 3	Card 4
ENTRY 6		Point Number	Web depth at left end Inches Inches D_1	Web depth #5 Web case #5 only Inches D_5
ENTRY 5	If sustained DL to be applied to composite section, enter value of n for sustained dead load Use in LL run only	Point Number	Typical Web Case 0.=Const. Mom. of Iner. 1.=Uniform Varying 2.=Uniform Haunch 3.=Parabolic Haunch 4.=121-124 Cards to enter 5.=Immediate Break	Web range #4 Web case #5 only
ENTRY 4	Basic Structure Type 0=Cell type 9=7-19 Span Cont. 10=Slant Leg (3 span) 11=Slant Leg (5 span)	Point Number	Web Range #2 Feet	Web depth #4 Web case #5 only Inches D_4
ENTRY 3	Number of typical cross section in this structure. Do not include circular.	Point Number	When Case No. (Entry 5) is: 0., Enter Moment of Inertia (In.^{4}); 1,2,3, or 5, Enter Web Range No. 1 (ft.); 4, Leave Blank.	Web range #3 Web case #5 only Feet
ENTRY 2	Number of members in this structure.	Point Number	Length of this span Feet	Web depth at right end of left haunch or left end of right haunch Inches D_3
ENTRY 1	11111 — Influence Lines? Equations of Indet.? Beam Characteristic? Beam Properties? Shear Infl. Lin.?	Point Number 205. = Span #2 at 5/10 point	Designated number of this span (corresponds to basic structure type chosen, Entry 4 on Control Card)	Web depth at right end Inches D_2
DATA CODE	0 0 1	1 0 0 — DESIGN POINTS CARD Max.No. = 11 points per span. If not entered, all points will be analyzed.	1 0 1 — SPAN CARD NUMBER 1 (See Figure 44)	1 0 2 — SPAN CARD NUMBER 2 (Must follow a 101 card) (See Figure 44)
WORK CODE	D C			

Table A-1 cont.

	Card 103		Card 104		Card 105		Card 106
ENTRY 6		Cross Section Code for Range #3 (from 1 to 10 for typical sections. Equal to '11' for Circular Sections)		Cross Section Code for Range #6 (from 1 to 10 for typical sections. Equal to '11' for Circular Sections)		Cross Section Code for Range #9 (from 1 to 10 for typical sections. Equal to '11' for Circular Sections)		Cross Section Code for Range #12 (from 1 to 10 for typical sections. Equal to '11' for Circular Sections)
ENTRY 5		Cross Section Range #3 (distance from left end to where Entry #6 cross section is typical) Feet		Cross Section Range #6 (distance from left end to where Entry #6 cross section is typical) Feet		Cross Section Range #9 (distance from left end to where Entry #6 cross section is typical) Feet		Cross Section Range #12 (distance from left end to where Entry #6 cross section is typical) Feet
ENTRY 4		Cross Section Code for Range #2 (from 1 to 10 for typical sections. Equal to '11' for Circular Sections)		Cross Section Code for Range #5 (from 1 to 10 for typical sections. Equal to '11' for Circular Sections)		Cross Section Code for Range #8 (from 1 to 10 for typical sections. Equal to '11' for Circular Sections)		Cross Section Code for Range #11 (from 1 to 10 for typical sections. Equal to '11' for Circular Sections)
ENTRY 3		Cross Section Range #2 (distance from left end to where Entry #4 cross section is typical) Feet		Cross Section Range #5 (distance from left end to where Entry #4 corss section is typical) Feet		Cross Section Range #8 (distance from left end to where Entry #4 cross section is typical) Feet		Cross Section Range #11 (distance from left end to where Entry #4 cross section is typical) Feet
ENTRY 2		Cross Section Code for Range #1 (from 1 to 10 for typical sections. Equal to '11' for Circular Sections)		Cross Section Code for Range #4 (from 1 to 10 for typical sections. Equal to '11' for Circular Sections)		Cross Section Code for Range #7 (from 1 to 10 for typical sections Equal to '11' for Circular sections)		Cross Section Code for Range #10 (from 1 to 10 for typical sections. Equal to '11' for Circular Sections)
ENTRY 1		Cross Section Range #1 (distance from left end to where Entry #2 cross section is typical) Feet		Cross Section Range #4 (distance from left end to where Entry #2 cross section is typical) Feet		Cross Section Range #7 (distance from left end to where Entry #2 cross section is typical) Feet		Cross Section Range #10 (distance from left end to where Entry #2 cross section is typical) Feet
DATA CODE	1 0 3	SPAN CARD NUMBER 3 (Must follow a 102 card)	1 0 4	SPAN CARD NUMBER 4 (Must follow a 103 card)	1 0 5	SPAN CARD NUMBER 5 (Must follow a 104 card)	1 0 6	SPAN CARD NUMBER 6 (Must follow a 105 card)
WORK CODE								

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Table A-1 cont.

CONT.				
ENTRY 6	Cross Section Code for Range #15 (from 1 to 10 for typical sections. Equal to '11' for Circular Sections)	Cross Section for Range #18 (from 1 to 10 for typical sections. Equal to '11' for Circular Sections)	Angle $\beta 6$	
ENTRY 5	Cross Section Range #15 (distance from left end to where Entry #6 cross section is typical) Feet	Cross Section Range #18 (distance from left end to where Entry #6 cross section is typical) Feet	Angle $\alpha 4$ or $\beta 5$	
ENTRY 4	Cross Section Code for Range #14 (from 1 to 10 for typical sections. Equal to '11' for Circular Sections)	Cross Section Code for Range #17 (from 1 to 10 for typical sections. Equal to '11' for Circular Sections)	Angle $\alpha 3$ or $\beta 4$	
ENTRY 3	Cross Section Range #14 (distance from left end to where Entry #4 cross section is typical) Feet	Cross Section Range #17 (distance from left end to where Entry #4 cross section is typical) Feet	Angle $\alpha 2$ or $\beta 3$	
ENTRY 2	Cross Section Code for Range #13 (from 1 to 10 for typical sections. Equal to '11' for Circular Sections)	Cross Section Code for Range #16 (from 1 to 10 for typical sections. Equal to '11' for Circular Sections)	Angle $\alpha 1$ or $\beta 2$	
ENTRY 1	Cross Section Range #13 (distance from left end to where Entry #2 cross section is typical) Feet	Cross Section Range #16 (distance from left end to where Entry #2 cross section is typical) Feet	Angle $\beta 1$	Angle $\beta 7$
DATA CODE	107 SPAN CARD NUMBER 7 (Must follow a 106 card)	108 SPAN CARD NUMBER 8 (Must follow a 107 card)	109 ANGLE OF LEGS (See Figures 41 and 42) Degrees and decimals of degrees	110 ANGLE OF LEG
WORK CODE				

Table A-1 cont.

	Card 1	Card 2	Card 3	Card 4
ENTRY 6	Bottom Flange Thickness (T_2) Inches	Width of Bottom Left Fillet (F_6) Inches	Ratio of modulus elasticity of steel to concrete (n). Enter a 1. if Entries #3 and #4 are for cover plates.	Area steel in composite slab (AS_2) Inches^2
ENTRY 5	Top Flange Thickness (T_1) Inches	Height of Bottom Left Fillet (F_5) Inches	Distance from top of steel flange to bottom of concrete flange or cover plate (D_4) Inches	Distance from AS_1 to top of top flange (D_6) Inches
ENTRY 4	Top Flange Width (B_3) Inches	Width of Top Right Fillet (F_4) Inches	Concrete Flange Thickness or Cover Plate (T_3) Inches	Area steel in composite slab (AS_1) Inches^2
ENTRY 3	Bottom Flange Width (B_2) Inches	Height of Top Right Fillet (F_3) Inches	Effective concrete flange width for composite girder or width of cover plate (B_4) Inches	Distance between bottom flange and bottom cover plate (D_5) Inches
ENTRY 2	Web Thickness (B_1) Inches	Width of Top Left Fillet (F_2) Inches	Width of Bottom Right Fillet (F_8) Inches	Width of Bottom Cover Plate (B_5) Inches
ENTRY 1	Cross Section Code (For cross section to be defined by these dimensions) (1 thru 10)	Height of Top Left Fillet (F_1) Inches	Height of Bottom Right Fillet (F_7) Inches	Thickness of Bottom Cover Plate (T_4) Inches
DATA CODE	111 CROSS SECTION DIMENSIONS CARD NUMBER 1 See Figure 45	112 CROSS SECTION DIMENSIONS CARD NUMBER 2 (Must follow a 111 card)	113 CROSS SECTION DIMENSIONS CARD NUMBER 3 (Must follow a 112 card)	114 CROSS SECTION DIMENSIONS CARD NUMBER 4 (Must follow a 113 card)
WORK CODE				

Table A-1 cont.

	Card 1-1-5	Card 1-2-1	Card 1-2-2	Card 1-2-3
ENTRY 6		Moment of Inertia at 5/20 of span Inches^4	Moment of Inertia at 11/20 of span Inches^4	Moment of Inertia at 17/20 of span Inches^4
ENTRY 5		Moment of Inertia at 4/20 of span Inches^4	Moment of Inertia at 10/20 of span Inches^4	Moment of Inertia at 16/20 of span Inches^4
ENTRY 4		Moment of Inertia at 3/20 of span Inches^4	Moment of Inertia at 9/20 of span Inches^4	Moment of Inertia at 15/20 of span Inches^4
ENTRY 3		Moment of Inertia at 2/20 of span Inches^4	Moment of Inertia at 8/20 of span Inches^4	Moment of Inertia at 14/20 of span Inches^4
ENTRY 2		Moment of Inertia at 1/20 of span Inches^4	Moment of Inertia at 7/20 of span Inches^4	Moment of Inertia at 13/20 of span Inches^4
ENTRY 1	Distance from AS_2 to top of top flange (D_7) Inches	Moment of Inertia at left support Inches^4	Moment of Inertia at 6/20 of span Inches^4	Moment of Inertia at 12/20 of span Inches^4
DATA CODE	1 1 5 CROSS SECTION DIMENSIONS CARD NUMBER 5 (Must follow a 114 card) See Figure 45	1 2 1 MOMENTS OF INERTIA CARD NUMBER 1	1 2 2 MOMENTS OF INERTIA CARD NUMBER 2 (Must follow a 121 card)	1 2 3 MOMENTS OF INERTIA CARD NUMBER 3 (Must follow a 122 card)
WORK CODE				

2730

Table A-1 cont.

	Card 124	Card 131	Card 132	Card 133
ENTRY 6		X-Bar at 5/20 span Inches	X-Bar at 11/20 span Inches	X-Bar at 17/20 span Inches
ENTRY 5		X-Bar at 4/20 span Inches	X-Bar at 10/20 span Inches	X-Bar at 16/20 span Inches
ENTRY 4		X-Bar at 3/20 span Inches	X-Bar at 9/20 span Inches	X-Bar at 15/20 span Inches
ENTRY 3	Moment of Inertia at right support Inches^4	X-Bar at 2/20 span Inches	X-Bar at 8/20 span Inches	X-Bar at 14/20 span Inches
ENTRY 2	Moment of Inertia at 19/20 of span Inches^4	X-Bar at 1/20 span Inches	X-Bar at 7/20 span Inches	X-Bar at 13/20 span Inches
ENTRY 1	Moment of Inertia at 18/20 of span Inches^4	X-Bar at left support Inches	X-Bar at 6/20 span Inches	X-Bar at 12/20 span Inches
DATA CODE	1 2 4 MOMENTS OF INERTIA CARD NUMBER 4 (Must follow a 123 card)	1 3 1 DISTANCE TO CENTROID CARD NUMBER 1 (X-BAR) See Figure 45	1 3 2 DISTANCE TO CENTROID CARD NUMBER 2 (X-BAR) (Must follow a 131 card)	1 3 3 DISTANCE TO CENTROID CARD NUMBER 3 (X-BAR) (Must follow a 132 card)
WORK CODE				

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Table A-1 cont.

ENTRY 6		Span with fixed joint at left end		
ENTRY 5		Span with fixed joint at left end		
ENTRY 4		Span with fixed joint at left end		
ENTRY 3	X-Bar at right support Inches	Span with fixed joint at left end		
ENTRY 2	X-Bar at 19/20 span Inches	Span with fixed joint at left end		
ENTRY 1	X-Bar at 18/20 span Inches	Span with fixed joint at left end	Span with fixed joint at left end	
DATA CODE	1 3 4 DISTANCE TO CENTROID CARD NUMBER 4 (X-BAR) (Must follow a 133 card)	4 0 1 JOINT FIXITY CARD NUMBER 1	4 0 2 JOINT FIXITY CARD NUMBER 2	
WORK CODE				

Table A-2
Structural Loading Component

	Card 200	Card 201	Card 202	Card 203
ENTRY 6	Total weight truck #3 Tons		Last span with uniform load of Entry #4	Magnitude of point load Kips
ENTRY 5	Total weight truck #2 Tons		First span with uniform load of Entry #4.	Distance from left support to point of application Feet
ENTRY 4	Total weight truck #1 Tons		Uniform load on the following spans. Kips/Ft.	Span number this load will be on.
ENTRY 3	Percent of impact (above 1.) to be used.	Modulus of elasticity of girder material. Kips/Sq. In.	Last span with uniform load of Entry #1.	Magnitude of point load Kips
ENTRY 2	Wheel fraction	Unit weight of the girder material. Kips/Cu. Ft.	First span with uniform load of Entry #1.	Distance from left support to point of application Feet
ENTRY 1	1111111 Deflections wanted Dead load Live load Max. Design values Deflect, infl. lines Deflection card input Live load composite m	Uniform load on all spans (This loading may be modified by 202 Card). Kips/Ft.	Uniform load on the following spans. Kips/Ft	Span number this load will be on.
DATA CODE	0 0 2 CONTROL CARD	2 0 1 GENERAL DATA	2 0 2 UNIFORM LOAD CARD (Modifies 201 Card Entry #1).	2 0 3 POINT LOAD CARD Maximum of 72 Point Loads (36 cards).
WORK CODE	D C			

2733

2734

Table A-2 cont.

	301	302	309	401
ENTRY 6	Truck wheel load #3 Kips	Truck wheel load #6 Kips		
ENTRY 5	Spacing between truck wheels #2 and #3. (When HS loading is indicated, enter minimum spacing). Feet	Spacing between truck wheels #5 and #6. Feet		
ENTRY 4	Truck wheel load #2 Kips	Truck wheel load #5 Kips		
ENTRY 3	Spacing between truck wheels #1 and #2 Feet	Spacing between truck wheels #4 and #5 Feet	Concentrated load for shear Kips	Modulus of elasticity of girder material. Kips/Sq. In.
ENTRY 2	Truck wheel load #1 Kips	Truck wheel load #4 Kips	Concentrated load for moment Kips	Length of span Feet
ENTRY 1	11 CONTROL CODE Direction Code 1=Up M.P. 2=Down M.P. 3=Up and down M.P. Loading Type 1=HS 2=Special Load	Spacing between truck wheels #3 and #4. (When HS loading is indicated, enter maximum spacing between wheels #2 & #3) Feet	Uniform lane load Kips/Ft.	Length of span number one (Reference span)
DATA CODE	301 TRUCK LOAD DATA	302 TRUCK LOAD DATA (continued) Required for HS loading or more than 3 overload wheels. (See P96 f.)	309 LANE LOAD CARD	401 SPAN DATA FOR DEFLECTIONS (Card Input) Entry #1 of 002 card must equal 100000.
WORK CODE				

Table A-2 cont.

	Card 402	Card 403	Card 404	Card 405
ENTRY 6	Moment at 5/10 point Kip-Feet		Moment of inertia at 5/20 point Inches^4	Moment of inertia at 11/20 point Inches^4
ENTRY 5	Moment at 4/10 point Kip-Feet	Moment at right support Kip-Feet	Moment of inertia at 4/20 point Inches^4	Moment of inertia at 10/20 point Inches^4
ENTRY 4	Moment at 3/10 point Kip-Feet	Moment at 9/10 point Kip-Feet	Moment of inertia at 3/20 point Inches^4	Moment of inertia at 9/20 point Inches^4
ENTRY 3	Moment at 2/10 point Kip-Feet	Moment at 8/10 point Kip-Feet	Moment of inertia at 2/20 point Inches^4	Moment of inertia at 8/20 point Inches^4
ENTRY 2	Moment at 1/10 point Kip-Feet	Moment at 7/10 point Kip-Feet	Moment of inertia at 1/20 point Inches^4	Moment of inertia at 7/20 point Inches^4
ENTRY 1	Moment at left support Kip-Feet	Moment at 6/10 point Kip-Feet	Moment of inertia at left support Inches^4	Moment of inertia at 6/20 point Inches^4
DATA CODE / WORK CODE	4 0 2 REAL LOAD MOMENTS for Deflections (Card Input)	4 0 3 REAL LOAD MOMENTS (continued)	4 0 4 MOMENTS OF INERTIA for Deflections (Card Input)	4 0 5 MOMENTS OF INERTIA (continued)

Table A-2 cont.

ENTRY 6	Moment of inertia at 17/20 point Inches^4		Coefficient at 5/10 point	:
ENTRY 5	Moment of inertia at 16/20 point Inches^4		Coefficient at 4/10 point	Coefficient at right support
ENTRY 4	Moment of inertia at 15/20 point Inches^4		Coefficient at 3/10 point	Coefficient at 9/10 point
ENTRY 3	Moment of inertia at 14/20 point Inches^4	Moment of inertia at right support Inches^4	Coefficient at 2/10 point	Coefficient at 8/10 point
ENTRY 2	Moment of inertia at 13/20 point Inches^4	Moment of inertia at 19/20 point Inches^4	Coefficient at 1/10 point	Coefficient at 7/10 point
ENTRY 1	Moment of inertia at 12/20 point Inches^4	Moment of inertia at 18/20 point Inches^4	Coefficient at left support	Coefficient at 6/10 point
DATA CODE	4 0 6 MOMENTS OF INERTIA	4 0 7 MOMENTS OF INERTIA	4 0 8 LEFT SUPPORT MOMENT INFLUENCE LINE	4 0 9 LEFT SUPPORT MOMENT INFLUENCE LINE
WORK CODE	(continued)	(continued)	for Deflections (Card Input)	(continued)

Table A-2 cont.

	4.1.0	4.1.1		
DATA CODE / WORK CODE	RIGHT SUPPORT MOMENT INFLUENCE LINE for Deflections (Card Input)	RIGHT SUPPORT MOMENT INFLUENCE LINE (continued)		
ENTRY 1	Coefficient at left support	Coefficient at 6/10 point		
ENTRY 2	Coefficient at 1/10 point	Coefficient at 7/10 point		
ENTRY 3	Coefficient at 2/10 point	Coefficient at 8/10 point		
ENTRY 4	Coefficient at 3/10 point	Coefficient at 9/10 point		
ENTRY 5	Coefficient at 4/10 point	Coefficient at right support		
ENTRY 6	Coefficient at 5/10 point			

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Table A-3

Girder Section Design and Review Component

CARD				
ENTRY 6				Type Code
ENTRY 5		Allowable stress over design stress - timber	Allowable stress over design stress - timber	Section Number
ENTRY 4		Allowable stress over yield stress - structural steel	Allowable stress over yield stress - structural steel	Type Code
ENTRY 3	Composite dead load run 0=No, 1=Yes, 2=Composite live load run	Allowable stress over ultimate stress - concrete	Allowable stress over ultimate stress - concrete	Section Number
ENTRY 2	Run Control 0=Design-Review 1=Rating	Allowable stress over yield stress-reinforcing steel (columns)	Allowable stress over yield stress-reinforcing steel (columns	Type Code 1=Steel (welded, rolled or riveted) 3=Concrete, reinforced 5=Composite, steel&concrete 7=Timber
ENTRY 1	Report Request Rating Report Design Report 1 1	Allowable stress over yield stress-reinforcing steel (beams)	Allowable stress over yield stress-reinforcing steel (beams)	Section Number
DATA CODE	0 0 5 CONTROL CARD	5 0 1 MATERIALS FACTORS (Design, Review or Inventory Rating)	5 0 2 MATERIALS FACTORS (Operating Rating)	5 1 0 SECTION TYPES (Sections as numbered in Structural Analysis) define all sections
WORK CODE	D C			

Table A-3 cont.

	520	521	522	523
CONT				
ENTRY 6	Point Number	Moment-yy Kip/Feet		
ENTRY 5	Point Number	Moment-xx (Torque) Kip/Feet		
ENTRY 4	Point Number	Axial Kips		
ENTRY 3	Point Number	Moment-zz Kip/Feet		
ENTRY 2	Point Number	Shear-yz Kips	Reaction-yy Kips	Moment of Inertia about yy axis Inches^4
ENTRY 1	Point Number	Point Number	Shear-zy Kips	Point Number
DATA CODE	5 2 0 DESIGN POINTS Max. No. = 18 Points	5 2 1 ADD ACTIONS Max. No. cards = 18 See Figure 70	5 2 2 ADD ACTIONS (Continued)	5 2 3 ADD PROPERTIES
WORK CODE				

Table A-3 cont.

CONT	1	1	1	
ENTRY 6	Modulus of elasticity ratio - steel to concrete (n)	Unsupported length of sompression flange Feet	NOTE: Each group of 530 thru 533 data cards must be in sequence. If 531, 532 and/or 533 cards are required to further define a given point number (Entry #1 of the 530 card) a continue statement, number "1" is required in the	
ENTRY 5	Yield stress of top flange (if same as web stress, do not enter) Lbs./Sq. In.	Are there longitudinal stiffeners? 1 = Yes 0 = No	"CONT" column of all but the last card in the sequence. It is not necessary, however, that each of the 531 thru 533 cards be required in each group.	
ENTRY 4	Yield stress of bottom flange (if same as web stress, do not enter) Lbs./Sq. In.	Bearing stiffener width Inches	Data cards 550 thru 554 must be coded in a like manner.	
ENTRY 3	Yield stress of web Lbs./Sq. In.	Bearing stiffener thick-ness Inches		f'_c (Composite LL run only) Lbs./Sq. In.
ENTRY 2	Type Section 2=Rolled Section or Welded Plate 3=Riveted 4=Composite, Pos. Mom. 5=Composite, Neg. Mom.	Transverse stiffener spacing Inches	Radius of fillet Inches	Allowable shear at lower cover plate Lbs./In.
ENTRY 1	Point Number	Angle of web from verti-cal Degrees and decimals of degrees	Type of Section 1=Open 2=Closed	Allowable shear at compo-site or upper cover plate Lbs./In.
DATA CODE	5 3 0 STEEL SECTION DETAILS	5 3 1 STEEL SECTION DETAILS - WEB AND STIFFENERS (Continued)	5 3 2 STEEL SECTION DETAILS - TORSION (Continued)	5 3 3 COMPOSITE AND COVER PLATE SHEARS
WORK CODE				

Table A-3 cont.

ENTRY 6	Modulus of elasticity ratio-steel to concrete (n)		Distance to centroid of AS3 (D3) Inches	Spacing of stirrups, ties or spiral reinforcement Inches
ENTRY 5	Percent of concrete to be used in shear normal to the member		Area of steel (AS3) Sq. In.	Area steel stirrups or ties, or spiral reinforcement Sq. In.
ENTRY 4	Ultimate stress of concrete Lbs./Sq. In.		Distance to centroid of AS2 (D2) Inches	Distance to centroid of AS5 (D5) Inches
ENTRY 3	Yield stress of reinforcing steel for stirrups, ties, etc. Lbs./Sq. In.		Area of steel (AS2) Sq. In.	Area of steel (AS5) Sq. In.
ENTRY 2	Yield stress of main reinforcing steel Lbs./Sq. In.	Distance to centroid of steel in top of section Inches	Distance to centroid of ASI (D1) Inches	Distance to centroid of AS4 (D4) Inches
ENTRY 1	Point Number	Distance to centroid of steel in bottom of section Inches	Area of steel (AS1) Sq. In.	Area of steel (AS4) Sq. In.
DATA CODE	5 5 0 DETAILS FOR REINFORCED CONCRETE SECTIONS (Design and Review)	5 5 1 DETAILS FOR REINFORCED CONCRETE SECTIONS (Continued) (Design run only)	5 5 2 DETAILS FOR REINFORCED CONCRETE SECTIONS (Continued) (Review and Rating) See Figures 72-75, p 126	5 5 3 DETAILS FOR REINFORCED CONCRETE SECTIONS (Continued) (Review and Rating)
WORK CODE				

Table A-3 cont.

CONT				
ENTRY 6				
ENTRY 5	Type of shear reinforcement 1 = Tie 2 = Spiral			
ENTRY 4	Distance to centroid of ASR (CLR) Inches	Design stress of timber in compression perpendicular to grain Lbs./Sq. In.		
ENTRY 3	Area of steel in right end of column (ASR) Sq. In.	Design stress of timber in horizontal shear Lbs./Sq. In.	Width of bearing area Inches	
ENTRY 2	Distance to centroid of ASL (CLL) Inches	Design stress of timber in flexure Lbs./Sq. In.	Distance from end of member to beginning of bearing area Inches	
ENTRY 1	Area of steel in left end of section (ASL) Sq. In.	Point Number	Length of bearing area Inches	
DATA CODE	5.5.4 DETAILS FOR REINFORCED CONCRETE SECTIONS (Continued) (Column Review)	5.9.0 TIMBER DESIGN	5.9.1 TIMBER BEARING DATA	
WORK CODE	Do not use for sidewalls			

Table A-4
Deck Design and Review Components

	Card 011	Card 012	Card 013	Card 014
ENTRY 6	Impact fraction (generally $\leq .3$)	Distance from bottom of deck to centroid of AS2 (C2) inches	Fraction of f'_c to be used as allowable stress for Inventory Rating	Wheel load truck #3 (Maximum wheel of truck #3 in the Girder Analysis) Kips
ENTRY 5	Enter 1. for timber deck	Distance from top of deck to centroid of AS1 (C1) Inches	Fraction of f_y to be used as allowable stress for Inventory Rating	Wheel load truck #2 (Maximum wheel of truck #2 in the Girder Analysis) Kips
ENTRY 4	20=No cantilevers * 21=Identical cantilevers 22=Non-identical cantilevers	Compressive steel in negative moment region (AS4) Inches²/Ft.	Fraction of f'_c to be used as allowable stress for Operating Rating	Wheel load truck #1 (Maximum wheel of truck #1 in the Girder Analysis) Kips
ENTRY 3	2=Steel girders * 3=Concrete girders without fillets 4=Concrete girders with fillets	Tensile steel in negative moment region (AS3) Inches²/Ft.	Fraction of f_y to be used as allowable stress for Operating Rating	Slab thickness in spans (T) Inches (Not required for timber)
ENTRY 2	7=Simply supported * 8=Continuous over steel girders 9=Continuous over concrete girders or timber girders	Tensile steel in positive moment region (AS2) Inches²/Ft.	f_y - yield stress of reinforcing steel Lbs./Sq. In.	Flange width or web thickness Inches (Not required for timber)
ENTRY 1 (11)	Output Control Design = 1. Rating = 11.	Compressive steel in positive moment region (AS1) Inches²/Ft.	f'_c - 28-day compressive stress of concrete Lbs./Sq. In.	Girder spacing or center to center supports Feet (Not required for timber)
DATA CODE	0 0 6 CONTROL CARD	0 1 1 REINFORCED CONCRETE DECK DATA	0 1 2 MATERIALS FACTORS (Required for Concrete Decks)	0 1 3 GENERAL DATA (Always Required)
WORK CODE	D C			

* These entries apply only to concrete decks.

Table A-4 cont.

ENTRY 6		Distance from outside of deck to second concentrated load, P2 Feet	Distance from centerline exterior girder to start of taper or fillet (D12) Feet	Second cantilever concentrated load (P2) Lbs./Ft.
ENTRY 5	Distance from bottom of deck to centroid of AS4 (C4) Inches	Width of miscellaneous uniform load (d5) Feet	Curb width (D11) Feet	Weight of miscellaneous uniform load (W3) Lbs./Sq. Ft.
ENTRY 4	Distance from top of deck to centroid of AS3 (C3) Inches	Distance from outside of deck to outside edge of miscellaneous uniform load (D4) Feet	Curb height (D10) Inches	Impact fraction to be used on cantilever if not equal to impact fraction for spans
ENTRY 3	Weight of wearing surface (W2) Lbs./Sq. Ft.	Distance from outside of deck to first concentrated load, P1 (D3) Feet	Depth of deck without tapers (D9) Inches	Modulus of elasticity ratio - steel to concrete (n)
ENTRY 2	Weight of concrete (W1) Lbs./Cu. Ft.	Length of taper or horizontal leg of fillet on cantilever (D2) Feet	Depth of taper or vertical leg of fillet on cantilever (D8) Inches	Vertical leg of fillets on interior spans (FVL) Inches
ENTRY 1	First cantilever concentrated load usually railing (P1) Lbs./Ft.	Cantilever length, centerline exterior girder to outside edge of deck (D1) Feet	Total depth of deck plus taper at cantilever Do not include depth of fillets (D7) Inches	Horizontal leg of fillets on interior spans (FHL) Inches
DATA CODE	0 1 4 GENERAL DATA (continued)	0 1 5 CANTILEVER DATA (Required only for decks with cantilevers) See Figure 13	0 1 6 CANTILEVER DATA (continued)	0 1 7 MISCELLANEOUS DATA (Required for decks with fillets, lightweight aggregates, misc. loads on cantilever or different impact for cantilever)
WORK CODE				

Table A-4 cont.

CARD	018	019	020	021
ENTRY 6	Distance from outside edge of deck to second concentrated load, P4 (D18) Feet	Distance from centerline exterior girder to start of taper or fillet (D24) Feet		:
ENTRY 5	Width of miscellaneous uniform load (D17) Feet	Curb width (D23) Feet		
ENTRY 4	Distance from outside edge of deck to outside edge of miscellaneous uniform load (D16) Feet	Curb height (D22) Inches	Second cantilever concentrated load (P4) Lbs./Ft.	Distance from bottom of deck to AS6 Not required if C6=C4 (C6) Inches
ENTRY 3	Distance from outside edge of deck to first concentrated load, P3 (D15) Feet	Depth of deck without tapers (D21) Inches	First cantilever concentrated load usually railing (P3) Lbs./Ft.	Distance from top of deck to AS5 Not required if C5=C3 (C5)
ENTRY 2	Length of taper or horizontal leg of fillet on cantilever (D14) Feet	Depth of taper or vertical leg of fillet on cantilever (D20) Inches	Weight of miscellaneous uniform load (W5) Lbs./Sq. Ft.	Compressive steel in cantilever Not required if AS6=AS4 (AS6) Inches^2/Ft.
ENTRY 1	Cantilever length, centerline exterior girder to outside edge of deck (D13) Feet	Total depth of deck plus taper at cantilever Do not include depth of fillets (D19) Inches	Weight of wearing surface (W4) Lbs./Sq. Ft.	Tensile steel in cantilever Not required if AS5=AS3 (AS5) Inches^2/Ft.
DATA CODE	0 1 8	0 1 9	0 2 0	0 2 1
WORK CODE	CANTILEVER DATA (continued) Used only when right and left cantilevers are not identical (Figure 13)	CANTILEVER DATA (continued)	CANTILEVER DATA (continued)	CANTILEVER DATA (continued) Used only if steel areas or centroids at the cantilever differ with those over the supports

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Table A-4 cont.

ENTRY 6	Width of stringer or supporting member Inches	1=Plank floor 2=Laminated floor 3=Splined or doweled floor	Width of tire, truck #3 Inches	
ENTRY 5	Weight of wearing surface Lbs./Sq. Ft.	Enter 1. if decking is continuous over more than two spans	Length of tire, truck #3 Inches	
ENTRY 4	Weight of timber decking Lbs./Cu. Ft.	Allowable horizontal shear stress for decking (Inventory Rating) Lbs./Sq. In.	Width of tire, truck #2 Inches	
ENTRY 3	Depth of flooring member (planks) Inches	Allowable bending stress in decking (Inventory Rating) Lbs./Sq. In.	Length of tire truck #2 Inches	
ENTRY 2	Width of flooring member (planks) Inches	Allowable horizontal shear stress for decking (Operating Rating) Lbs./Sq. In.	Width of tire, truck #1 (See AASHO 1.3.4(a)) Inches	
ENTRY 1	Stringer spacing Feet	Allowable bending stress in decking (Operating Rating) Lbs./Sq. In.	Length of tire, truck #1, if other than allowed by AASHO Inches	
DATA CODE	0 2 2 TIMBER DECK DATA	0 2 3 TIMBER DECK DATA (continued)	0 2 4 TIMBER DECK LOADING CARD	
WORK CODE				

APPENDIX B

Input Needed for a Continuous Girder Bridge Sample Problem Under the Unmodified BRASS System

2748

FORM C-16
Rev. 3/11/69

WYOMING STATE HIGHWAY DEPARTMENT
CHEYENNE WYOMING
BRIDGE DIVISION

DESIGN SYSTEM

//EXEC BRSYSØØ

SHEET NO. 1 OF 4
BY DAG DATE 9-27-73
CHECKED ______

Employee No. (65–68)	Dept. Code	P o/D	Job Code (75)	Work Code	Str. No. (80)
5857	7Ø	P	EKR9	DES	

COMMENT CARD (1–64)

1ØØ SAMPLE PROBLEM NO. 2 WELDED PL GIRDER BRIDGE

WORK CODE (1–2)	DATA CODE (3–5)	ENTRY 1 (6–15)	ENTRY 2 (–25)	ENTRY 3 (–35)	ENTRY 4 (–45)	ENTRY 5 (–55)	ENTRY 6 (–65)	CONT (66)
DC	ØØ6	11.	8.	2.	2Ø.		.3	
	11		.75	.88			1.38	
	12	325Ø.	6ØØØØ.	.55	.55	.4	.4	
	13	9.25	14.	7.5	16.	9.	9.	
	14		15Ø.		1.88			
DC	ØØ1	Ø111Ø.	5.	2.				
	1ØØ	1Ø4.	2ØØ.	2Ø5.	3ØØ.	3Ø5.	4ØØ.	
	1ØØ	5ØØ.						
	1Ø1	1.	11Ø.	11Ø.		1.	87.	
	1Ø2	87.						
	1Ø5	87.5	1.	87.5	2.	11Ø.	2.	
	1Ø1	2.	137.	137.		1.	87.	
	1Ø2	87.						
	1Ø3	26.5	2.	26.5	1.	11Ø.5	1.	
	1Ø4	11Ø.5	2.	137.	2.			
	1Ø1	3.	137.	137.		1.	87.	
	1Ø2	87.						

TRAILER CARD

~~999~~ (1–3)

NOTE: A trailer card must follow the last structure card containing data

FORM C-16
Rev. 3/11/69

WYOMING STATE HIGHWAY DEPARTMENT
CHEYENNE WYOMING
BRIDGE DIVISION

DESIGN SYSTEM

SHEET NO. 2 OF 4
BY DAG DATE 9-27-73
CHECKED

//EXEC BRSYSØØ

Employee No. (65–68)	Dept. Code	P or D	Job Code (75)	Work Code	Str. No. (80)

1 COMMENT CARD 64

WORK CODE (1–2)	DATA CODE (3–5)	ENTRY 1 (6–15)	ENTRY 2 (25)	ENTRY 3 (35)	ENTRY 4 (45)	ENTRY 5 (55)	ENTRY 6 (65)	CONT (66)
	1Ø3	26.5	2.	26.5	1.	11Ø.5	1.	
	1Ø4	11Ø.5	2.	137.	2.			
	1Ø1	4.	137.	137.		1.	87.	
	1Ø2	87.						
	1Ø3	26.5	2.	26.5	1.	11Ø.5	1.	
	1Ø4	11Ø.5	2.	137.	2.			
	1Ø1	5.	11Ø.	11Ø.		1.	87.	
	1Ø2	87.						
	1Ø3	22.5	2.	22.5	1.	11Ø.	1.	
	111	1.	.3125	14.	14.	.875	.875	
	111	2.	.3125	14.	14.	1.125	1.125	
DC	ØØ2	Ø111Ø.	1.6818	1ØØ.	35.	39.95	22.	
	2Ø1	.95	.49	29ØØØ.				
	3Ø1	23.	4.	14.	16.	14.	16.	
	3Ø2	3Ø.						
	3Ø1	23.	3.95	11.	9.	4.	9.	

TRAILER CARD
999
1 3

NOTE: A trailer card must follow the last structure card containing data

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FORM C-16
Rev. 3/11/69

WYOMING STATE HIGHWAY DEPARTMENT
CHEYENNE WYOMING
BRIDGE DIVISION

DESIGN SYSTEM

SHEET NO. 3 OF 4
BY DAG DATE 9-27-73
CHECKED

Employee No. (65–68)	Dept. Code	P or D	Job Code (75)	Work Code	Str. No. (80)

//EXEC BRSYSØØ

1 COMMENT CARD

ØØØ

WORK CODE (1–2)	DATA CODE (3–5)	ENTRY 1 (6–15)	ENTRY 2 (–25)	ENTRY 3 (–35)	ENTRY 4 (–45)	ENTRY 5 (–55)	ENTRY 6 (–65)	CONT (66)
	3Ø2	29.	9.	4.	9.			
	3Ø1	23.	4.	15.	9.	4.	9.	
DC	ØØ5	11.	1.					
	5Ø1				.55			
	5Ø2				.75			
	51Ø	1.	1.	2.	1.			
	53Ø	1Ø4.	2.	36ØØØ.				/
	531		48.			1.		
	53Ø	2ØØ.	2.	36ØØØ.	5ØØØØ.	5ØØØØ.		/
	531		26.	1.25	6.75	1.	2Ø.5	
	53Ø	2Ø5.	2.	36ØØØ.				/
	531		48.			1.		
	53Ø	3ØØ.	2.	36ØØØ.	5ØØØØ.	5ØØØØ.		/
	531		26.	1.25	6.75	1.	2Ø.5	
	53Ø	3Ø5.	2.	36ØØØ.				/
	531		48.			1.		

TRAILER CARD

999

NOTE: A trailer card must follow the last structure card containing data

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WYOMING STATE HIGHWAY DEPARTMENT
CHEYENNE WYOMING
BRIDGE DIVISION

DESIGN SYSTEM

SHEET NO. 4 OF 4
BY DAG DATE 9-27-73
CHECKED

Employee No. (65–68)	Dept. Code	P or D	Job Code (75)	Work Code	Str. No. (80)

//EXEC BRSYSØØ

1 COMMENT CARD (64)

Work Code (1–2)	Data Code (3–5)	Entry 1 (6–15)	Entry 2 (–25)	Entry 3 (–35)	Entry 4 (–45)	Entry 5 (–55)	Entry 6 (–65)	Cont (66)
	53Ø	4ØØ.	2.	36ØØØ.	5ØØØØ.	5ØØØØ.		/
	531		26.	1.25	6.75	1.	2Ø.5	
	53Ø	5ØØ.	2.	36ØØØ.	5ØØØØ.	5ØØØØ.		/
	531		26.	1.25	6.75	1.	2Ø.5	

TRAILER CARD

999 (1–3)

NOTE: A trailer card must follow the last structure card containing data

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APPENDIX C

Input Needed for the Sample Problem in Appendix B Under Modified BRASS System

·2754

Card	COLUMNS 1 – 10	11 – 20	21 – 30	31 – 40	41 – 50	51 – 60	61 – 70	71
1	100 Title							
2	Area of tensile steel in positive moment region	Concrete cover	Concrete compressive strength	Grade of reinforcing steel	Girder spacing	Top flange width	Slab thickness	Number of girders
3	Number of typical X-sections	Span numbers	Span length 1	Span length 2	Span length 3	Span length 4	Span length 5	Web depth 1
4	Web depth 2	Web depth 3	Web depth 4	Web depth 5	No.of X-sections for Span 1	No.of X-sections for Span 2	No.of X-sections for Span 3	No.of X-sections for Span 4
5	No.of X-sections for Span 5	Distance to X-section change 1, Span 1	Distance to X-section change 2, Span 1	Distance to X-section change 1, Span 2	Distance to X-section change 2, Span 2	Distance to X-section change 1, Span 3	Distance to X-section change 2, Span 3	Distance to X-section change 1, Span 4
6	Distance to X-section change 2, Span 4	Distance to X-section change 1, Span 5	Distance to X-section change 2, Span 5	First X-section type, Span 1	Second X-section type, Span 1	Third X-section type, Span 1	First X-section type, Span 2	Second X-section type, Span 2
7	Third X-section type, Span 2	First X-section type, Span 3	Second X-section type, Span 3	Third X-section type, Span 3	First X-section type, Span 4	Second X-section type, Span 4	Third X-section type, Span 4	First X-section type, Span 5
8	Second X-section type, Span 5	Third X-section type, Span 5	X-section type 1	X-section type 2	X-section type 3	Web thickness, X-section, type 1	Web thickness, X-section, type 2	Web thickness, X-section, type 3
9	Bottom flange width, X-section type 1	Bottom flange width, X-section type 2	Bottom flange width, X-section type 3	Top flange width, X-section type 1	Top flange width, X-section type 2	Top flange width, X-section type 3	Top flange thickness, X-section type 1	Top flange thickness, X-section type 2
10	Top flange thickness, X-section type 3	Bottom flange thickness, X-section type 1	Bottom flange thickness, X-section type 2	Bottom flange thickness, X-section type 3	Distribution factor	Truck weight 1	Truck weight 2	Truck weight 3
11	Superimposed dead load							

APPENDIX D

Listing of the Preprocessor Subroutine in the Modified BRASS System

2756

```
      DIMENSION A(20)
      REAL V(80),OP(8),DC,BLANK
      DATA DC,BLANK/2HDC,2H  /
      DATA OP/8*0.0/
      READ(5,4000)A
      READ (5,5000)V
 4000 FORMAT(20A4)
 5000 FORMAT(8F10.0)
 8000 FORMAT(A2,I3,6F10.4)
 8100 FORMAT('999')
      WRITE(8,4000)A
      OP(1)=DC
      OP(2)=6.
      OP(3)=11.
      OP(4)=8.
      OP(5)=2.
      OP(6)=20.
      OP(7)=0.
      OP(8)=0.3
      I=IFIX(OP(2))
      WRITE(8,8000)OP(1),I,(OP(J),J=3,8)
      OP(1)=BLANK
      OP(2)=11.
      OP(3)=0
      OP(4)=V(1)
      OP(5)=0.88
      OP(6)=0
      OP(7)=0
      OP(8)=V(2)
      I=IFIX(OP(2))
      WRITE(8,8000)OP(1),I,(OP(J),J=3,8)
      OP(2)=12.
      OP(3)=V(3)
      OP(4)=V(4)
      OP(5)=0.55
      OP(6)=0.55
      OP(7)=0.4
      OP(8)=0.4
      I=IFIX(OP(2))
      WRITE(8,8000)OP(1),I,(OP(J),J=3,8)
      OP(2)=13.
      OP(3)=V(5)
      OP(4)=V(6)
      OP(5)=V(7)
      OP(6)=16.
      OP(7)=9.
      OP(8)=9.
      I=IFIX(OP(2))
      WRITE(8,8000)OP(1),I,(OP(J),J=3,8)
      OP(2)=14.
      OP(3)=0
      OP(4)=150.
      OP(5)=0
      OP(6)=1.88
      OP(7)=0
      OP(8)=0
      I=IFIX(OP(2))
      WRITE(8,8000)OP(1),I,(OP(J),J=3,8)
```

```
      OP(1)=DC
      OP(2)=1.
      OP(4)=V(8)
      OP(5)=V(9)
      OP(6)=0.
      I=IFIX(OP(2))
      WRITE(8,8000)OP(1),I,(OP(J),J=3,8)
      IC=IFIX(V(10))
      OP(4)=0
      OP(5)=0
      OP(1)=BLANK
      OP(2)=100.
      OP(3)=105.
      IF(IC.EQ.1.0)                   GO TO 70
      OP(4)=200.
      OP(5)=205.
      IF(IC.EQ.2.0)                   GO TO 70
      OP(6)=300.
      OP(7)=305.
      IF(IC.EQ.3.0)                   GO TO 70
      OP(8)=400.
      I=IFIX(OP(2))
   70 WRITE(8,8000)OP(1),I,(OP(J),J=3,8)
      IF(IC.LT.4)                     GO TO 175
   80 OP(3)=405.
      OP(4)=0
      OP(5)=0
      OP(6)=0
      OP(7)=0
      OP(8)=0
      IF(IC.EQ.4.0)                   GO TO 90
      OP(4)=500.
      OP(5)=505.
      I=IFIX(OP(2))
   90 WRITE(8,8000)OP(1),I,(OP(J),J=3,8)
  175 DO 100 I=1,IC
      OP(2)=101.
      OP(3)=I
      OP(4)=V(10+I)
      OP(5)=OP(4)
      OP(6)=0.
      OP(7)=1.0
      OP(8)=V(15+I)
      L=IFIX(OP(2))
      WRITE(8,8000)OP(1),L,(OP(J),J=3,8)
      OP(2)=102.
      OP(3)=OP(8)
      OP(4)=0
      OP(5)=0.
      OP(7)=0
      OP(8)=0
      L=IFIX(OP(2))
      WRITE(8,8000)OP(1),L,(OP(J),J=3,8)
      OP(2)=103.
      OP(3)=V(2*I+24)
      OP(4)=V(3*I+33)
      IF(V(I+20).EQ.1) GO TO 100
      OP(5)=V(2*I+24)
```

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```
      OP(6)=V(3*I+34)
      OP(7)=V(2*I+25)
      OP(8)=OP(6)
      L=IFIX(OP(2))
      WRITE(8,8000)OP(1),L,(OP(J),J=3,8)
      IF(V(I+20).EQ.2) GO TO 100
      OP(2)=104.
      OP(3)=V(2*I+25)
      OP(4)=V(3*I+35)
      OP(5)=V(I+10)
      OP(6)=OP(4)
      OP(7)=0
      OP(8)=0
      L=IFIX(OP(2))
      WRITE(8,8000)OP(1),L,(OP(J),J=3,8)
  100 CONTINUE
      DO 200 I=1,3
      IF(V(I+50).EQ.0.)GO TO 300
      OP(2)=111.
      OP(3)=I
      OP(4)=V(I+53)
      OP(5)=V(I+56)
      OP(6)=V(I+59)
      OP(7)=V(I+62)
      OP(8)=V(I+65)
      L=IFIX(OP(2))
      WRITE(8,8000)OP(1),L,(OP(J),J=3,8)
  200 CONTINUE
  300 OP(1)=DC
      OP(2)=2.
      OP(3)=0.
      OP(4)=V(69)
      OP(5)=100.
      OP(6)=V(70)
      OP(7)=V(71)
      OP(8)=V(72)
      I=IFIX(OP(2))
      WRITE(8,8000)OP(1),I,(OP(J),J=3,8)
      OP(1)=BLANK
      OP(2)=201.
      OP(3)=V(73)
      OP(4)=0.49
      OP(5)=29000.
      OP(6)=0
      OP(7)=0
      OP(8)=0
      I=IFIX(OP(2))
      WRITE(8,8000)OP(1),I,(OP(J),J=3,8)
      OP(2)=301.
      OP(3)=13.
      OP(4)=4.
      OP(5)=14.
      OP(6)=16.
      OP(7)=14.
      OP(8)=16.
      I=IFIX(OP(2))
      WRITE(8,8000)OP(1),I,(OP(J),J=3,8)
      OP(2)=302.
```

```
      OP(3)=30.
      OP(4)=0
      OP(5)=0
      OP(6)=0
      OP(7)=0
      OP(8)=0
      I=IFIX(OP(2))
      WRITE(8,8000)OP(1),I,(OP(J),J=3,8)
      OP(1)=DC
      OP(2)=5.
      OP(3)=11.
      OP(4)=1.
      I=IFIX(OP(2))
      WRITE(8,8000)OP(1),I,(OP(J),J=3,8)
      OP(1)=BLANK
      OP(2)=501.
      OP(3)=0
      OP(4)=0
      OP(6)=0.55
      I=IFIX(OP(2))
      WRITE(8,8000)OP(1),I,(OP(J),J=3,8)
      OP(2)=502.
      OP(6)=0.75
      I=IFIX(OP(2))
      WRITE(8,8000)OP(1),I,(OP(J),J=3,8)
      OP(2)=510.
      OP(3)=1.
      I=IFIX(OP(2))
      OP(4)=1.
      OP(5)=0
      OP(6)=0
      IF(V(52).EQ.0)                GO TO 400
      OP(5)=2.
      OP(6)=1.
      IF(V(53).EQ.0)                GO TO 400
      OP(7)=3.
      OP(8)=1.
  400 WRITE(8,8000)OP(1),I,(OP(J),J=3,8)
      OP(2)=530.
      OP(3)=105.
      OP(4)=2.
      OP(5)=36000.
      OP(6)=0
      OP(7)=0
      OP(8)=0
      I=IFIX(OP(2))
      WRITE(8,8000)OP(1),I,(OP(J),J=3,8)
      IF(IC.EQ.1)                 GO TO 1000
      OP(3)=200.
      I=IFIX(OP(2))
      WRITE(8,8000)OP(1),I,(OP(J),J=3,8)
      OP(3)=205.
      I=IFIX(OP(2))
      WRITE(8,8000)OP(1),I,(OP(J),J=3,8)
      IF(IC.EQ.2)                 GO TO 1000
      OP(3)=300.
      I=IFIX(OP(2))
      WRITE(8,8000)OP(1),I,(OP(J),J=3,8)
```

```
      OP(3)=305.
      I=IFIX(OP(2))
      WRITE(8,8000)OP(1),I,(OP(J),J=3,8)
      IF(IC.EQ.3)                     GO TO 1000
      OP(3)=400.
      I=IFIX(OP(2))
      WRITE(8,8000)OP(1),I,(OP(J),J=3,8)
      OP(3)=405.
      I=IFIX(OP(2))
      WRITE(8,8000)OP(1),I,(OP(J),J=3,8)
      IF(IC.EQ.4)                     GO TO 1000
      OP(3)=500.
      I=IFIX(OP(2))
      WRITE(8,8000)OP(1),I,(OP(J),J=3,8)
      OP(3)=505.
      I=IFIX(OP(2))
      WRITE(8,8000)OP(1),I,(OP(J),J=3,8)
 1000 WRITE(8,8100)
      END
```

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APPENDIX E

Output of the Sample Problem Shown in Figure 1 —
Same Output was Obtained in Both the Unmodified and the
Modified BRASS Systems

VIRGINIA DEPARTMENT OF HIGHWAYS AND TRANSPORTATION
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SAMPLE PROBLEM NO 2 WELDED PL GIRDER BRIDGE

INPUT AS RECEIVED BY COMPUTER

WORK CODE	DATA CODE	ENTRY 1	ENTRY 2	ENTRY 3	ENTRY 4	ENTRY 5	ENTRY 6	
DC	6	11.00000	8.00000	2.00000	20.00000	0.0	0.30000	
	11	0.0	0.75000	0.88000	0.0	0.0	1.38000	
	12	3250.00000	60000.0000	0.55000	0.55000	0.40000	0.40000	
	13	9.25000	14.00000	7.50000	16.00000	9.00000	9.00000	
	14	0.0	150.00000	0.0	1.88000	0.0	0.0	
DC	1	0.0	5.00000	2.00000	0.0	0.0	0.0	MIN.STIRRUPS

SAMPLE PROBLEM NO 2 WELDED PL GIRDER BRIDGE

STRESSES, MOMENTS, AND REQUIRED STEEL AREAS FOR REINFORCED CONCRETE DECK

ALLOWABLE STRESSES FOR INVENTORY RATING-- FS= 24000. PSI FC= 1300. PSI
ALLOWABLE STRESSES FOR OPERATING RATING-- FS= 33000. PSI FC= 1788. PSI

AS1= 0.0 SQ IN C1= 0.0 IN AS2= 0.75 SQ IN C2= 1.38 IN AS3= 0.88 SQ IN C3= 1.88 IN
AS4= 0.0 SQ IN C4= 0.0 IN AS5= 0.0 SQ IN C5= 0.0 IN AS6= 0.0 SQ IN C6= 0.0 IN

FIRST WHEEL LOAD (16.00 KIPS)

	POSITIVE MOMENT REGION IN SPANS	NEGATIVE MOMENT REGION IN SPANS	FIRST CANTILEVER	SECOND CANTILEVER
LIVE LOAD MOMENT=	5.547 K-FT	-5.547 K-FT	0.0 K-FT	0.0 K-FT
DEAD LOAD MOMENT=	0.704 K-FT	-0.704 K-FT	0.0 K-FT	0.0 K-FT
FS=	18.579 KSI	17.479 KSI	0.0 KSI	0.0 KSI
FSPRIME=	0.0 KSI	0.0 KSI	0.0 KSI	0.0 KSI
FC=	1.051 KSI	1.150 KSI	0.0 KSI	0.0 KSI
REQUIRED AS(TOP)	0.0 SQ IN/FT	0.880 SQ IN/FT	0.0 SQ IN/FT	0.0 SQ IN/FT
REQUIRED AS(BOT)	0.750 SQ IN/FT	0.0 SQ IN/FT	0.0 SQ IN/FT	0.0 SQ IN/FT

SECOND WHEEL LOAD (9.00 KIPS)

	POSITIVE MOMENT REGION IN SPANS	NEGATIVE MOMENT REGION IN SPANS	FIRST CANTILEVER	SECOND CANTILEVER
LIVE LOAD MOMENT=	3.120 K-FT	-3.120 K-FT	0.0 K-FT	0.0 K-FT
DEAD LOAD MOMENT=	0.704 K-FT	-0.704 K-FT	0.0 K-FT	0.0 K-FT
FS=	11.366 KSI	10.693 KSI	0.0 KSI	0.0 KSI
FSPRIME=	0.0 KSI	0.0 KSI	0.0 KSI	0.0 KSI
FC=	0.643 KSI	0.703 KSI	0.0 KSI	0.0 KSI
REQUIRED AS(TOP)	0.0 SQ IN/FT	0.880 SQ IN/FT	0.0 SQ IN/FT	0.0 SQ IN/FT
REQUIRED AS(BOT)	0.750 SQ IN/FT	0.0 SQ IN/FT	0.0 SQ IN/FT	0.0 SQ IN/FT

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SAMPLE PROBLEM NO 2 WELDED PL GIRDER BRIDGE

THIRD WHEEL LOAD (9.00 KIPS)

	POSITIVE MOMENT REGION IN SPANS	NEGATIVE MOMENT REGION IN SPANS	FIRST CANTILEVER	SECOND CANTILEVER
LIVE LOAD MOMENT=	3.120 K-FT	-3.120 K-FT	0.0 K-FT	0.0 K-FT
DEAD LOAD MOMENT=	0.704 K-FT	-0.704 K-FT	0.0 K-FT	0.0 K-FT
FS=	11.366 KSI	10.693 KSI	0.0 KSI	0.0 KSI
FSPRIME=	0.0 KSI	0.0 KSI	0.0 KSI	0.0 KSI
FC=	0.643 KSI	0.703 KSI	0.0 KSI	0.0 KSI
REQUIRED AS(TOP)	0.0 SQ IN/FT	0.880 SQ IN/FT	0.0 SQ IN/FT	0.0 SQ IN/FT
REQUIRED AS(BOT)	0.750 SQ IN/FT	0.0 SQ IN/FT	0.0 SQ IN/FT	0.0 SQ IN/FT

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SAMPLE PROBLEM NO 2 WELDED PL GIRDER BRIDGE

INPUT AS RECEIVED BY COMPUTER

WORK CODE	DATA CODE	ENTRY 1	ENTRY 2	ENTRY 3	ENTRY 4	ENTRY 5	ENTRY 6
DC	1	0.0	5.00000	2.00000	0.0	0.0	0.0
	100	105.00000	200.00000	205.00000	300.00000	305.00000	400.00000
	100	405.00000	500.00000	505.00000	0.0	0.0	0.0
	101	1.00000	110.00000	110.00000	0.0	1.00000	87.00000
	102	87.00000	0.0	0.0	0.0	0.0	0.0
	103	87.50000	1.00000	87.50000	2.00000	110.00000	2.00000
	101	2.00000	137.00000	137.00000	0.0	1.00000	87.00000
	102	87.00000	0.0	0.0	0.0	0.0	0.0
	103	26.50000	2.00000	26.50000	1.00000	110.50000	1.00000
	104	110.50000	2.00000	137.00000	2.00000	0.0	0.0
	101	3.00000	137.00000	137.00000	0.0	1.00000	87.00000
	102	87.00000	0.0	0.0	0.0	0.0	0.0
	103	26.50000	2.00000	26.50000	1.00000	110.50000	1.00000
	104	110.50000	2.00000	137.00000	2.00000	0.0	0.0
	101	4.00000	137.00000	137.00000	0.0	1.00000	87.00000
	102	87.00000	0.0	0.0	0.0	0.0	0.0
	103	26.50000	2.00000	26.50000	1.00000	110.50000	1.00000
	104	110.50000	2.00000	137.00000	2.00000	0.0	0.0
	101	5.00000	110.00000	110.00000	0.0	1.00000	87.00000
	102	87.00000	0.0	0.0	0.0	0.0	0.0
	103	22.50000	2.00000	22.50000	1.00000	110.00000	1.00000
	111	1.00000	0.31250	14.00000	14.00000	0.87500	0.87500
	111	2.00000	0.31250	14.00000	14.00000	1.12500	1.12500

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SAMPLE PROBLEM NO 2 WELDED PL GIRDER BRIDGE

INPUT AS RECEIVED BY COMPUTER

WORK CODE	DATA CODE	ENTRY 1	ENTRY 2	ENTRY 3	ENTRY 4	ENTRY 5	ENTRY 6
DC	2	0.0	1.68180	100.00000	36.00000	0.0	0.0
	201	0.95000	0.49000	29000.0000	0.0	0.0	0.0
	301	13.00000	4.00000	14.00000	16.00000	14.00000	16.00000
	302	30.00000	0.0	0.0	0.0	0.0	0.0
DC	5	11.00000	1.00000	0.0	0.0	0.0	0.0

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SAMPLE PROBLEM NO 2 WELDED PL GIRDER BRIDGE

INPUT AS RECEIVED BY THE COMPUTER

WORK CODE	DATA CODE	ENTRY 1	ENTRY 2	ENTRY 3	ENTRY 4	ENTRY 5	ENTRY 6	
DC	5	11.00000	1.00000	0.0	0.0	0.0	0.0	0
	501	0.0	0.0	0.0	0.55000	0.0	0.0	0
	502	0.0	0.0	0.0	0.75000	0.0	0.0	0
	510	1.00000	1.00000	2.00000	1.00000	0.0	0.0	0
	530	105.00000	2.00000	36000.0000	0.0	0.0	0.0	0
	530	200.00000	2.00000	36000.0000	0.0	0.0	0.0	0
	530	205.00000	2.00000	36000.0000	0.0	0.0	0.0	0
	530	300.00000	2.00000	36000.0000	0.0	0.0	0.0	0
	530	305.00000	2.00000	36000.0000	0.0	0.0	0.0	0
	530	400.00000	2.00000	36000.0000	0.0	0.0	0.0	0
	530	405.00000	2.00000	36000.0000	0.0	0.0	0.0	0
	530	500.00000	2.00000	36000.0000	0.0	0.0	0.0	0
	530	505.00000	2.00000	36000.0000	0.0	0.0	0.0	0

****

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SAMPLE PROBLEM NO 2 WELDED PL GIRDER BRIDGE

STRUCTURAL STEEL REVIEW

SPAN 1 @ 5 TENTHS POINT

INPUT SECTION DIMENSIONS

DEPTH OF WEB	87.00	TOP FLANGE THICKNESS	0.88	BOTTOM FLANGE THICKNESS	0.88
THICKNESS OF WEB	0.31	TOP FLANGE WIDTH	14.00	BOTTOM FLANGE WIDTH	14.00

MATERIALS FACTOR

YIELD STRENGTH OF WEB 36000. YIELD STR. OF TOP FLNG. 36000. YIELD STR. OF BOT. FLNG. 36000.

APPLIED ACTIONS

	DEAD LOAD	TRUCK # 1 POSITIVE	TRUCK # 1 NEGATIVE	TRUCK # 2 POSITIVE	TRUCK # 2 NEGATIVE	TRUCK # 3 POSITIVE	TRUCK # 3 NEGATIVE
MOMENT Z-Z	805.65	1368.99	-455.24	0.0	0.0	0.0	0.0
SHEAR Y-Z	-16.31	36.81		0.0		0.0	
AXIAL X-X	0.0	0.0	0.0	0.25	0.25	0.25	0.25

FIRST LOADING

ALLOWABLE STRESSES

FLEXURE, T. FL.	19800.	FLEXURE, B. FL.	19800.
FLEXURE,IN WEB	19800.	COMPOSITE CONCRETE	0.
SHEAR IN WEB	11880.	BEARING STIFFENERS	0.

ACTUAL STRESSES

DESIGN POINTS

	ONE	TWO	THREE	FOUR	FIVE	SIX	SEVEN
SHEAR-N(HORIZONTAL)	0.	0.	1420.	2200.	1420.	0.	0.
SHEAR-P(HORIZONTAL)	0.	0.	1420.	2200.	1420.	0.	0.
SHEAR IN WEB (VERTICAL)				1954.			

MINIMUM WEB THICKNESS CRITERIA

WITH OUT STIFFENERS 0.580 WITH TRANSVERSE STIFF. 0.350 WITH LONGITUDINAL STIFF. 0.256

STIFFENER DATA

TRANSVERSE STIFFENER-SPACING 77.76 MOMENT OF INERTIA 2.45

LONGITUDINAL STIFFENER-MOMENT OF INERTIA 4.75 WIDTH 4.45 THICKNESS 0.16

SAMPLE PROBLEM NO 2 WELDED PL GIRDER BRIDGE

STRUCTURAL STEEL REVIEW

SPAN 2 @ 0 TENTHS POINT

INPUT SECTION DIMENSIONS

DEPTH OF WEB	87.00	TOP FLANGE THICKNESS	1.13	BOTTOM FLANGE THICKNESS	1.13
THICKNESS OF WEB	0.31	TOP FLANGE WIDTH	14.00	BOTTOM FLANGE WIDTH	14.00

MATERIALS FACTOR

YIELD STRENGTH OF WEB 36000. YIELD STR. OF TOP FLNG. 36000. YIELD STR. OF BOT. FLNG. 36000.

APPLIED ACTIONS

	DEAD LOAD	TRUCK # 1 POSITIVE	TRUCK # 1 NEGATIVE	TRUCK # 2 POSITIVE	TRUCK # 2 NEGATIVE	TRUCK # 3 POSITIVE	TRUCK # 3 NEGATIVE
MOMENT Z-Z	-1803.13	254.43	-901.80	0.0	0.0	0.0	0.0
SHEAR Y-Z	77.39	68.42		0.0		0.0	
AXIAL X-X	0.0	0.0	0.0	0.25	0.25	0.25	0.25

FIRST LOADING

ALLOWABLE STRESSES

FLEXURE, T. FL.	19800.	FLEXURE, B. FL.	19800.
FLEXURE, IN WEB	19800.	COMPOSITE CONCRETE	0.
SHEAR IN WEB	11880.	BEARING STIFFENERS	15982.

ACTUAL STRESSES

DESIGN POINTS

	ONE	TWO	THREE	FOUR	FIVE	SIX	SEVEN
SHEAR-N(HORIZONTAL)	0.	0.	4135.	5897.	4135.	0.	0.
SHEAR-P(HORIZONTAL)	0.	0.	4135.	5897.	4135.	0.	0.
SHEAR IN WEB (VERTICAL)				5363.			

MINIMUM WEB THICKNESS CRITERIA

WITH OUT STIFFENERS 0.850 WITH TRANSVERSE STIFF. 0.579 WITH LONGITUDINAL STIFF. 0.257

STIFFENER DATA

TRANSVERSE STIFFENER-SPACING 46.94 MOMENT OF INERTIA 8.64

LONGITUDINAL STIFFENER-MOMENT OF INERTIA 1.51 WIDTH 2.94 THICKNESS 0.18

BEARING STIFFENERS -AREA 0.0 WIDTH 6.50 THICKNESS 1.00

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SAMPLE PROBLEM NO 2 WELDED PL GIRDER BRIDGE

STRUCTURAL STEEL REVIEW

SPAN 2 @ 5 TENTHS POINT

INPUT SECTION DIMENSIONS

DEPTH OF WEB	87.00	TOP FLANGE THICKNESS	0.88	BOTTOM FLANGE THICKNESS	0.88
THICKNESS OF WEB	0.31	TOP FLANGE WIDTH	14.00	BOTTOM FLANGE WIDTH	14.00

MATERIALS FACTOR

YIELD STRENGTH OF WEB 36000. YIELD STR. OF TOP FLNG. 36000. YIELD STR. OF BOT. FLNG. 36000.

APPLIED ACTIONS

	DEAD LOAD	TRUCK # 1 POSITIVE	TRUCK # 1 NEGATIVE	TRUCK # 2 POSITIVE	TRUCK # 2 NEGATIVE	TRUCK # 3 POSITIVE	TRUCK # 3 NEGATIVE
MOMENT Z-Z	839.08	1371.60	-307.48	0.0	0.0	0.0	0.0
SHEAR Y-Z	-0.05	30.52		0.0		0.0	
AXIAL X-X	0.0	0.0	0.0	0.25	0.25	0.25	0.25

FIRST LOADING

ALLOWABLE STRESSES

FLEXURE, T. FL.	19800.	FLEXURE, B. FL.	19800.
FLEXURE,IN WEB	19800.	COMPOSITE CONCRETE	0.
SHEAR IN WEB	11880.	BEARING STIFFENERS	0.

ACTUAL STRESSES

DESIGN POINTS

	ONE	TWO	THREE	FOUR	FIVE	SIX	SEVEN
SHEAR-N(HORIZONTAL)	0.	0.	0.	0.	0.	0.	0.
SHEAR-P(HORIZONTAL)	0.	0.	814.	1262.	814.	0.	0.
SHEAR IN WEB (VERTICAL)				1121.			

MINIMUM WEB THICKNESS CRITERIA

WITH OUT STIFFENERS 0.580 WITH TRANSVERSE STIFF. 0.265 WITH LONGITUDINAL STIFF. 0.256

STIFFENER DATA

TRANSVERSE STIFFENER-SPACING 87.00 MOMENT OF INERTIA 1.22

LONGITUDINAL STIFFENER-MOMENT OF INERTIA 6.03 WIDTH 4.17 THICKNESS 0.25

SAMPLE PROBLEM NO 2 WELDED PL GIRDER BRIDGE

STRUCTURAL STEEL REVIEW

SPAN 3 @ 0 TENTHS POINT

INPUT SECTION DIMENSIONS

DEPTH OF WEB	87.00	TOP FLANGE THICKNESS	1.13	BOTTOM FLANGE THICKNESS	1.13
THICKNESS OF WEB	0.31	TOP FLANGE WIDTH	14.00	BOTTOM FLANGE WIDTH	14.00

MATERIALS FACTOR

YIELD STRENGTH OF WEB 36000. YIELD STR. OF TOP FLNG. 36000. YIELD STR. OF BOT. FLNG. 36000.

APPLIED ACTIONS

	DEAD LOAD	TRUCK # 1 POSITIVE	TRUCK # 1 NEGATIVE	TRUCK # 2 POSITIVE	TRUCK # 2 NEGATIVE	TRUCK # 3 POSITIVE	TRUCK # 3 NEGATIVE
MOMENT Z-Z	-1810.54	244.29	-864.08	0.0	0.0	0.0	0.0
SHEAR Y-Z	77.45	68.33		0.0		0.0	
AXIAL X-X	0.0	0.0	0.0	0.25	0.25	0.25	0.25

FIRST LOADING

ALLOWABLE STRESSES

FLEXURE, T. FL.	19800.	FLEXURE, B. FL.	19800.
FLEXURE, IN WEB	19800.	COMPOSITE CONCRETE	0.
SHEAR IN WEB	11880.	BEARING STIFFENERS	15982.

ACTUAL STRESSES

DESIGN POINTS	ONE	TWO	THREE	FOUR	FIVE	SIX	SEVEN
SHEAR-N(HORIZONTAL)	0.	0.	4134.	5895.	4134.	0.	0.
SHEAR-P(HORIZONTAL)	0.	0.	4134.	5895.	4134.	0.	0.
SHEAR IN WEB (VERTICAL)				5362.			

MINIMUM WEB THICKNESS CRITERIA

WITH OUT STIFFENERS 0.849 WITH TRANSVERSE STIFF. 0.579 WITH LONGITUDINAL STIFF. 0.256

STIFFENER DATA

TRANSVERSE STIFFENER-SPACING 46.94 MOMENT OF INERTIA 8.64

LONGITUDINAL STIFFENER-MOMENT OF INERTIA 1.51 WIDTH 2.95 THICKNESS 0.18

BEARING STIFFENERS -AREA 0.0 WIDTH 6.50 THICKNESS 1.00

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SAMPLE PROBLEM NO 2 WELDED PL GIRDER BRIDGE

STRUCTURAL STEEL REVIEW

SPAN 3 @ 5 TENTHS POINT

INPUT SECTION DIMENSIONS

DEPTH OF WEB	87.00	TOP FLANGE THICKNESS	0.88	BOTTOM FLANGE THICKNESS	0.88
THICKNESS OF WEB	0.31	TOP FLANGE WIDTH	14.00	BOTTOM FLANGE WIDTH	14.00

MATERIALS FACTOR

YIELD STRENGTH OF WEB 36000. YIELD STR. OF TOP FLNG. 36000. YIELD STR. OF BOT. FLNG. 36000.

APPLIED ACTIONS

	DEAD LOAD	TRUCK # 1 POSITIVE	TRUCK # 1 NEGATIVE	TRUCK # 2 POSITIVE	TRUCK # 2 NEGATIVE	TRUCK # 3 POSITIVE	TRUCK # 3 NEGATIVE
MOMENT Z-Z	835.38	1380.24	-305.60	0.0	0.0	0.0	0.0
SHEAR Y-Z	-0.00	30.27		0.0		0.0	
AXIAL X-X	0.0	0.0	0.0	0.25	0.25	0.25	0.25

FIRST LOADING

ALLOWABLE STRESSES

FLEXURE, T. FL.	19800.	FLEXURE, B. FL.	19800.
FLEXURE, IN WEB	19800.	COMPOSITE CONCRETE	0.
SHEAR IN WEB	11880.	BEARING STIFFENERS	0.

ACTUAL STRESSES

DESIGN POINTS	ONE	TWO	THREE	FOUR	FIVE	SIX	SEVEN
SHEAR-N(HORIZONTAL)	0.	0.	809.	1253.	809.	0.	0.
SHEAR-P(HORIZONTAL)	0.	0.	809.	1253.	809.	0.	0.
SHEAR IN WEB (VERTICAL)				1113.			

MINIMUM WEB THICKNESS CRITERIA

WITH OUT STIFFENERS 0.580 WITH TRANSVERSE STIFF. 0.264 WITH LONGITUDINAL STIFF. 0.256

STIFFENER DATA

TRANSVERSE STIFFENER-SPACING 87.00 MOMENT OF INERTIA 1.22

LONGITUDINAL STIFFENER-MOMENT OF INERTIA 6.03 WIDTH 4.70 THICKNESS 0.17

SAMPLE PROBLEM NO 2 WELDED PL GIRDER BRIDGE

STRUCTURAL STEEL REVIEW

SPAN 4 @ 0 TENTHS POINT

INPUT SECTION DIMENSIONS

DEPTH OF WEB	87.00	TOP FLANGE THICKNESS	1.13	BOTTOM FLANGE THICKNESS	1.13
THICKNESS OF WEB	0.31	TOP FLANGE WIDTH	14.00	BOTTOM FLANGE WIDTH	14.00

MATERIALS FACTOR

YIELD STRENGTH OF WEB 36000. YIELD STR. OF TOP FLNG. 36000. YIELD STR. OF BOT. FLNG. 36000.

APPLIED ACTIONS

	DEAD LOAD	TRUCK # 1 POSITIVE	TRUCK # 1 NEGATIVE	TRUCK # 2 POSITIVE	TRUCK # 2 NEGATIVE	TRUCK # 3 POSITIVE	TRUCK # 3 NEGATIVE
MOMENT Z-Z	-1810.54	244.29	-864.08	0.0	0.0	0.0	0.0
SHEAR Y-Z	77.50	68.29		0.0		0.0	
AXIAL X-X	0.0	0.0	0.0	0.25	0.25	0.25	0.25

FIRST LOADING

ALLOWABLE STRESSES

FLEXURE, T. FL.	19800.	FLEXURE, B. FL.	19800.
FLEXURE, IN WEB	19800.	COMPOSITE CONCRETE	0.
SHEAR IN WEB	11880.	BEARING STIFFENERS	15982.

ACTUAL STRESSES

DESIGN POINTS	ONE	TWO	THREE	FOUR	FIVE	SIX	SEVEN
SHEAR-N(HORIZONTAL)	0.	0.	4134.	5896.	4134.	0.	0.
SHEAR-P(HORIZONTAL)	0.	0.	4134.	5896.	4134.	0.	0.
SHEAR IN WEB (VERTICAL)				5362.			

MINIMUM WEB THICKNESS CRITERIA

WITH OUT STIFFENERS 0.849 WITH TRANSVERSE STIFF. 0.579 WITH LONGITUDINAL STIFF. 0.256

STIFFENER DATA

TRANSVERSE STIFFENER-SPACING 46.94 MOMENT OF INERTIA 8.64

LONGITUDINAL STIFFENER-MOMENT OF INERTIA 1.51 WIDTH 2.95 THICKNESS 0.18

BEARING STIFFENERS -AREA 0.0 WIDTH 6.50 THICKNESS 1.00

SAMPLE PROBLEM NO 2 WELDED PL GIRDER BRIDGE

STRUCTURAL STEEL REVIEW

SPAN 4 @ 5 TENTHS POINT

INPUT SECTION DIMENSIONS

DEPTH OF WEB 87.00 TOP FLANGE THICKNESS 0.88 BOTTOM FLANGE THICKNESS 0.88
THICKNESS OF WEB 0.31 TOP FLANGE WIDTH 14.00 BOTTOM FLANGE WIDTH 14.00

MATERIALS FACTOR

YIELD STRENGTH OF WEB 36000. YIELD STR. OF TOP FLNG. 36000. YIELD STR. OF BOT. FLNG. 36000.

APPLIED ACTIONS

	DEAD LOAD	TRUCK # 1 POSITIVE	TRUCK # 1 NEGATIVE	TRUCK # 2 POSITIVE	TRUCK # 2 NEGATIVE	TRUCK # 3 POSITIVE	TRUCK # 3 NEGATIVE
MOMENT Z-Z	839.08	1371.60	-304.82	0.0	0.0	0.0	0.0
SHEAR Y-Z	0.05	30.52		0.0		0.0	
AXIAL X-X	0.0	0.0	0.0	0.25	0.25	0.25	0.25

FIRST LOADING

ALLOWABLE STRESSES

FLEXURE, T. FL. 19800. FLEXURE, B. FL. 19800.
FLEXURE, IN WEB 19800. COMPOSITE CONCRETE 0.
SHEAR IN WEB 11880. BEARING STIFFENERS 0.

ACTUAL STRESSES

DESIGN POINTS

	ONE	TWO	THREE	FOUR	FIVE	SIX	SEVEN
SHEAR-N(HORIZONTAL)	0.	0.	814.	1262.	814.	0.	0.
SHEAR-P(HORIZONTAL)	0.	0.	814.	1262.	814.	0.	0.
SHEAR IN WEB (VERTICAL)				1121.			

MINIMUM WEB THICKNESS CRITERIA

WITH OUT STIFFENERS 0.580 WITH TRANSVERSE STIFF. 0.265 WITH LONGITUDINAL STIFF. 0.256

STIFFENER DATA

TRANSVERSE STIFFENER-SPACING 87.00 MOMENT OF INERTIA 1.22
LONGITUDINAL STIFFENER-MOMENT OF INERTIA 6.03 WIDTH 4.70 THICKNESS 0.17

SAMPLE PROBLEM NO 2 WELDED PL GIRDER BRIDGE

STRUCTURAL STEEL REVIEW

SPAN 5 @ 0 TENTHS POINT

INPUT SECTION DIMENSIONS

DEPTH OF WEB	87.00	TOP FLANGE THICKNESS	1.13	BOTTOM FLANGE THICKNESS	1.13
THICKNESS OF WEB	0.31	TOP FLANGE WIDTH	14.00	BOTTOM FLANGE WIDTH	14.00

MATERIALS FACTOR

YIELD STRENGTH OF WEB 36000. YIELD STR. OF TOP FLNG. 36000. YIELD STR. OF BOT. FLNG. 36000.

APPLIED ACTIONS

	DEAD LOAD	TRUCK # 1 POSITIVE	TRUCK # 1 NEGATIVE	TRUCK # 2 POSITIVE	TRUCK # 2 NEGATIVE	TRUCK # 3 POSITIVE	TRUCK # 3 NEGATIVE
MOMENT Z-Z	-1803.14	259.12	-901.80	0.0	0.0	0.0	0.0
SHEAR Y-Z	78.76	69.50		0.0		0.0	
AXIAL X-X	0.0	0.0	0.0	0.25	0.25	0.25	0.25

FIRST LOADING

ALLOWABLE STRESSES

FLEXURE, T. FL.	19800.	FLEXURE, B. FL.	19800.
FLEXURE, IN WEB	19800.	COMPOSITE CONCRETE	0.
SHEAR IN WEB	11880.	BEARING STIFFENERS	15982.

ACTUAL STRESSES

DESIGN POINTS

	ONE	TWO	THREE	FOUR	FIVE	SIX	SEVEN
SHEAR-N(HORIZONTAL)	0.	0.	4204.	5996.	4204.	0.	0.
SHEAR-P(HORIZONTAL)	0.	0.	4204.	5996.	4204.	0.	0.
SHEAR IN WEB (VERTICAL)				5453.			

MINIMUM WEB THICKNESS CRITERIA

WITH OUT STIFFENERS 0.857 WITH TRANSVERSE STIFF. 0.584 WITH LONGITUDINAL STIFF. 0.257

STIFFENER DATA

TRANSVERSE STIFFENER-SPACING 46.55 MOMENT OF INERTIA 8.76

LONGITUDINAL STIFFENER-MOMENT OF INERTIA 1.48 WIDTH 2.93 THICKNESS 0.18

BEARING STIFFENERS -AREA 0.0 WIDTH 6.50 THICKNESS 1.00

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SAMPLE PROBLEM NO 2 WELDED PL GIRDER BRIDGE

STRUCTURAL STEEL REVIEW

SPAN 5 @ 5 TENTHS POINT

INPUT SECTION DIMENSIONS

DEPTH OF WEB	87.00	TOP FLANGE THICKNESS	0.88	BOTTOM FLANGE THICKNESS	0.88
THICKNESS OF WEB	0.31	TOP FLANGE WIDTH	14.00	BOTTOM FLANGE WIDTH	14.00

MATERIALS FACTOR

YIELD STRENGTH OF WEB 36000. YIELD STR. OF TOP FLNG. 36000. YIELD STR. OF BOT. FLNG. 36000.

APPLIED ACTIONS

	DEAD LOAD	TRUCK # 1 POSITIVE	TRUCK # 1 NEGATIVE	TRUCK # 2 POSITIVE	TRUCK # 2 NEGATIVE	TRUCK # 3 POSITIVE	TRUCK # 3 NEGATIVE
MOMENT Z-Z	805.65	1368.99	-450.90	0.0	0.0	0.0	0.0
SHEAR Y-Z	16.31	36.81		0.0		0.0	
AXIAL X-X	0.0	0.0	0.0	0.25	0.25	0.25	0.25

FIRST LOADING

ALLOWABLE STRESSES

FLEXURE, T. FL.	19800.	FLEXURE, B. FL.	19800.
FLEXURE, IN WEB	19800.	COMPOSITE CONCRETE	0.
SHEAR IN WEB	11880.	BEARING STIFFENERS	0.

ACTUAL STRESSES

DESIGN POINTS	ONE	TWO	THREE	FOUR	FIVE	SIX	SEVEN
SHEAR-N(HORIZONTAL)	0.	0.	0.	0.	0.	0.	0.
SHEAR-P(HORIZONTAL)	0.	0.	1420.	2200.	1420.	0.	0.
SHEAR IN WEB (VERTICAL)				1954.			

MINIMUM WEB THICKNESS CRITERIA

WITH OUT STIFFENERS 0.580 WITH TRANSVERSE STIFF. 0.350 WITH LONGITUDINAL STIFF. 0.256

STIFFENER DATA

TRANSVERSE STIFFENER-SPACING 77.76 MOMENT OF INERTIA 2.45

LONGITUDINAL STIFFENER-MOMENT OF INERTIA 4.75 WIDTH 3.93 THICKNESS 0.23

SAMPLE PROBLEM NO 2 WELDED PL GIRDER BRIDGE

INVENTORY RATING FOR SPAN 1 @ 5 TENTH (LOAD 1)

	TOP FLANGE FLEXURE	VERTICAL SHEAR	HORIZONTAL SHEAR	BEARING STIFFENERS (COMP)	BEARING STIFFENERS (BEARING)	HORIZONTAL SHEAR (COV PLTS)	BOT FLANGE FLEXURE
POS.M.	1.162	4.886	4.367	*****	*****	*****	1.162
NEG.M.	*****	4.886	4.367	*****	*****	*****	*****

OPERATING RATING FOR SPAN 1 @ 5 TENTH (LOAD 1)

	TOP FLANGE FLEXURE	VERTICAL SHEAR	HORIZONTAL SHEAR	BEARING STIFFENERS (COMP)	BEARING STIFFENERS (BEARING)	HORIZONTAL SHEAR (COV PLTS)	BOT FLANGE FLEXURE
POS.M.	1.798	6.578	5.869	*****	*****	*****	1.798
NEG.M.	*****	6.578	5.869	*****	*****	*****	*****

INVENTORY RATING FOR SPAN 2 @ 0 TENTH (LOAD 1)

	TOP FLANGE FLEXURE	VERTICAL SHEAR	HORIZONTAL SHEAR	BEARING STIFFENERS (COMP)	BEARING STIFFENERS (BEARING)	HORIZONTAL SHEAR (COV PLTS)	BOT FLANGE FLEXURE
POS.M.	*****	3.590	3.162	*****	*****	*****	*****
NEG.M.	1.211	3.590	3.162	*****	*****	*****	1.211

OPERATING RATING FOR SPAN 2 @ 0 TENTH (LOAD 1)

	TOP FLANGE FLEXURE	VERTICAL SHEAR	HORIZONTAL SHEAR	BEARING STIFFENERS (COMP)	BEARING STIFFENERS (BEARING)	HORIZONTAL SHEAR (COV PLTS)	BOT FLANGE FLEXURE
POS.M.	*****	5.306	4.724	*****	*****	*****	*****
NEG.M.	2.379	5.306	4.724	*****	*****	*****	2.379

INVENTORY RATING FOR SPAN 2 @ 5 TENTH (LOAD 1)

	TOP FLANGE FLEXURE	VERTICAL SHEAR	HORIZONTAL SHEAR	BEARING STIFFENERS (COMP)	BEARING STIFFENERS (BEARING)	HORIZONTAL SHEAR (COV PLTS)	BOT FLANGE FLEXURE
POS.M.	1.135	*****	9.401	*****	*****	*****	1.135

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SAMPLE PROBLEM NO 2 WELDED PL GIRDER BRIDGE

OPERATING RATING FOR SPAN 2 @ 5 TENTH (LOAD 1)

	TOP FLANGE FLEXURE	VERTICAL SHEAR	HORIZONTAL SHEAR	BEARING STIFFENERS (COMP)	BEARING STIFFENERS (BEARING)	HORIZONTAL SHEAR (COV PLTS)	BOT FLANGE FLEXURE
POS.M.	1.771	*****	*****	*****	*****	*****	1.771

INVENTORY RATING FOR SPAN 3 @ 0 TENTH (LOAD 1)

	TOP FLANGE FLEXURE	VERTICAL SHEAR	HORIZONTAL SHEAR	BEARING STIFFENERS (COMP)	BEARING STIFFENERS (BEARING)	HORIZONTAL SHEAR (COV PLTS)	BOT FLANGE FLEXURE
POS.M.	*****	3.593	3.166	*****	*****	*****	*****
NEG.M.	1.256	3.593	3.166	*****	*****	*****	1.256

OPERATING RATING FOR SPAN 3 @ 0 TENTH (LOAD 1)

	TOP FLANGE FLEXURE	VERTICAL SHEAR	HORIZONTAL SHEAR	BEARING STIFFENERS (COMP)	BEARING STIFFENERS (BEARING)	HORIZONTAL SHEAR (COV PLTS)	BOT FLANGE FLEXURE
POS.M.	*****	5.312	4.729	*****	*****	*****	*****
NEG.M.	2.474	5.312	4.729	*****	*****	*****	2.474

INVENTORY RATING FOR SPAN 3 @ 5 TENTH (LOAD 1)

	TOP FLANGE FLEXURE	VERTICAL SHEAR	HORIZONTAL SHEAR	BEARING STIFFENERS (COMP)	BEARING STIFFENERS (BEARING)	HORIZONTAL SHEAR (COV PLTS)	BOT FLANGE FLEXURE
POS.M.	1.131	*****	9.480	*****	*****	*****	1.131
NEG.M.	*****	*****	9.480	*****	*****	*****	*****

OPERATING RATING FOR SPAN 3 @ 5 TENTH (LOAD 1)

	TOP FLANGE FLEXURE	VERTICAL SHEAR	HORIZONTAL SHEAR	BEARING STIFFENERS (COMP)	BEARING STIFFENERS (BEARING)	HORIZONTAL SHEAR (COV PLTS)	BOT FLANGE FLEXURE
POS.M.	1.762	*****	*****	*****	*****	*****	1.762
NEG.M.	*****	*****	*****	*****	*****	*****	*****

SAMPLE PROBLEM NO 2 WELDED PL GIRDER BRIDGE

INVENTORY RATING FOR SPAN 4 @ 0 TENTH (LOAD 1)

	TOP FLANGE FLEXURE	VERTICAL SHEAR	HORIZONTAL SHEAR	BEARING STIFFENERS (COMP)	BEARING STIFFENERS (BEARING)	HORIZONTAL SHEAR (COV PLTS)	BOT FLANGE FLEXURE
POS.M.	*****	3.595	3.167	*****	*****	*****	*****
NEG.M.	1.256	3.595	3.167	*****	*****	*****	1.256

OPERATING RATING FOR SPAN 4 @ 0 TENTH (LOAD 1)

	TOP FLANGE FLEXURE	VERTICAL SHEAR	HORIZONTAL SHEAR	BEARING STIFFENERS (COMP)	BEARING STIFFENERS (BEARING)	HORIZONTAL SHEAR (COV PLTS)	BOT FLANGE FLEXURE
POS.M.	*****	5.315	4.731	*****	*****	*****	*****
NEG.M.	2.474	5.315	4.731	*****	*****	*****	2.474

INVENTORY RATING FOR SPAN 4 @ 5 TENTH (LOAD 1)

	TOP FLANGE FLEXURE	VERTICAL SHEAR	HORIZONTAL SHEAR	BEARING STIFFENERS (COMP)	BEARING STIFFENERS (BEARING)	HORIZONTAL SHEAR (COV PLTS)	BOT FLANGE FLEXURE
POS.M.	1.135	*****	9.431	*****	*****	*****	1.135
NEG.M.	*****	*****	9.431	*****	*****	*****	*****

OPERATING RATING FOR SPAN 4 @ 5 TENTH (LOAD 1)

	TOP FLANGE FLEXURE	VERTICAL SHEAR	HORIZONTAL SHEAR	BEARING STIFFENERS (COMP)	BEARING STIFFENERS (BEARING)	HORIZONTAL SHEAR (COV PLTS)	BOT FLANGE FLEXURE
POS.M.	1.771	*****	*****	*****	*****	*****	1.771
NEG.M.	*****	*****	*****	*****	*****	*****	*****

INVENTORY RATING FOR SPAN 5 @ 0 TENTH (LOAD 1)

	TOP FLANGE FLEXURE	VERTICAL SHEAR	HORIZONTAL SHEAR	BEARING STIFFENERS (COMP)	BEARING STIFFENERS (BEARING)	HORIZONTAL SHEAR (COV PLTS)	BOT FLANGE FLEXURE
POS.M.	*****	3.514	3.094	*****	*****	*****	*****
NEG.M.	1.211	3.514	3.094	*****	*****	*****	1.211

VIRGINIA DEPARTMENT OF HIGHWAYS AND TRANSPORTATION
BRIDGE DIVISION

SAMPLE PROBLEM NO 2 WELDED PL GIRDER BRIDGE

OPERATING RATING FOR SPAN 5 @ 0 TENTH (LOAD 1)

	TOP FLANGE FLEXURE	VERTICAL SHEAR	HORIZONTAL SHEAR	BEARING STIFFENERS (COMP)	BEARING STIFFENERS (BEARING)	HORIZONTAL SHEAR (COV PLTS)	BOT FLANGE FLEXURE
POS.M.	*****	5.204	4.631	*****	*****	*****	*****
NEG.M.	2.379	5.204	4.631	*****	*****	*****	2.379

INVENTORY RATING FOR SPAN 5 @ 5 TENTH (LOAD 1)

	TOP FLANGE FLEXURE	VERTICAL SHEAR	HORIZONTAL SHEAR	BEARING STIFFENERS (COMP)	BEARING STIFFENERS (BEARING)	HORIZONTAL SHEAR (COV PLTS)	BOT FLANGE FLEXURE
POS.M.	1.162	8.331	7.351	*****	*****	*****	1.162

OPERATING RATING FOR SPAN 5 @ 5 TENTH (LOAD 1)

	TOP FLANGE FLEXURE	VERTICAL SHEAR	HORIZONTAL SHEAR	BEARING STIFFENERS (COMP)	BEARING STIFFENERS (BEARING)	HORIZONTAL SHEAR (COV PLTS)	BOT FLANGE FLEXURE
POS.M.	1.798	*****	*****	*****	*****	*****	1.798

INVENTORY RATING FOR CONCRETE DECK (LOAD 1)

	POSITIVE STEEL	NEGATIVE STEEL	CONCRETE FLEXURE	STIRRUPS
POS M.	1.329	********	1.268	********
NEG M.	1.420	********	1.147	********

OPERATING RATING FOR CONCRETE DECK (LOAD 1)

	POSITIVE STEEL	NEGATIVE STEEL	CONCRETE FLEXURE	STIRRUPS
POS M.	1.875	********	1.791	********
NEG M.	2.001	********	1.625	********

SAMPLE PROBLEM NO 2 WELDED PL GIRDER BRIDGE

LOAD RATING SUMMARY SHEET

INVENTORY RATING
CONTROL POINT--SPAN 3 @ 5 TENTH (LOAD 1)

STEEL SECTION I (TOP FLANGE FLEXURE)
POSITIVE MOMENT RATING FACTOR = 1.131
LOAD RATING = 40.714 TONS

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APPENDIX F

Input Needed for BRRAT Program to Solve the Sample Problem of Figure 1

```
100100       SGGG HS20 1 0.   7.5
    9.25                .841 7.5    0.         3250 8Y
C110. 137. 137. 137. 110.
G187.5             87.    87.   .312514. .875 14. .875 N50.
G1110.             87.    87.   .312514. 1.12514. 1.125N50.
G226.5             87.    87.   .312514. 1.12514. 1.125N50.
G2110.5            87.    87.   .312514. .875 14. .875 N50.
G2137.0            87.    87.   .312514. 1.12514. 1.125N50.
G326.5             87.    87.   .312514. 1.12514. 1.125N50.
G368.5             87.    87.   .312514. .875 14. .875 N50.
```

APPENDIX G

Output of the Sample Problem Shown in Figure 1 Using BRRAT

* * * * * BRIDGE ANALYSIS AND RATING * * * * *

% OF AASHTO IMPACT FACTORS IR	OR	SLC	SLC STRESS LEVEL	SP. LL.	MATERIAL	FLOOR SYSTEM	TIE PLATE
100.	100.	0.	0.	0	S	GGG	

				GIRDER			FLOORBEAM			STRINGER		
LOAD	BUG	LANE	INF	UNL	K	A	UNL	K	A	UNL	K	A
HS20	0.0	1	0	0.0	7.50	0.0	0.0	0.0	0.0	0.0	0.0	0.0

PARAPET PLUS SIDEWALK WIDTH	GIRDER OR TRUSS SPACING	CL.OF GIRDER OR TRUSS TO CURB	** ROADWAY WIDTH ** LEFT	MEDIAN	RIGHT
0.0	9.25	0.0	0.0	0.0	0.0

DISTR. FACTOR	SLAB THICKNESS	HAUNCH	SUPER DL	HARD-WARE	SIDEWALK LIVE LOAD	F'C	N	SYMMETRY
0.841	7.50	0.0	0.0	0.	0.	3.250	8.	Y

* * * * * SPAN LENGTHS * * * * *
(CONTINUOUS)

SPAN #	1	2	3	4	5	6	7	8
LENGTH	110.00	137.00	137.00	137.00	110.00			

* * * * * STEEL MEMBER PROPERTIES * * * * *

TYPE	SPAN	RANGE	WF BEAM OR WEB BUILT-UP SECTION INERTIA	AREA	WF OR WEB PLATE DEPTH LEFT	RIGHT	V	THICK	TOP PLATE WIDTH	THICK	BOTTOM PLATE WIDTH	THICK	COMP	FY
G	1	87.50	0.0	0.0	87.00	87.00		0.3125	14.00	0.8750	14.00	0.8750	N	50.0
G	1	110.00	0.0	0.0	87.00	87.00		0.3125	14.00	1.1250	14.00	1.1250	N	50.0
G	2	26.50	0.0	0.0	87.00	87.00		0.3125	14.00	1.1250	14.00	1.1250	N	50.0
G	2	110.50	0.0	0.0	87.00	87.00		0.3125	14.00	0.8750	14.00	0.8750	N	50.0
G	2	137.00	0.0	0.0	87.00	87.00		0.3125	14.00	1.1250	14.00	1.1250	N	50.0
G	3	26.50	0.0	0.0	87.00	87.00		0.3125	14.00	1.1250	14.00	1.1250	N	50.0
G	3	68.50	0.0	0.0	87.00	87.00		0.3125	14.00	0.8750	14.00	0.8750	N	50.0

****
**** GIRDER RATINGS ****
****

***** LIVE LOAD - HS20 *****

THE LOCATION OF THE CRITICAL SECTION IS AT
137.00 FT. FROM THE LEFT END OF SPAN NO. 3.

* * * * * SECTION PROPERTIES * * * * *

	DEPTH	GROSS AREA	MOMENT OF INERTIA	C BOTTOM	SECTION MODULUS TOP	BOTTOM
NON-COMPOSITE	89.25	58.69	78305.87	44.63	1754.8	1754.8

(((((LANE LOADING GOVERNS)))))

DL1 MOMENT	DL2 MOMENT	LL + IMPACT MOMENT FOR IR	OR	SLC	ALLOWABLE STRESSES FOR IR	OR	SLC	
-20544.7	0.0	-21763.8	-21763.8	-18276.0	27.500	37.500	34.375	TENSION
					27.500	37.500	34.375	COMPRESSION

	STRESSES DUE TO DL1	DL2	STRESSES DUE TO LL+I FOR IR	OR	SLC
TOP FIBER	11.708	0.0	12.403	12.403	10.415
BOTTOM FIBER	11.708	0.0	12.403	12.403	10.415

INVENTORY RATING	1.2733
OPERATING RATING	2.0795
SAFE LOAD CAPACITY	2.1763

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