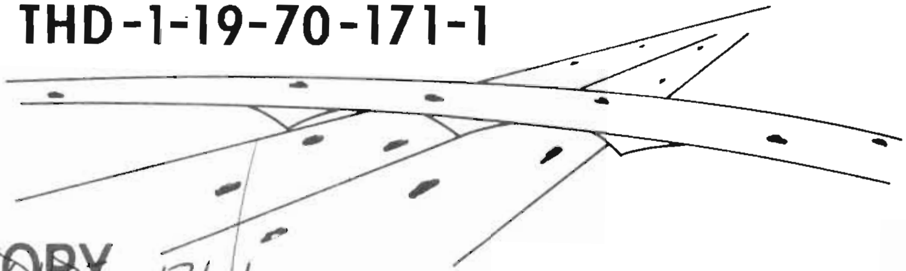
THD-1-19-70-171-1



171-1

DEPARTMENTAL RESEARCH

Report Number : 171-1

EXTENSIONS OF THE ROADWAY DESIGN SYSTEM - BRIDGE DESIGN

TEXAS HIGHWAY DEPARTMENT

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16. Abstract

The existing Roadway Design System (RDS) has been extended so that it can handle a majority of possible bridge configurations. This was accomplished by adding a series of special bridge commands. Each command is explained and instructions are given for data input. Two comprehensive example bridge design problems, one for a simple span and one for a continuous span, are provided showing input and associated output.

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Roadway Design System, bridge design, command structured input, bridge geometry

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EXTENSIONS OF THE TIES ROADWAY DESIGN SYSTEM - BRIDGE DESIGN

by

Larry G. Walker
and
Fred C. Herber, Jr.

Research Report 171-1
Extension of the TIES Road Design System

Research Study 1-19-70-171

Conducted by
Division of Automation
Texas Highway Department
In cooperation with the
U.S. Department of Transportation
Federal Highway Administration

May 1973

SUMMARY

The objective of this study was to extend the existing Roadway Design System (RDS) to accommodate a comprehensive general bridge geometry process that would handle the majority of possible bridge configurations. A secondary objective was to demonstrate how the computed geometric aspects of the structure could be linked to structural design and other design processes. These objectives were carried out by adding a special set of bridge commands to the existing command structure. These special commands allow the designer to:

1. Define the plan view elements of structures.
2. Compute the dimensional aspects of the bridge frame.
3. Store the dimensional aspects for further processing.
4. Plot the plan view of the structure along with any other features available through RDS plot capabilities.
5. Design simple prestressed concrete beams.
6. Do a preliminary design on continuous beams or slabs.
7. Compute the vertical and horizontal blocking data for continuous beams.
8. Compute vertical clearance between structures and lower roadways.
9. Plot surface contours on roadways to aid in design of ramp mergers.

An explanation is given for each command along with instructions for data input. This is followed by two comprehensive example bridge design problems, one for a simple span and one for a continuous span. Each problem contains (1) a description of the problem and a sketch of it, (2) input data with comments, and (3) selected output with explanatory notes.

IMPLEMENTATION

The overall objective of this study was directed toward implementing a comprehensive general geometry process which would handle the majority of possible bridge configurations. This has been carried out by writing a set of special bridge commands for use with the existing Roadway Design System (RDS). These commands are presently available to use in a design environment.

Table of Contents

EXTENSIONS OF THE ROADWAY DESIGN SYSTEM-
BRIDGE DESIGN

I. Introduction

The Roadway Design System (RDS) includes extensive capabilities for compiling and storing the three-dimensional aspects of highway roadways. It employs a command structured input for computing, storing and retrieving geometry related to the roadway. These commands employ a set of system utility routines to accomplish their computations. This report describes extensions to the Roadway Design System in the form of new commands which define and compute the properties of bridge frames and pass these on to other commands which accomplish the design of specific structural elements and compute relational aspects of bridge roadways.

These extensions to the Roadway Design System were developed under Texas Highway Department Research Project No. 171. The objective of this phase was to take advantage of all of the capabilities of RDS in the development of a comprehensive general bridge geometry process that will handle the majority of possible bridge configurations. A secondary objective was to demonstrate how the computed geometric aspects of the structure could be linked to structural design and other design processes.

This report provides instructions on use of the special set of bridge commands. Portions of RDS must be used in connection with these commands and all of the capabilities of RDS may be used in any program execution. The RDS commands are particularly helpful to the bridge designer for geometric layout of bridge structures. For these reasons it is necessary that the reader be familiar with the use of RDS as described in FHWA Report Number 72D-104R-2, Roadway Design System, Volume 2, User Manual.

The special set of bridge commands allows the designer to:

1. Define the plan view elements of structures.
2. Compute the dimensional aspects of the bridge frame.
3. Store the dimensional aspects for further processing.
4. Plot the plan view of the structure along with any other features available through RDS plot capabilities.
5. Design simple prestressed concrete beams.
6. Do a preliminary design on continuous beams or slabs.
7. Compute the vertical and horizontal blocking data for continuous beams.
8. Compute vertical clearance between structures and lower roadways.
9. Plot surface contours on roadways to aid in design of ramp mergers.

Referenced RDS Data

The bridge commands reference roadway surface definitions that must be stored through the RDS design data input facilities. Some commands optionally refer to point and curve data previously computed and/or stored by RDS. Familiarity with the RDS input and computations is assumed in the following discussions. Any of the roadways A through F and H through Z may be referenced by bridge commands as well as all available points and curves. Roadway surfaces and points or curves may have been stored in a previous RDS run.

How the Bridge Commands Are Used

Before giving instructions on how to input each command, here is a typical sequence of how the RDS capabilities and commands might be executed to accomplish a bridge design:

1. Store all pertinent roadways that are to be referenced.
2. Make any RDS general geometry computations that will be required. It is good practice to do this before beginning use of the bridge commands; however, it is not necessary since RDS commands can be mixed with the bridge commands.

3. Give the structure a name and establish a file for storing its data (up to 17 separate structures may be stored on an RDS file).
4. Define all bent lines on the structure.
5. Define transverse lines such as splices, diaframs, bearing conditions and other transverse lines.
6. Define longitudinal lines such as beam lines, slab edges, etc.
7. For each structural unit, i.e. simple span or continuous unit
    a. Define beams by parallel groups, simple span option groups or individual beams.
    b. Request frame layout computations.
    c. Request plot of frame layout (optional). Additional general plotting may also be requested.
    d. Request horizontal or vertical blocking for continuous units (optional).
    e. Request vertical clearance computations (optional).

This sequence is not rigid since the commands are independent of one another. It is only necessary that all of the data required by a command be previously established. The plotting of roadway surface contours was not mentioned in the above sequence since it is normally used prior to the sequence in the establishment of roadway surface definitions.

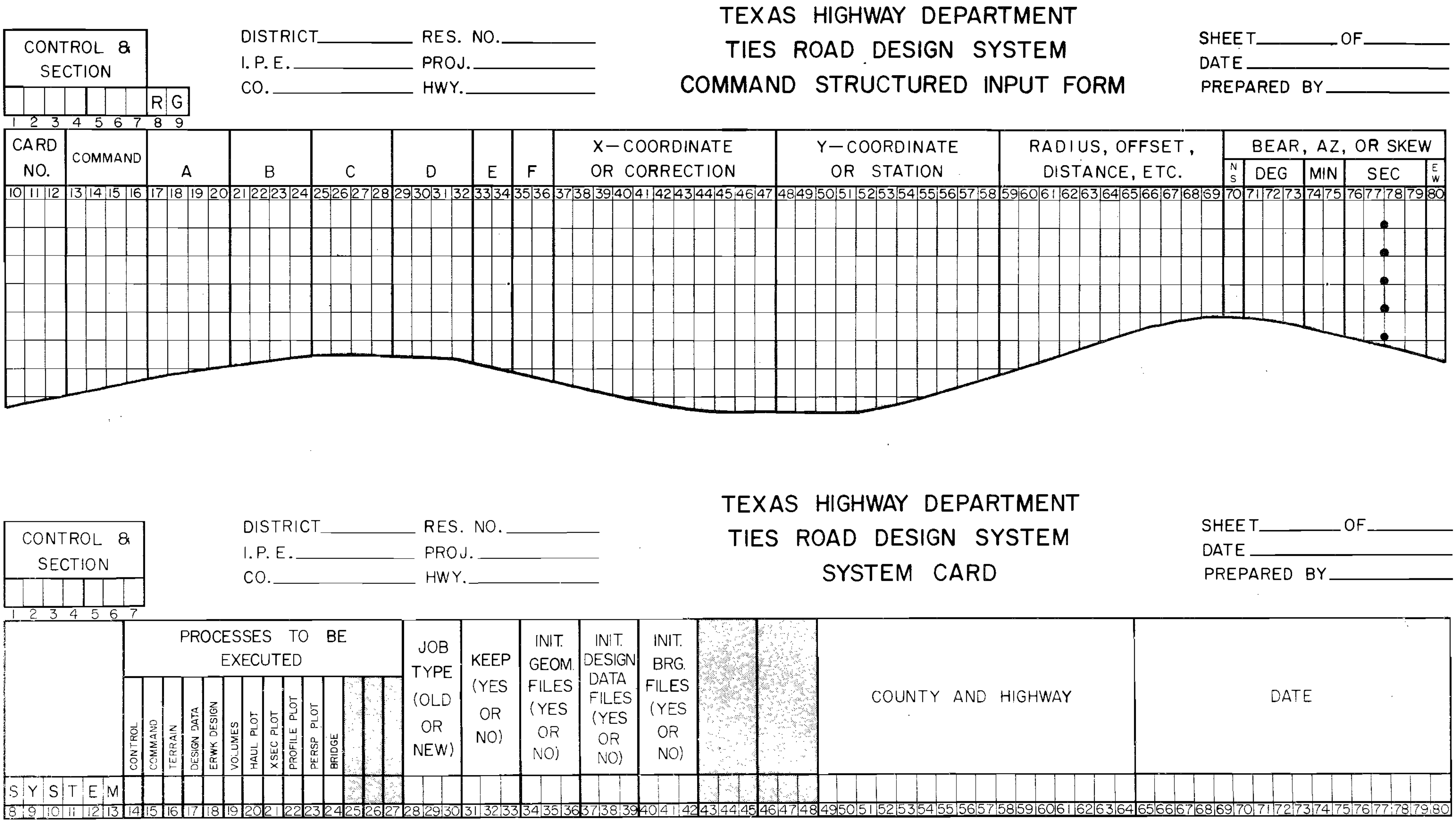
The input forms used with the bridge commands are discussed in the next section. This is followed by explanations of each command and instructions for inputting the commands. The last section contains sample input and output for a comprehensive example bridge design problem. Explanatory notes appear on both the input and output for this problem.

II. Data Entry

The bridge commands are entered on the RDS Command Structured Input form (Form 1323) shown on the next page. The user should be thoroughly familiar with Chapter V, Command Structured Input, of the Roadway Design System User Manual referenced in the Introduction. Data entry for control and section and card number for this form is given on pages 5-1 and 5-3 of the RDS Manual.

A System Card (Form 1322 Revised 10/72), shown on the next page, must always precede any data entered into RDS. This system card is similar to the Road Design System Card which is discussed in Chapter III, System Card, of the previously referenced RDS User Manual. The differences for this revised card are as follows:

1. Card column 24 entitled "BRIDGE" must have an X in it if the bridge design features are to be used.
2. Card columns 40 through 42 entitled "Init.Brg.Files(Yes or No)" indicate whether or not the user wishes to initialize the bridge files. This is normally done only on the first run. The user must enter YES or NO.



CONTROL & SECTION

							R	G
1	2	3	4	5	6	7	8	9

DISTRICT________ RES. NO.________
I. P. E.________ PROJ.________
CO.________ HWY.________

TEXAS HIGHWAY DEPARTMENT
TIES ROAD DESIGN SYSTEM
COMMAND STRUCTURED INPUT FORM

SHEET________ OF________
DATE________
PREPARED BY________

CARD NO.	COMMAND	A	B	C	D	E	F	X—COORDINATE OR CORRECTION	Y—COORDINATE OR STATION	RADIUS, OFFSET, DISTANCE, ETC.	BEAR, AZ, OR SKEW				
											N S	DEG	MIN	SEC	E W
10 11 12	13 14 15 16	17 18 19 20	21 22 23 24	25 26 27 28	29 30 31 32	33 34	35 36	37 38 39 40 41 42 43 44 45 46 47	48 49 50 51 52 53 54 55 56 57 58	59 60 61 62 63 64 65 66 67 68 69	70	71 72 73	74 75	76 77 78 79	80

CONTROL & SECTION

1	2	3	4	5	6	7

DISTRICT________ RES. NO.________
I. P. E.________ PROJ.________
CO.________ HWY.________

TEXAS HIGHWAY DEPARTMENT
TIES ROAD DESIGN SYSTEM
SYSTEM CARD

SHEET________ OF________
DATE________
PREPARED BY________

	PROCESSES TO BE EXECUTED														JOB TYPE (OLD OR NEW)	KEEP (YES OR NO)	INIT. GEOM. FILES (YES OR NO)	INIT. DESIGN DATA FILES (YES OR NO)	INIT. BRG. FILES (YES OR NO)			COUNTY AND HIGHWAY	DATE
	CONTROL	COMMAND	TERRAIN	DESIGN DATA	ERWK DESIGN	VOLUMES	HAUL PLOT	XSEC PLOT	PROFILE PLOT	PERSP PLOT	BRIDGE	▨	▨	▨						▨	▨		
S Y S T E M																							
8 9 10 11 12 13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28 29 30	31 32 33	34 35 36	37 38 39	40 41 42	43 44 45	46 47 48	49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64	65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80

Figure 1. Command Structured Input Form and System Card Form

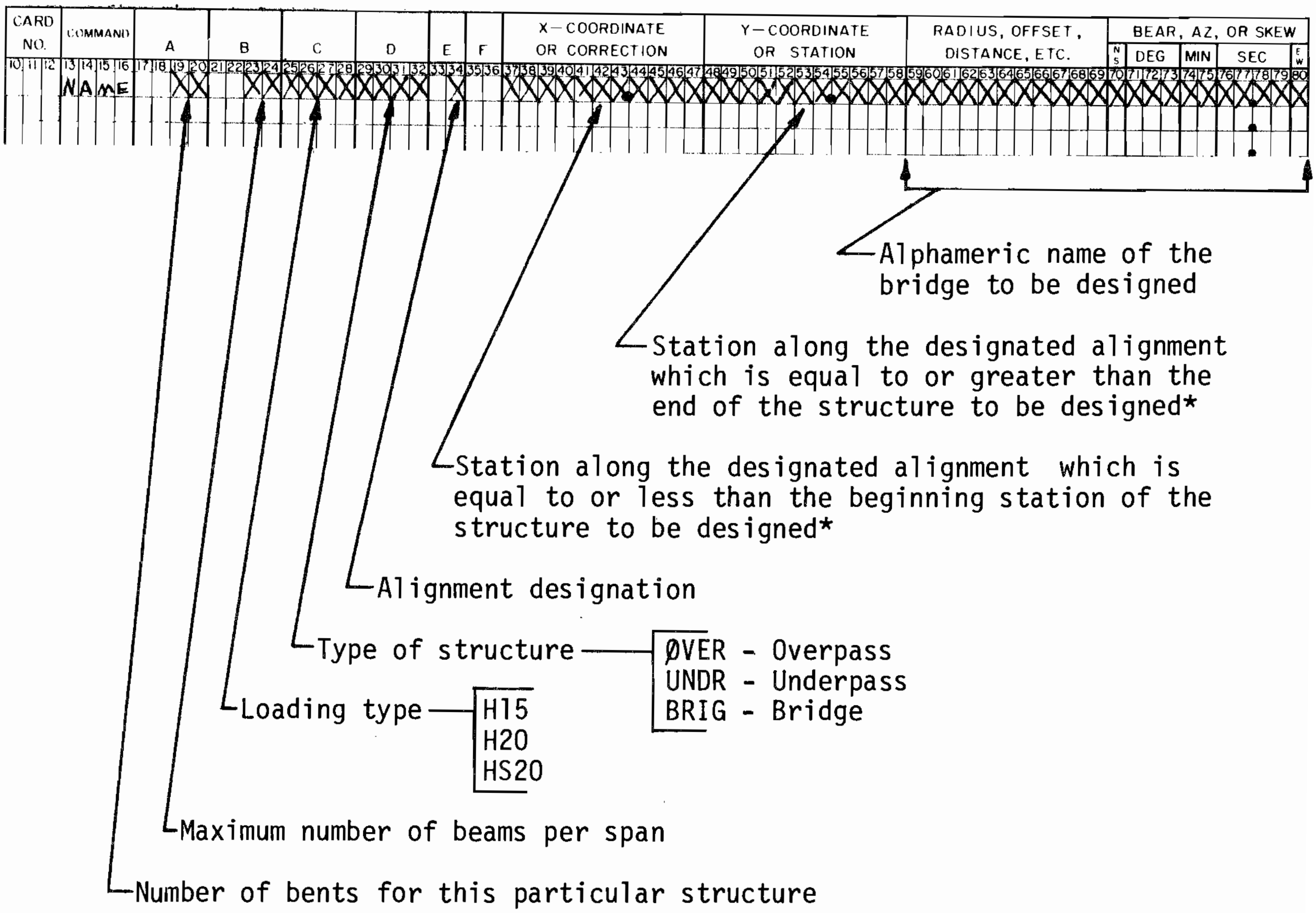
III. Commands

The following pages give the available bridge commands, their names, explanations and instructions for completing the form.

NAME

A NAME command must precede all bridge commands that pertain to a specific bridge. As used here, a specific bridge refers to any set of simple span or continuous units the designer desires to identify on a given roadway. Any other such set of units should be given a different name. The NAME command is used to establish, to identify or to correct bridge files that are needed for the bridge frame geometry processes to follow. There are three input formats available to the user, each performing its respective function. The function and input description of these three formats are as follows:

To establish a bridge file. This form of the NAME command provides the information which determines the size of the bridge file, defines the bridge type and the name of the structure to be used in printed and graphic output and identifies the structure to be designed with respect to horizontal and vertical alignments.



Alphameric name of the bridge to be designed

Station along the designated alignment which is equal to or greater than the end of the structure to be designed*

Station along the designated alignment which is equal to or less than the beginning station of the structure to be designed*

Alignment designation

Type of structure — ØVER - Overpass
UNDR - Underpass
BRIG - Bridge

Loading type — H15
H20
HS20

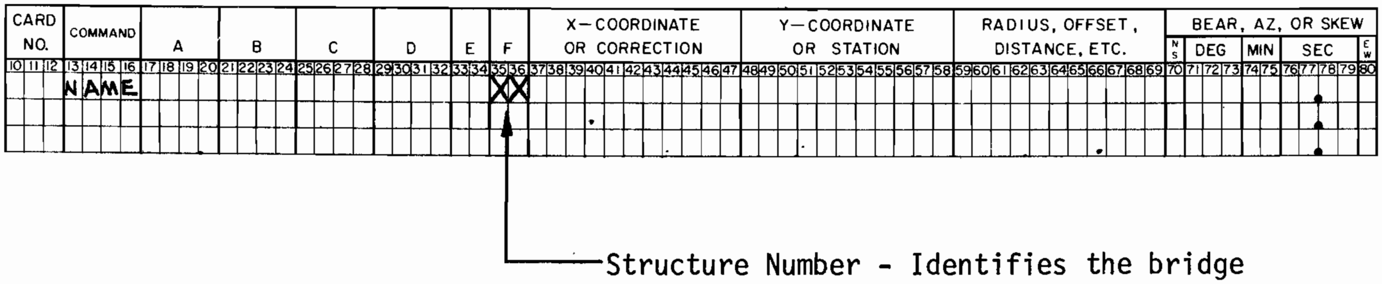
Maximum number of beams per span

Number of bents for this particular structure

*It is generally better to extend station limits about 100 feet beyond either end of the structure.

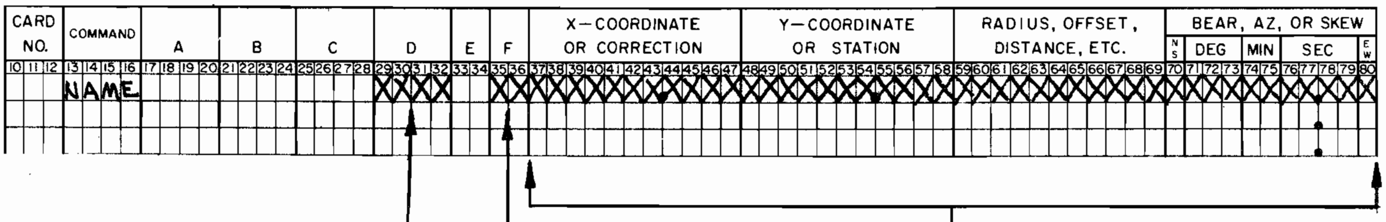
The initial use of the NAME command as illustrated above assigns a file number or "Structure Number" for the bridge. This number will be printed immediately following the listing of the NAME command input and the number must be used on subsequent data submissions for the structure.

To identify a bridge file. Once a bridge file has been created, subsequent data submissions will require data already defined and stored on the project file. This form of the NAME command provides the designer an easy method of making the bridge file available to the bridge system.



Structure Number - Identifies the bridge file that is to be used

To correct a bridge file NAME command. This form of the NAME command allows the bridge designer to correct inputs made on previous NAME commands.



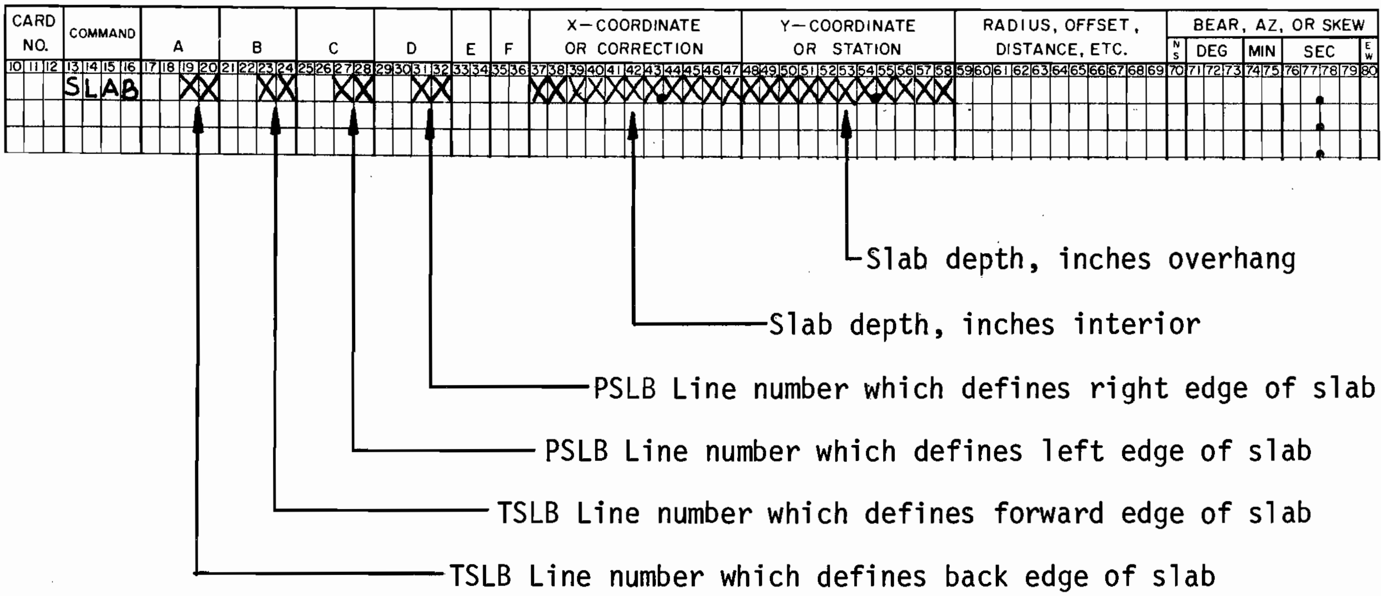
Any entry alters bridge limits and/or structure name - Bridge file remains intact

Structure number - Identifies the bridge file that is to be corrected

Any entry alters bridge type - Bridge file remains intact

SLAB

The SLAB command is used to define and enter into temporary storage the boundaries of bridge slabs and their interior and overhang depths. The boundaries are expressed in terms of previously defined TSLB (transverse to slab) Lines and PSLB (parallel to slab) Lines. Commands for defining these lines will be discussed later. The temporary nature of this storage offers flexibility, but at the same time requires particular attention to achieve the desired result. Before the first SLAB command of a run, all values are initialized at zero. After the first run, it is necessary only to enter the values that change. The other values will remain in effect. If it is desired to reset the values to zero in any of the data fields, a zero must be entered in that field. Data entry is as follows:



Slab depth, inches overhang

Slab depth, inches interior

PSLB Line number which defines right edge of slab

PSLB Line number which defines left edge of slab

TSLB Line number which defines forward edge of slab

TSLB Line number which defines back edge of slab

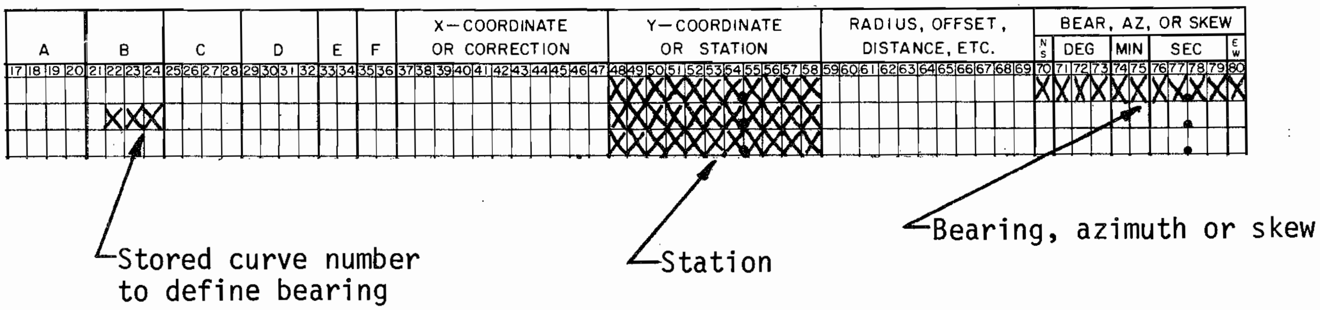
If both slab depths are zero the system will refer to the slab design parameter table. (See GDES Command.) If the overhang depth is zero and the interior slab depth is non-zero, the overhang will be assumed to be the same depth as the interior depth.

TRANSVERSE LINE COMMANDS (BENT, DIAF, SPLC, and TSLB)

One group of special bridge commands provides the bridge designer with the ability to define lines that run transverse to the bridge alignment. These lines are used to define bents, diaframs,* splice lines and a miscellaneous type of transverse slab line which may be used at the bridge designer's discretion.

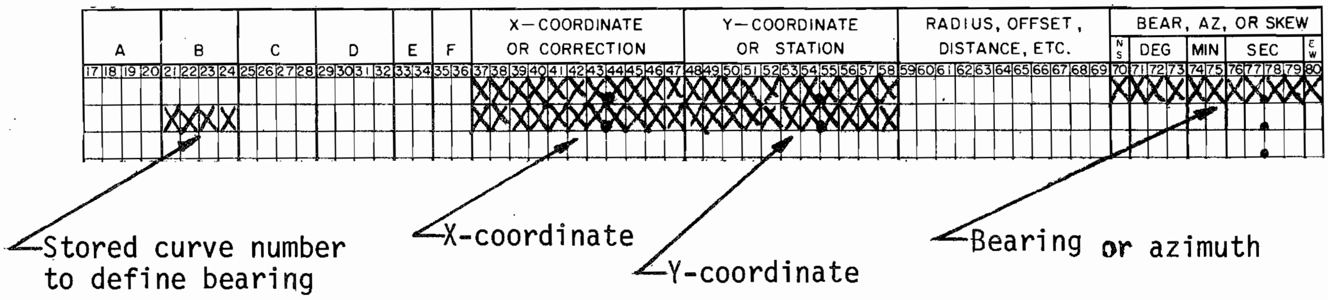
Each of these commands defines a straight line for storage along with other parameters unique to the command. The definition of a straight line requires the X-Y coordinates of a point on the line and its directional bearing. This may be accomplished in one of eight ways which are illustrated below. The lines defined may also be stored as general geometry curves by entering the desired geometry curve numbers in column C. This is optional. Line definition methods are the same for the BENT, DIAF, SPLC and TSLB commands, and a discussion of each of these commands will follow the line definition methods. In the line definition methods shown below, each input line illustrates one of the eight methods for defining lines.

Define a transverse line by giving the station number through which the line passes and one of the elements shown to define the bearing.



(Entering only the station defines perpendicular or radial lines.)

Define a line by giving X-Y coordinates and bearing or curve number.



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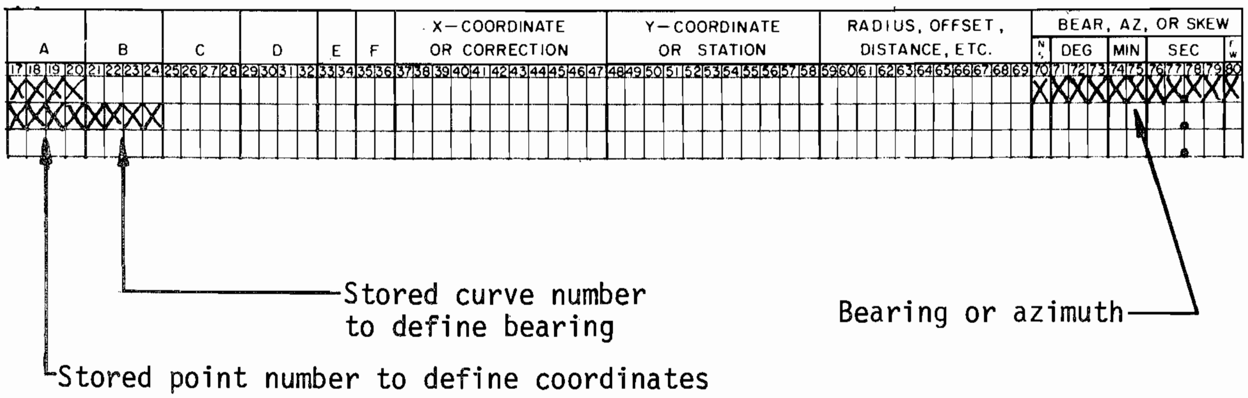
*Notation used for diaphragm

Define a line by giving a stored point to establish coordinates and bearing or curve number.

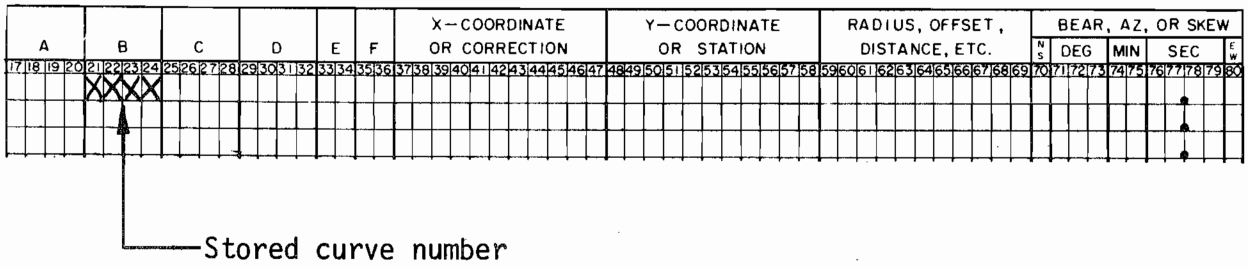


Stored curve number to define bearing

Bearing or azimuth

Stored point number to define coordinates

Define a line by giving a stored curve number which coincides with the desired line.

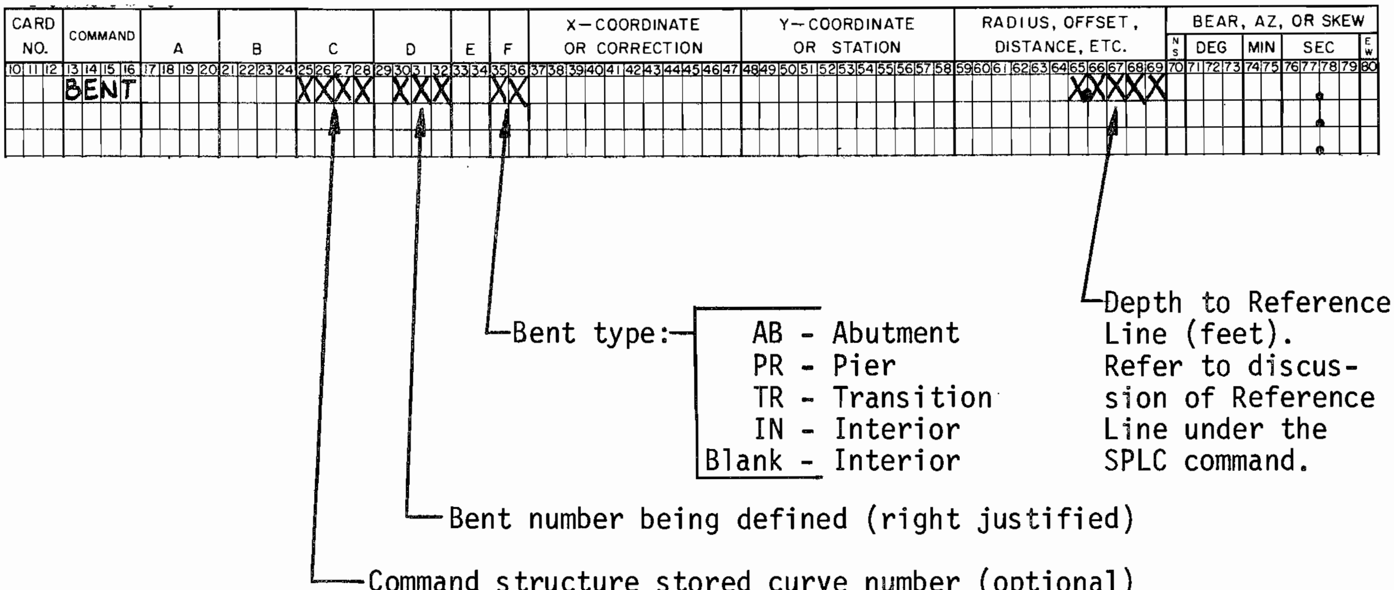


Stored curve number

BENT

The BENT command is used to define straight lines which represent the centerline of bents or other supporting members for structures. These bent lines may be for either simple or continuous units. The BENT command accomplishes the storage of Bent Lines. Designating a line as a Bent Line tells the system how it is to be treated in connection with intersections, framing layouts and other computations.

Bent Lines should be numbered consecutively from beginning to end of the structure beginning with one. The BRNG command establishes the locations of bearing seats and beam ends relative to the Bent Line.



Bent type:

AB - Abutment
PR - Pier
TR - Transition
IN - Interior
Blank - Interior

Depth to Reference Line (feet). Refer to discussion of Reference Line under the SPLC command.

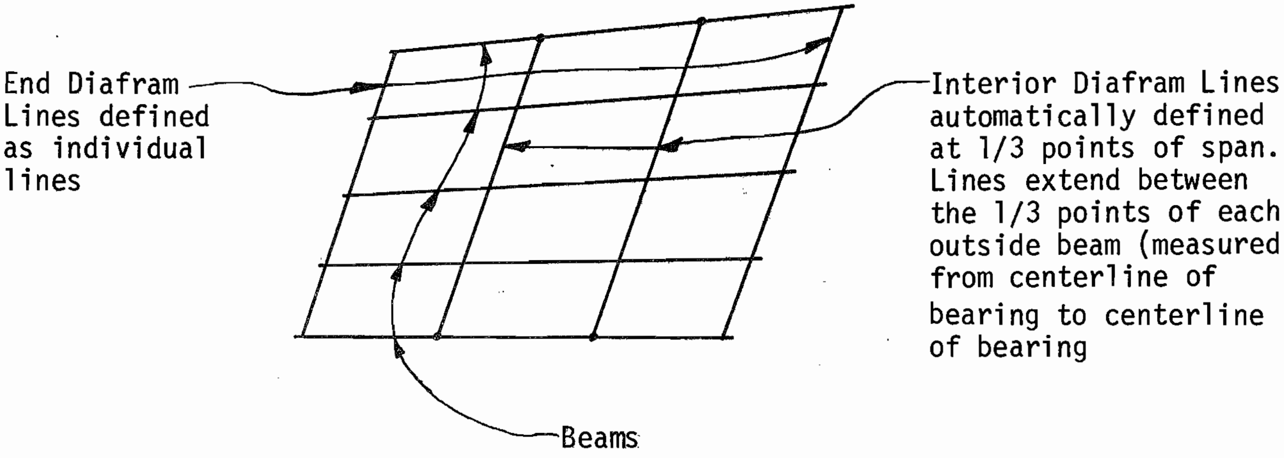
Bent number being defined (right justified)

Command structure stored curve number (optional)
(Stores the Bent Line for use with RDS commands)

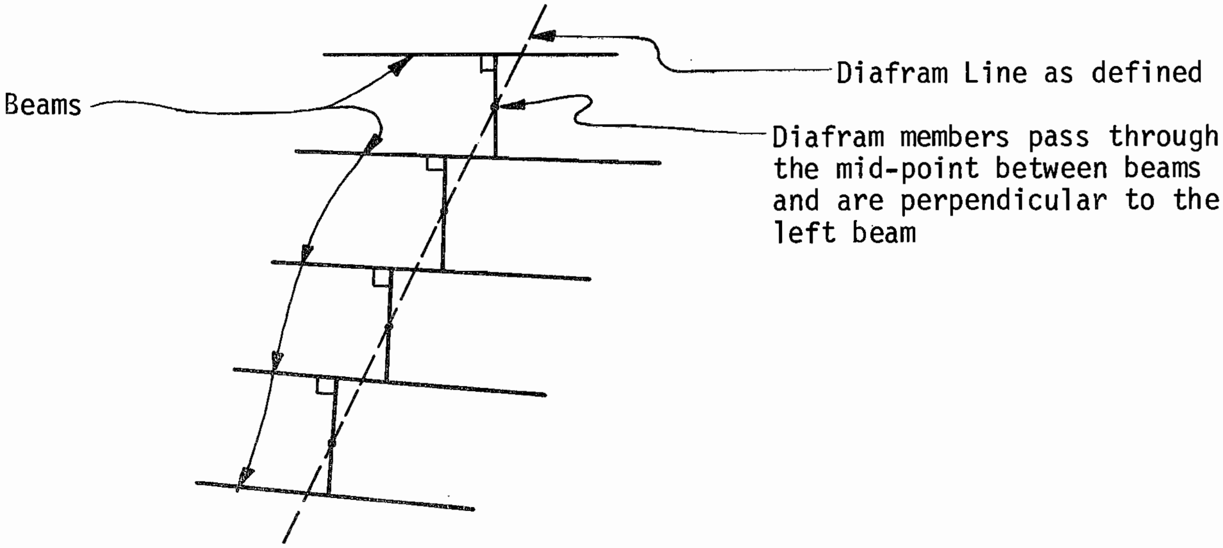
NOTE: In addition to the data shown enter sufficient data to define the desired line by one of the eight methods described under Transverse Line commands.

DIAF

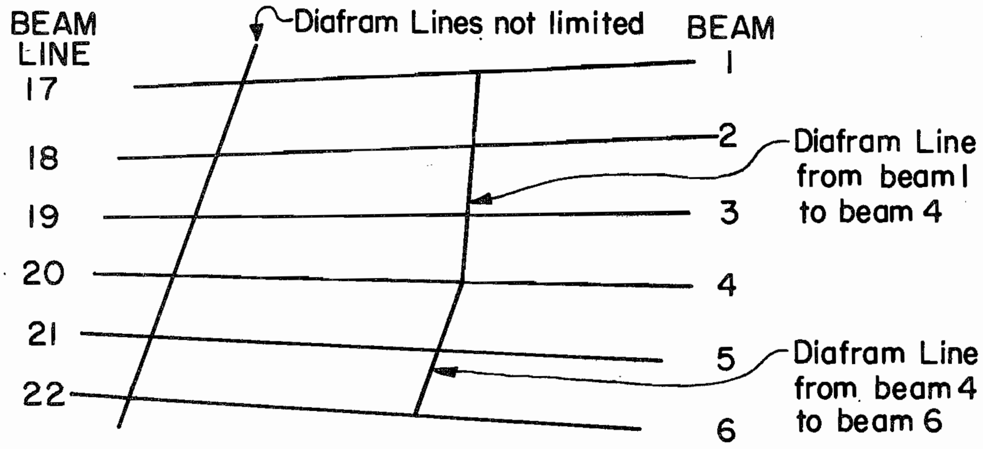
The DIAF command is used to define transverse lines which indicate the location of diafram members between beams. Diafram locations may be specified by defining a straight line by one of the transverse line methods, or an automatic option may be exercised to specify location of Diafram Lines at the mid-point, quarter points, third points, etc., of the simple or continuous span. A typical application of both approaches is shown here.



Diafram members may be located along the lines defined by either method or they may be specified to be located in a staggered pattern as illustrated here.

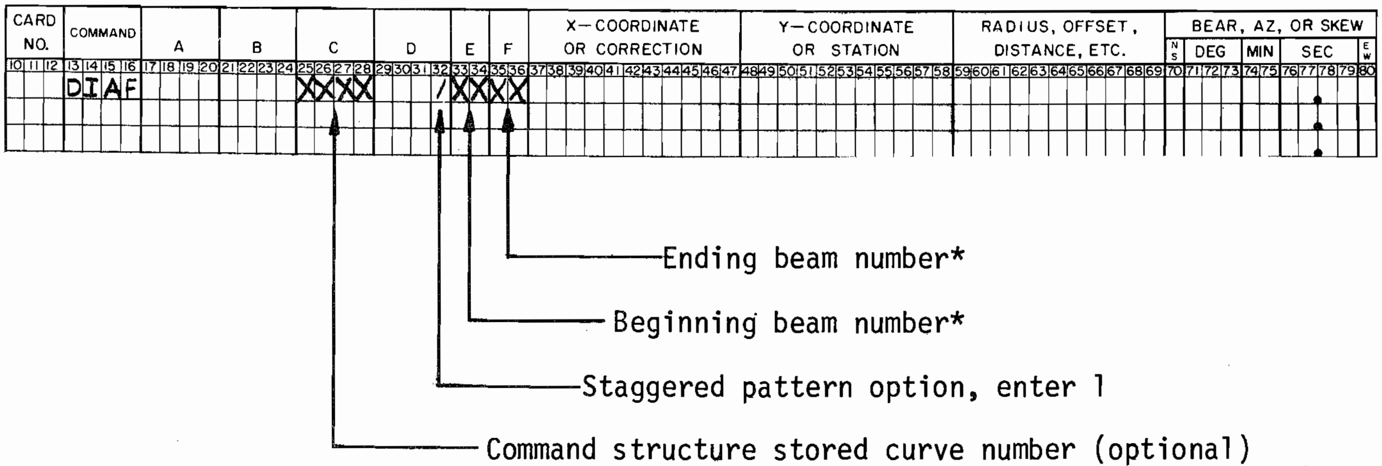


The designer may specify limits for diaframs which are defined as single lines by giving the beam numbers between which the Diafram Line applies. This feature is optional. If no beam numbers are given the diafram will be assumed to apply to all beams. When specifying the limits of Diafram Lines, the actual beam numbers for the applicable unit must be used, not Beam Line numbers. Regardless of Beam Line numbers which apply to a unit, the system treats the leftmost beam as number one; therefore, the third beam from the left would be number three. The option to limit the extent of Diafram Lines is illustrated here.



Diafram Lines are not assigned numbers; they are applied automatically to the appropriate units.

Defining individual straight diafram lines.



Ending beam number*

Beginning beam number*

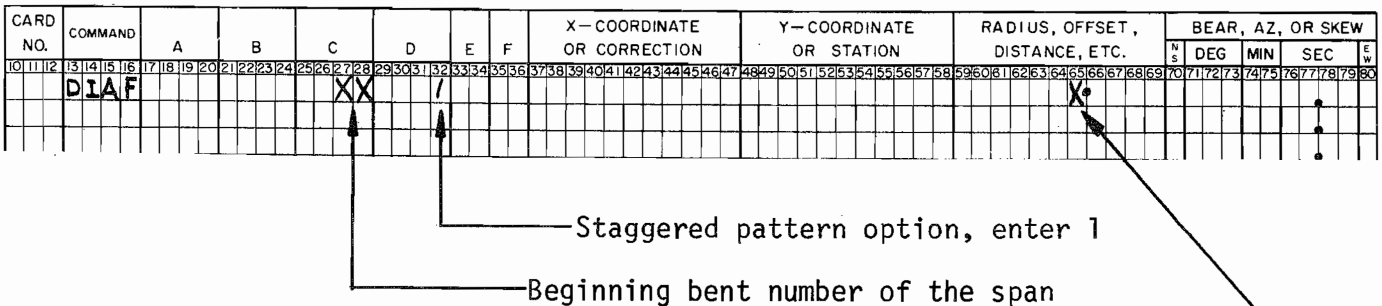
Staggered pattern option, enter 1

Command structure stored curve number (optional)
(Stores the Diafram Line for use with RDS commands.)

*Optional, must be the beam number for the applicable unit. The leftmost beam is always number 1. Two beams must be given to exercise the option.

NOTE: In addition to data shown, enter sufficient data to define the desired line by one of the eight methods described under Transverse Line commands.

Defining diaframs automatically at midpoint, 1/3 points, etc.



Staggered pattern option, enter 1

Beginning bent number of the span

Divisor - Enter the number of segments the span is divided into (maximum = 9)

Examples of Divisor

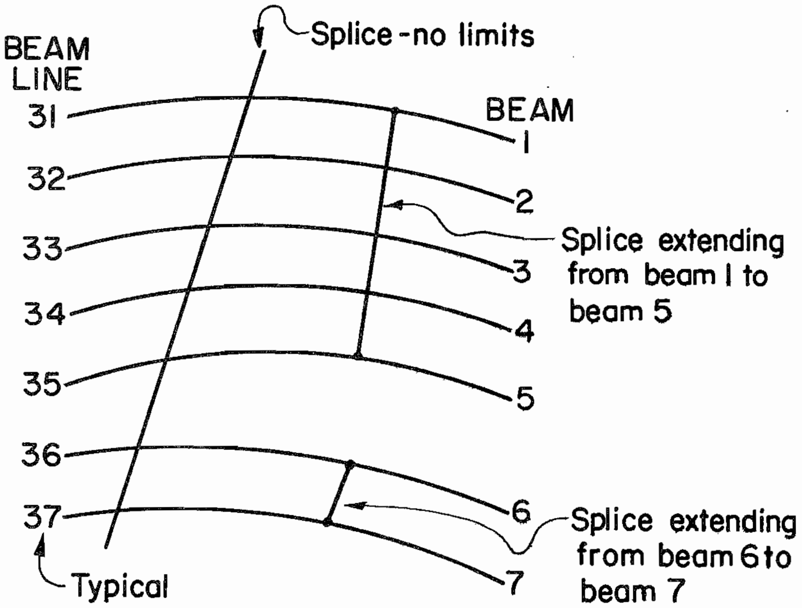
Enter	No.Lines Resulting	At Points
2	1	1/2
3	2	1/3
4	3	1/4
.	.	.
.	.	.
.	.	.

SPLC

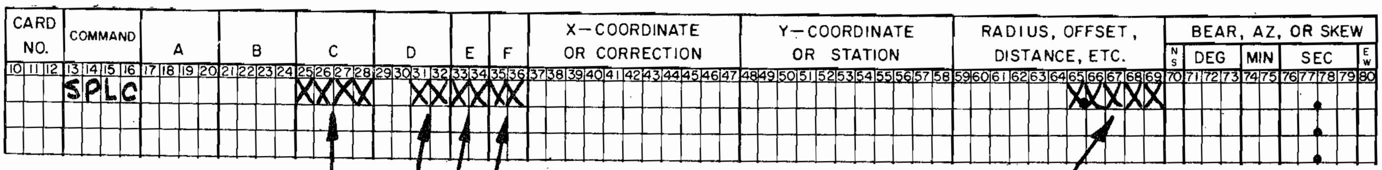
The SPLC command is used to define straight lines which indicate the location of beam splices in continuous units. These lines are not applicable to simple span units. Their intersection with Beam Lines determines the location of splice points.

The designer may specify the limits of the Splice Line by giving the beam numbers between which the Splice Line applies. This feature is optional. If no beam numbers are given, the Splice Line will be assumed to intersect all beams.

When specifying the limits of Splice Lines, the actual beam numbers for the continuous unit must be used, not Beam Line numbers. Regardless of Beam Line numbers which apply to a unit, the system treats the leftmost beam as beam number one; therefore, the third beam from the left would be beam number three. The option to limit the extent of splice lines is illustrated here.



Splice Lines should be numbered consecutively from beginning to end of the structure, beginning with one.



Depth to Reference Line (feet)

Ending beam number*

Beginning beam number*

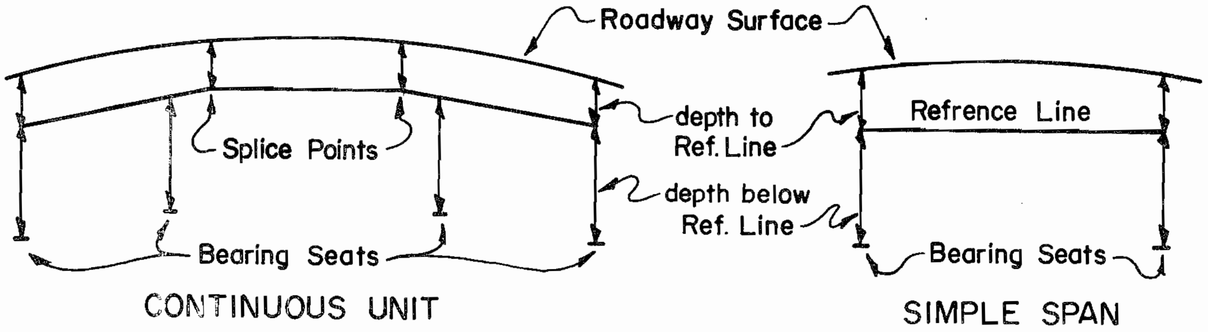
Splice Line number

Command structure stored curve number (optional) (Stores the Splice Line for use with RDS commands)

*Optional, must be the beam number for the continuous unit. The leftmost beam is always number 1. Two beam numbers must be given to exercise the option.

NOTE: In addition to the data shown, enter sufficient data to define the desired line by one of the eight methods described under Transverse Line commands.

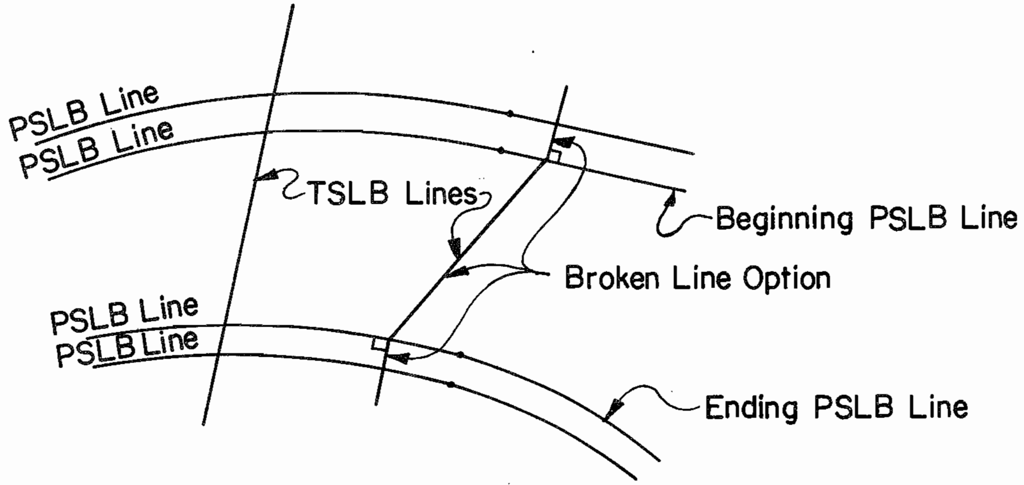
<u>Reference Line</u>. The Reference Line is a line through space which lies in a vertical plane through successive end bents and splice points. Its vertical position at these points is established by giving depths from the surface to the Reference Line at these points as illustrated here.



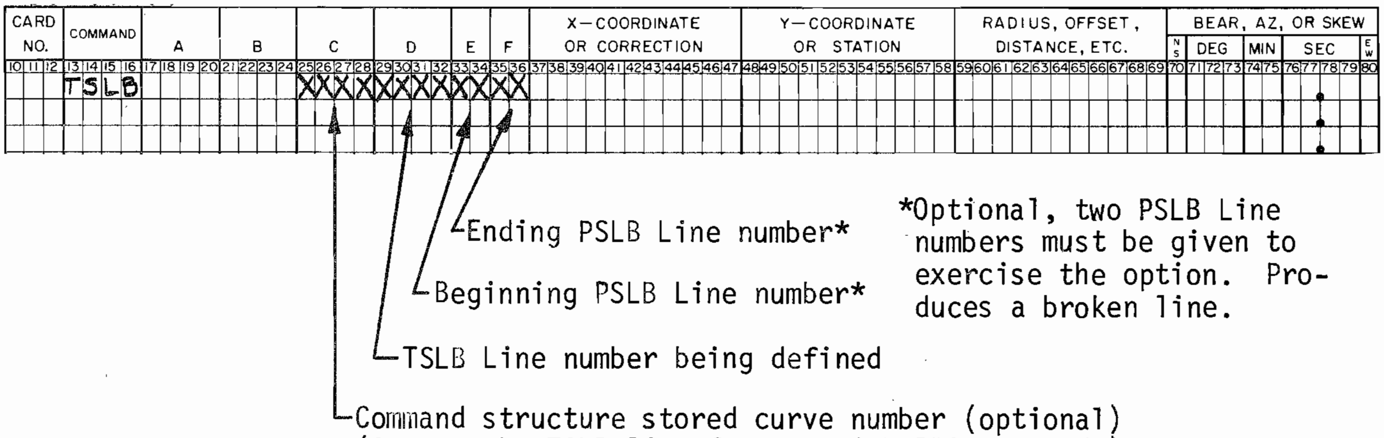
The primary purpose of the Reference Line is to give the designer facility for placement of the beam with reference to the roadway surface. It also serves to establish bearing seat elevations. The Reference Line is the designer's choice and is controlled by the dimensions shown above. For example, he might choose to have the Reference Line represent top of rolled section or top of web for plate girders. There will be cases where the designer does not know the proper dimensions. In this case he should set all dimensions at zero (or leave blank) and make proper corrections when depths are known.

TSLB

The TSLB command is used to define a miscellaneous type of transverse line which is used primarily to locate the ends of slabs for either continuous units or simple span units. Because of the general nature of this type of line, it may also be used for other purposes, such as the plotting of slab construction joints on structures. TSLB Lines may be defined either as a single straight line, or a broken straight line which extends between two specified PSLB Lines (the PSLB command is discussed later) and then extends perpendicularly or radially from the intersected PSLB Line, as illustrated here.



TSLB Lines should be numbered consecutively from beginning to end of the structure beginning with one.



CARD NO.	COMMAND	A	B	C	D	E	F	X—COORDINATE OR CORRECTION	Y—COORDINATE OR STATION	RADIUS, OFFSET, DISTANCE, ETC.	N/S	DEG	MIN	SEC	E/W
10 11 12	13 14 15 16	17 18 19 20	21 22 23 24	25 26 27 28	29 30 31 32	33 34	35 36	37 38 39 40 41 42 43 44 45 46 47	48 49 50 51 52 53 54 55 56 57 58	59 60 61 62 63 64 65 66 67 68 69	70	71 72 73	74 75	76 77 78 79	80
	TSLB			XXXX	XXXX	XX	XX								

BEAR, AZ, OR SKEW

Ending PSLB Line number*

Beginning PSLB Line number*

TSLB Line number being defined

Command structure stored curve number (optional)
(Stores the TSLB line for use with RDS commands)

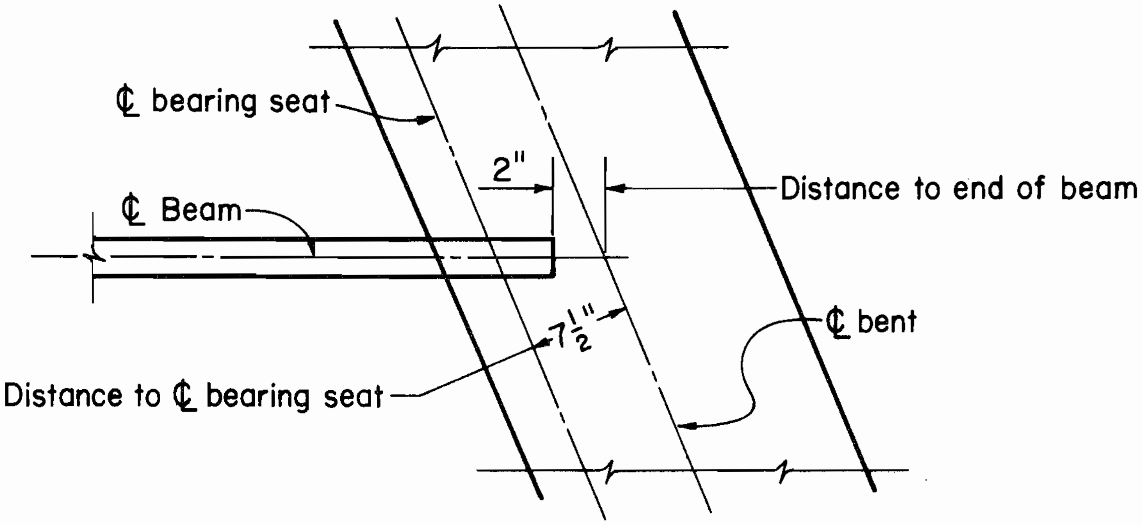
*Optional, two PSLB Line numbers must be given to exercise the option. Produces a broken line.

NOTE: In addition to data shown, enter sufficient data to define the desired line by one of the eight methods described under Transverse Line commands.

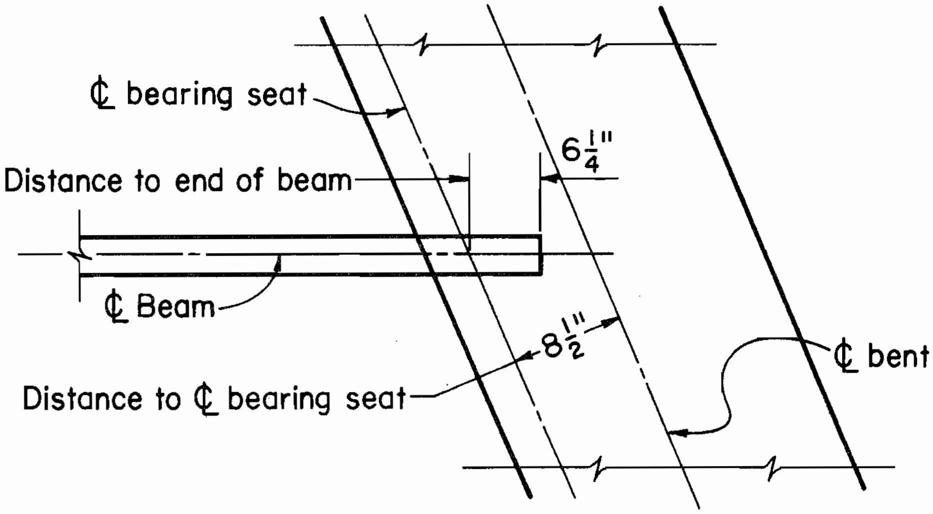
BRNG

The BRNG command is used to locate the centerline of bearing seats on bents. Three options are available by which the centerline of bearing seat may be defined. These options are given below.

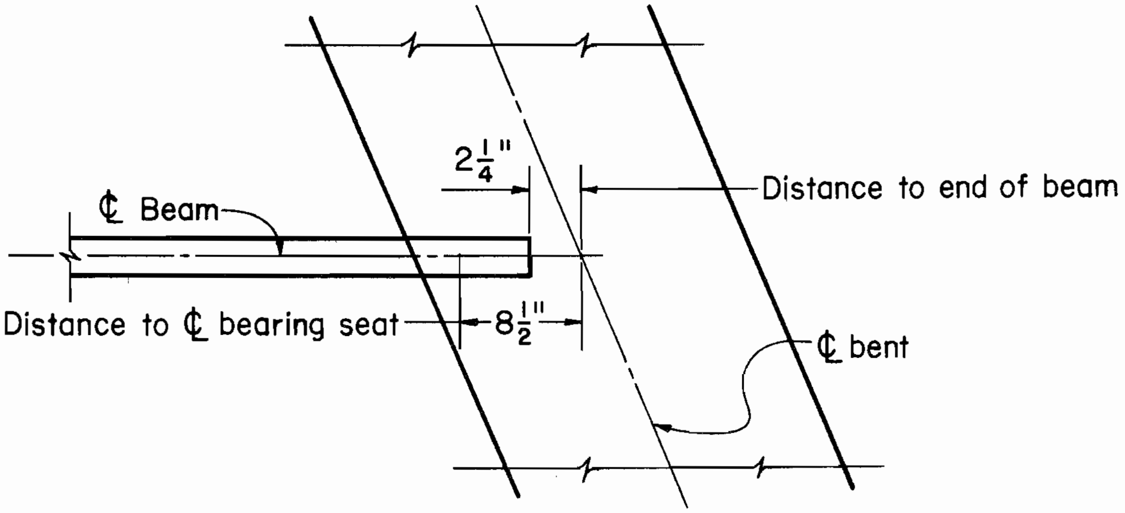
Option 1. The distances defining the location of the centerline of beam bearing seats are specified perpendicular to their respective bents. In this case lines are generated parallel to the centerline of bents and intersected with the individual beams to determine the location of the beam bearings. Beam ends are located a fixed distance from the bent as measured along the beam line.



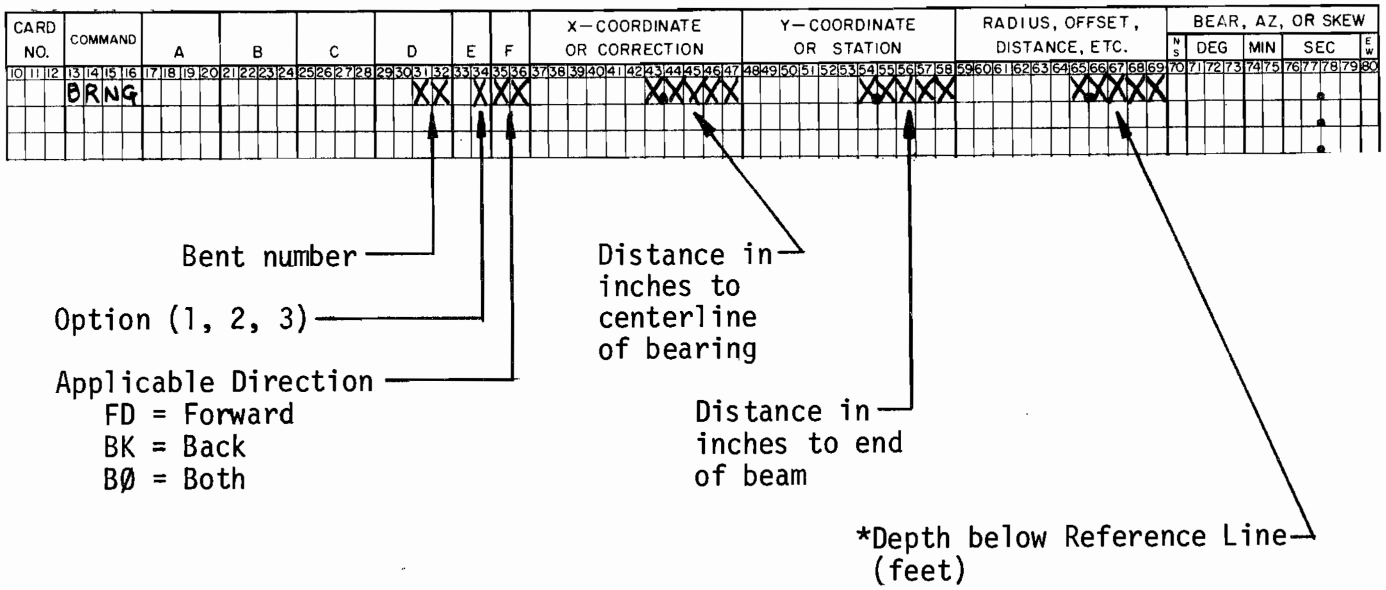
Option 2. The distances defining the location of the beam bearing seats are measured perpendicular to the centerline of the bents as indicated in Option 1. The distances to the ends of the beams are measured from the centerline of the bearing seats along the centerline of the beam lines.



Option 3. The distances defining the location of the centerline of beam bearing seats and beam ends are specified along the Beam Line and measured from the intersection point of the centerline of bent and centerline of the Beam Line.



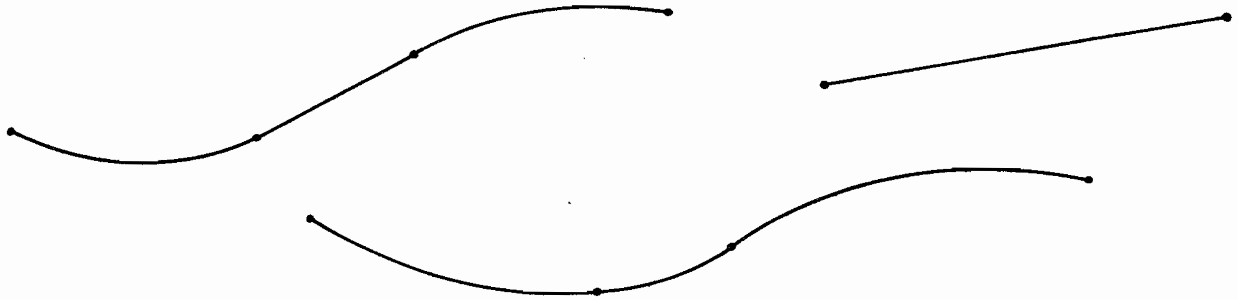
A BRNG command may be used to indicate beam bearing and end conditions on both sides of a bent if the data applies in both directions; otherwise, two BRNG commands must be entered for an interior bent.



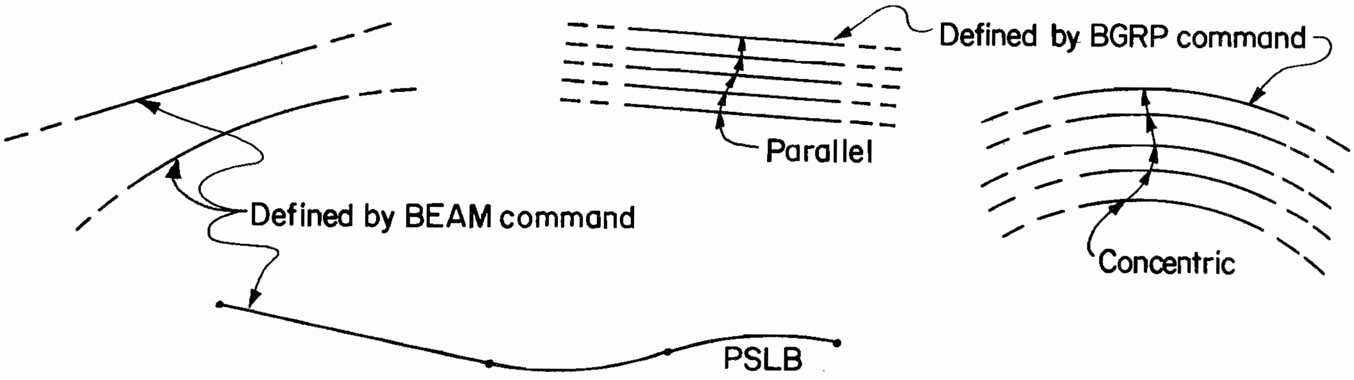
*Refer to the discussion of Reference Line under the SPLC command. This depth may not be known. If this field is left blank, the bearing seat elevation will be equal to the elevation of the Reference Line (which may be the surface elevation).

LONGITUDINAL LINE COMMANDS (PSLB, BEAM and BGRP)

Three commands (PSLB, BEAM and BGRP) are used to define lines that run in the longitudinal direction of the structure. The PSLB command defines a general case line which may be made up of one or more straight line and/or circular elements. PSLB Lines are limited in extent and are intended to be continuous like highway alignments. Examples of PSLB Lines are shown here.

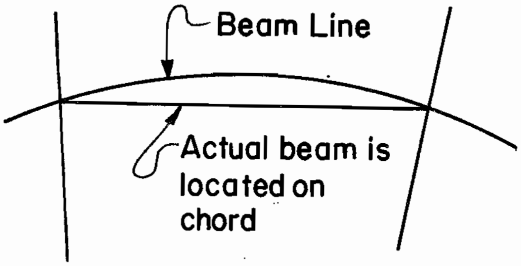


The BEAM command is used to define individual Beam Lines which may be straight lines or circles. The BEAM command may also refer to a PSLB Line for defining a Beam Line. The BGRP command provides a special case application of the BEAM command. It describes a group of parallel straight lines or concentric circles as Beam Lines. When applicable, the BGRP command will save effort on the part of the designer. Examples of Beam Lines are shown here.



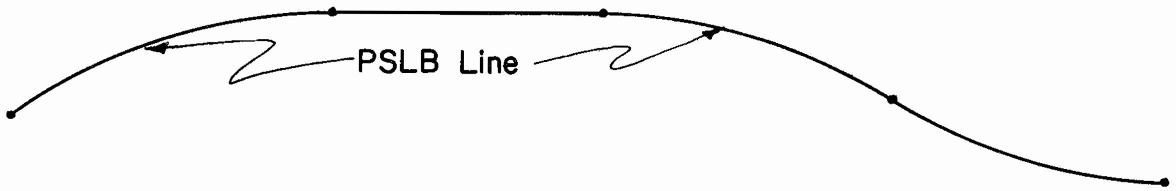
It is important to note the distinction between the longitudinal line types described above. PSLB Lines are general purpose lines which may be used for slab edges, parapet wall lines, slab break boundaries and any other applicable purpose. They do not serve as Beam Lines unless they are so designated by the BEAM command.

Beam Lines on the other hand serve strictly in the location of the actual beams in the structure. When a Beam Line is circular or is defined as a previously stored non-straight PSLB Line, the actual beam member may not coincide with the Beam Line as illustrated here and discussed further in connection with the FOPT command.



PSLB

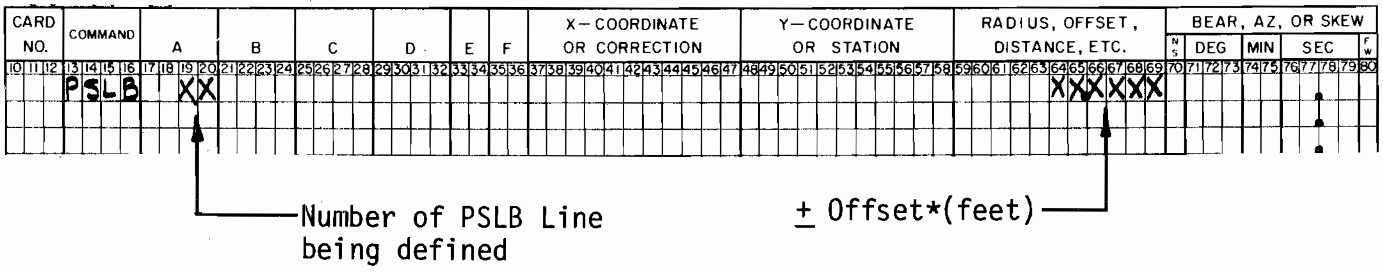
The PSLB command is used to define longitudinal lines which are pseudo alignments that may consist of one or more straight line and/or circle elements. They are limited in extent since their end points must be defined. These lines have a variety of applications.



PSLB Lines may be defined by giving their offset from another PSLB Line or from any stored alignment. In this case the direction of the PSLB Line will be the same as the direction of the PSLB Line or Alignment that it is referenced from. PSLB Lines may also be defined by referring to curves which have been previously stored by regular RDS commands. The extent of the curves is indicated by giving their end points which have been previously defined by RDS commands. The order of curve entry determines the direction of the PSLB Line in this case.

PSLB Lines defined by any of the possible methods are given a number for future reference and the designer should be aware of the direction of the alignment. Input for the various possible methods is given below.

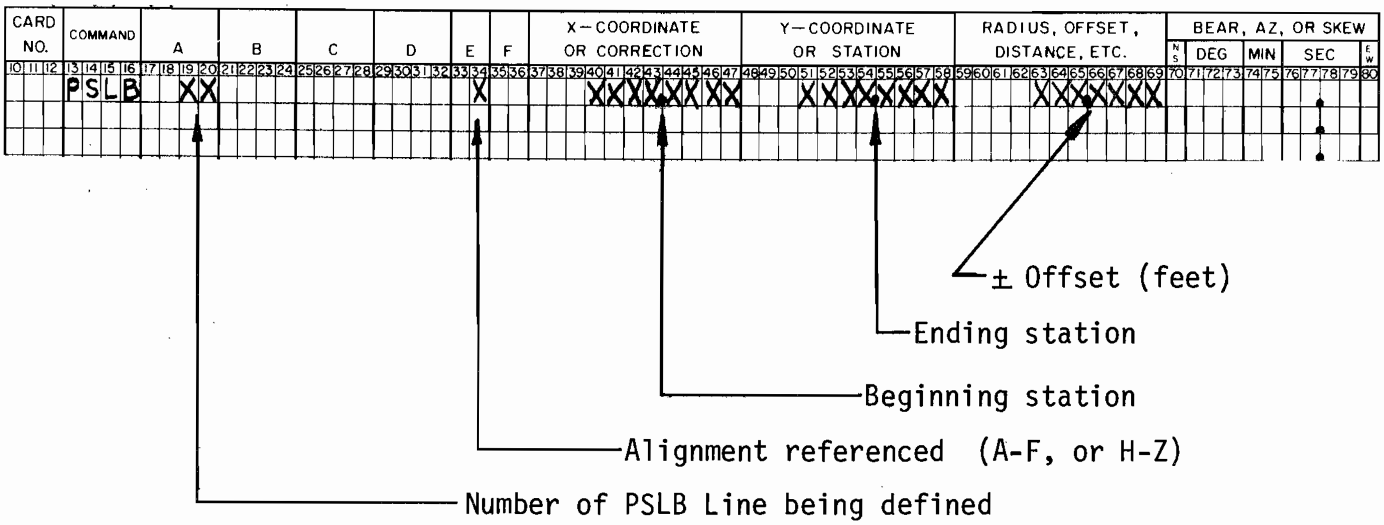
PSLB parallel to the centerline of the bridge. The centerline of the bridge between the station limits specified on the NAME command for the structure is stored for several purposes. A PSLB Line can be specified by assigning a number and giving an offset. In this case the PSLB Line will be parallel to the structure centerline between the limits indicated and have the same direction.



Number of PSLB Line being defined

± Offset*(feet)

PSLB parallel to another Alignment. A PSLB Line may be defined at an offset from an Alignment which is not the centerline of the structure by giving the selected roadway and indicating station limits on that Alignment for the extent of the desired PSLB Line.



± Offset (feet)

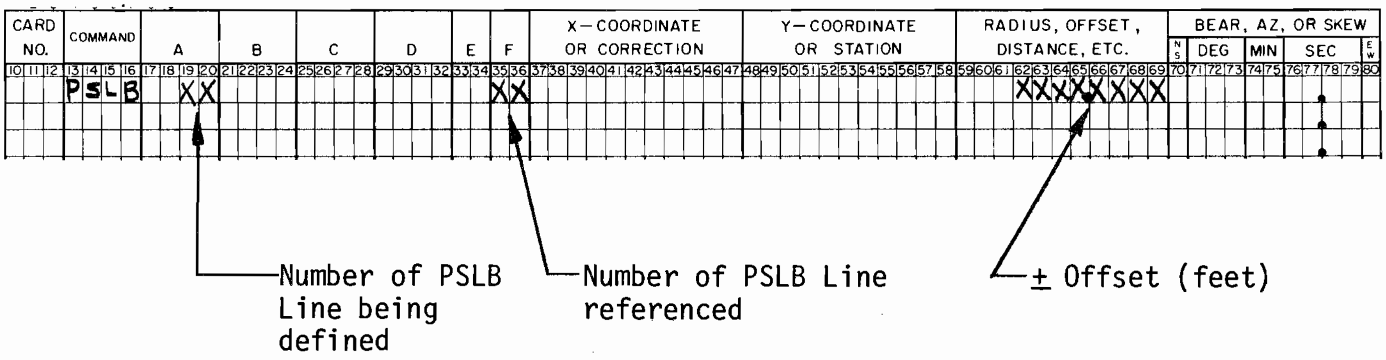
Ending station

Beginning station

Alignment referenced (A-F, or H-Z)

Number of PSLB Line being defined

PSLB parallel to another PSLB. In this case the PSLB Line will be defined parallel to the indicated PSLB Line at the given offset. The standard convention for offsets applies in the direction of the original PSLB Line.



Number of PSLB Line being defined

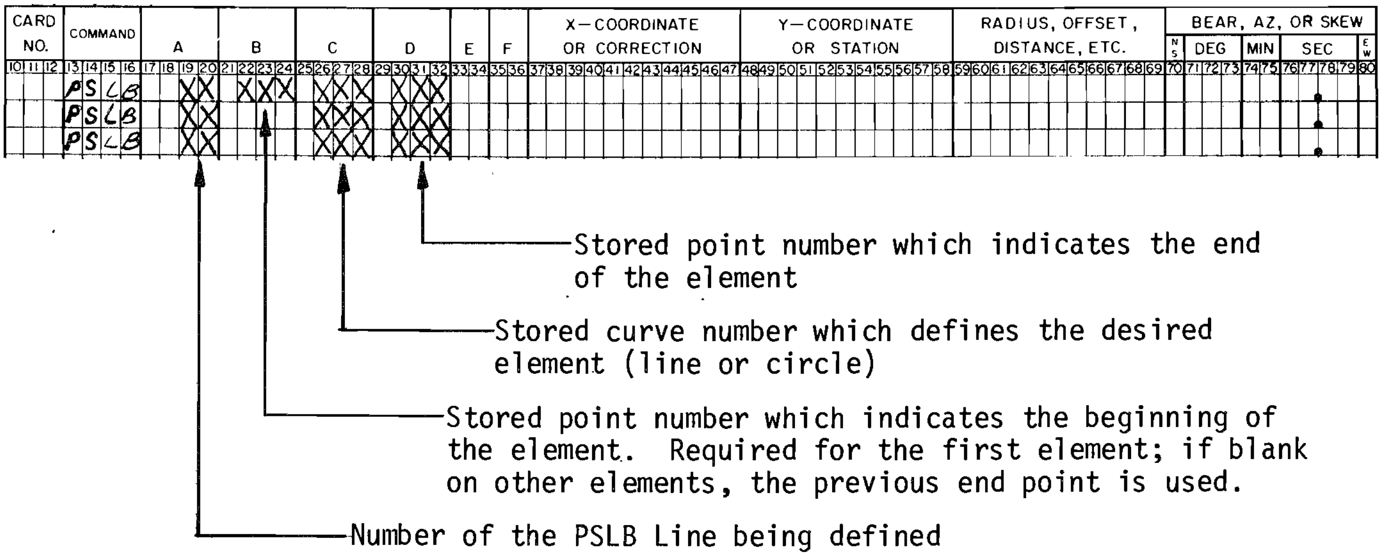
Number of PSLB Line referenced

± Offset (feet)

---

*An offset is considered negative when it is to the left of the station line when viewed in the direction of increasing stations.

<u>PSLB defined by previously stored curves and points</u>. In this case one PSLB command must be entered for each element of the PSLB Line. Entry should be made in the order which indicates the direction of the PSLB Line.



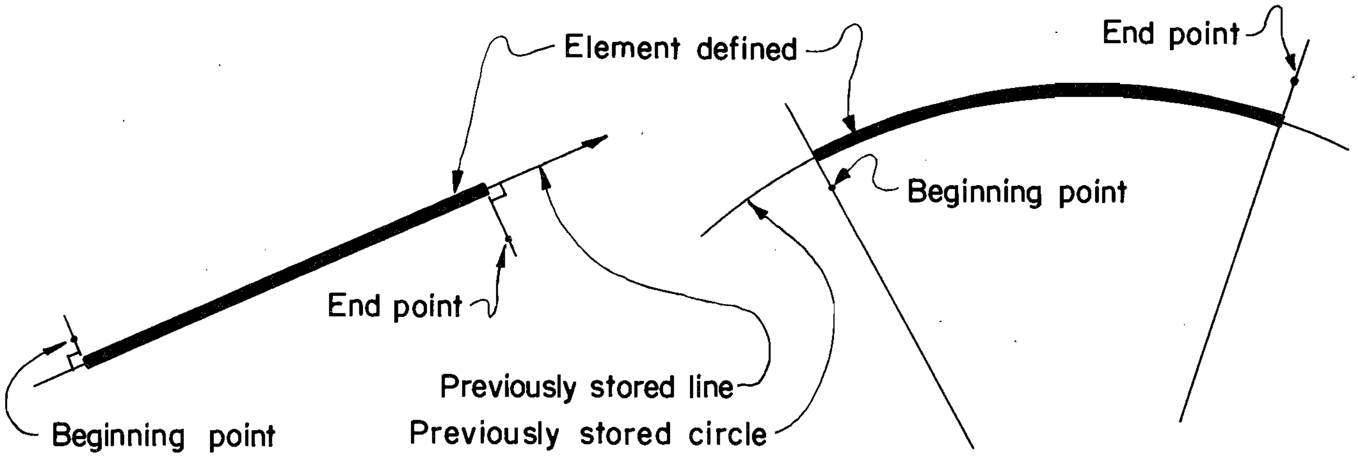
Stored point number which indicates the end of the element

Stored curve number which defines the desired element (line or circle)

Stored point number which indicates the beginning of the element. Required for the first element; if blank on other elements, the previous end point is used.

Number of the PSLB Line being defined

The beginning and end points of lines or circles should normally lie on the line or circle. These points will be used to determine limits of the element and will be treated as shown here when they do not fall on the line or circle.

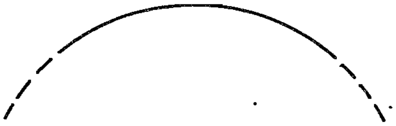


BEAM

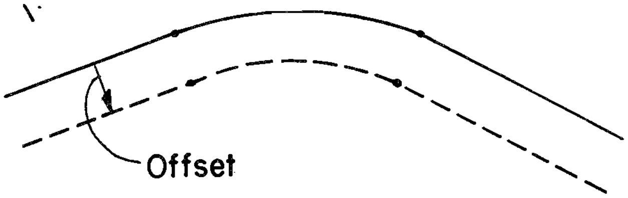
The BEAM command is used to define Beam Lines. Beam Lines are used in various ways to locate actual beams in the structure as discussed in connection with the FOPT command. Beam Lines may be:

1. Straight lines

2. Circles



3. Strings of straight lines and circles previously defined by the PSLB command.

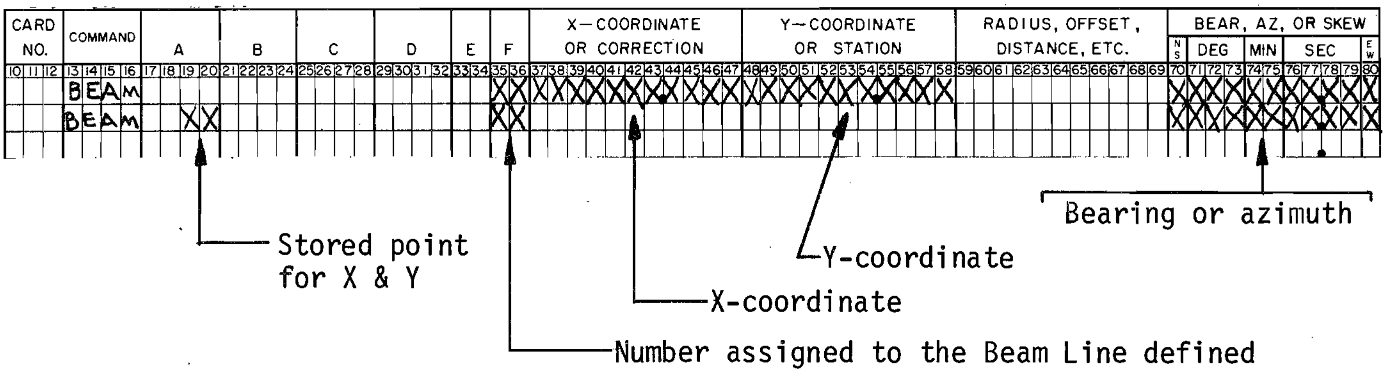


A Beam Line may also be defined as a string of straight lines and circles at an offset from a previously defined PSLB Line.

Each beam defined must be given a number between 1 and 99. If all of the Beam Lines for a unit are to be defined, they must be numbered consecutively from left to right. It is the responsibility of the user to be sure beams are properly numbered. Entering data for a Beam Line number that has been previously entered will eliminate the first entry. The automatic options for locating interior beams (FOPT command) do not affect these numbers.

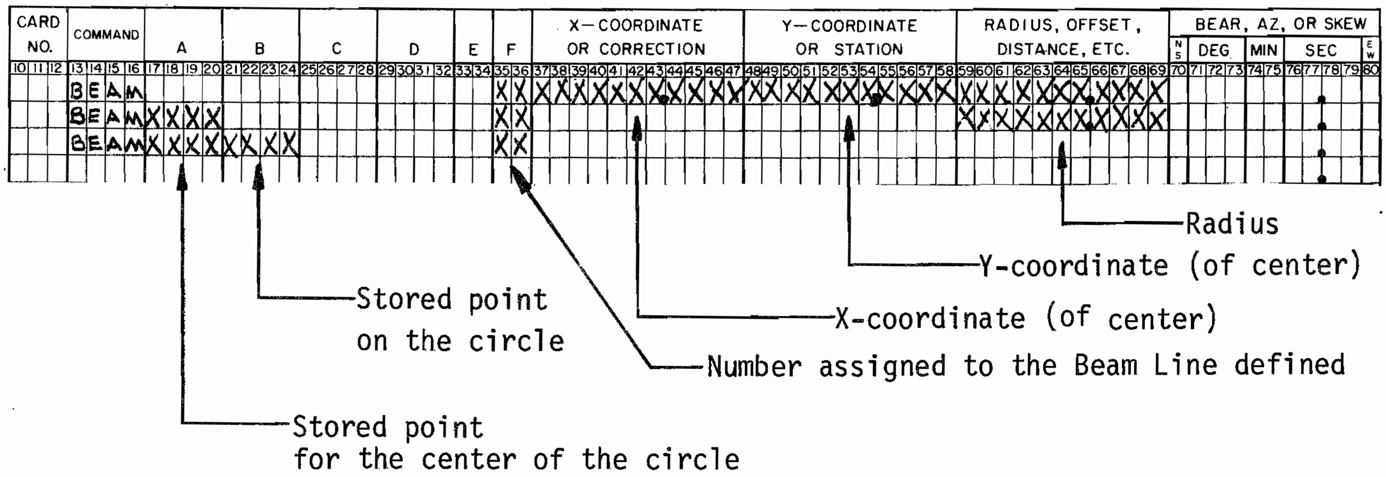
Beam Lines may be defined by one of the seven methods illustrated below. Each input line illustrates one method.

Straight lines.

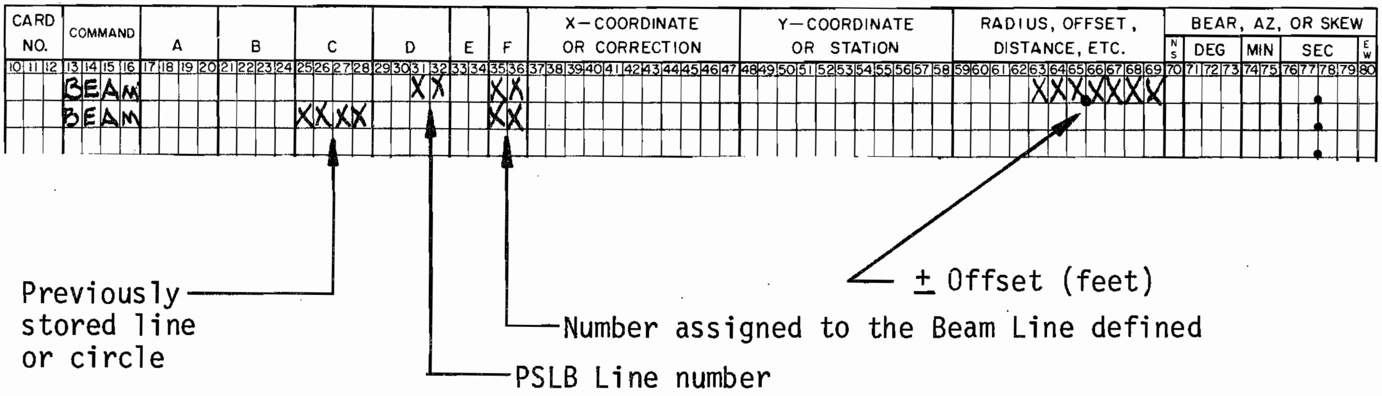


CARD NO. 10 11 12	COMMAND 13 14 15 16	A 17 18 19 20	B 21 22 23 24	C 25 26 27 28	D 29 30 31 32	E 33 34	F 35 36	X—COORDINATE OR CORRECTION 37–47	Y—COORDINATE OR STATION 48–58	RADIUS, OFFSET, DISTANCE, ETC. 59–69	BEAR, AZ, OR SKEW N/S 70	DEG 71 72 73	MIN 74 75	SEC 76 77 78 79	E/W 80
	BEAM						XX	XXXXXXXXXXX	XXXXXXXXXXX		X	XXX	XX	XXXX	X
	BEAM	XX					XX				X	XXX	XX	XXXX	X

Circles.



Previously defined curves or PSLB Lines.



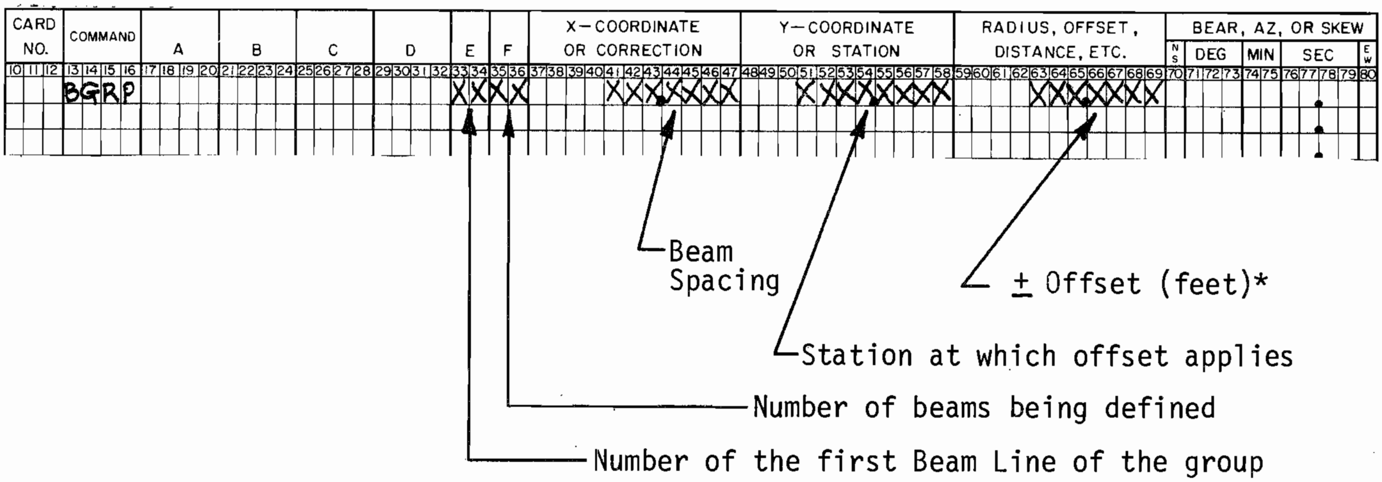
BGRP

The BGRP command is used to define groups of parallel straight line or concentric circle Beam Lines. This command is for the convenience of the designer and applies primarily for non-complex structures where Beam Lines are either parallel to the centerline at a given station or referenced to slab edge (or edges). In the latter case the slab edge should be all on a straight line or all on a circle; and, when both slab edges are referenced, they should be parallel. Slab edges must have been defined by using the SLAB command prior to entry of the BGRP command.

This command has the same effect as defining individual Beam Lines with the BEAM command; therefore, it is necessary that the number of the first Beam Line being defined be entered as well as the number of Beam Lines being defined. Care should be exercised to assure that Beam Lines thus defined are not unintentionally redefined by other BGRP or BEAM commands.

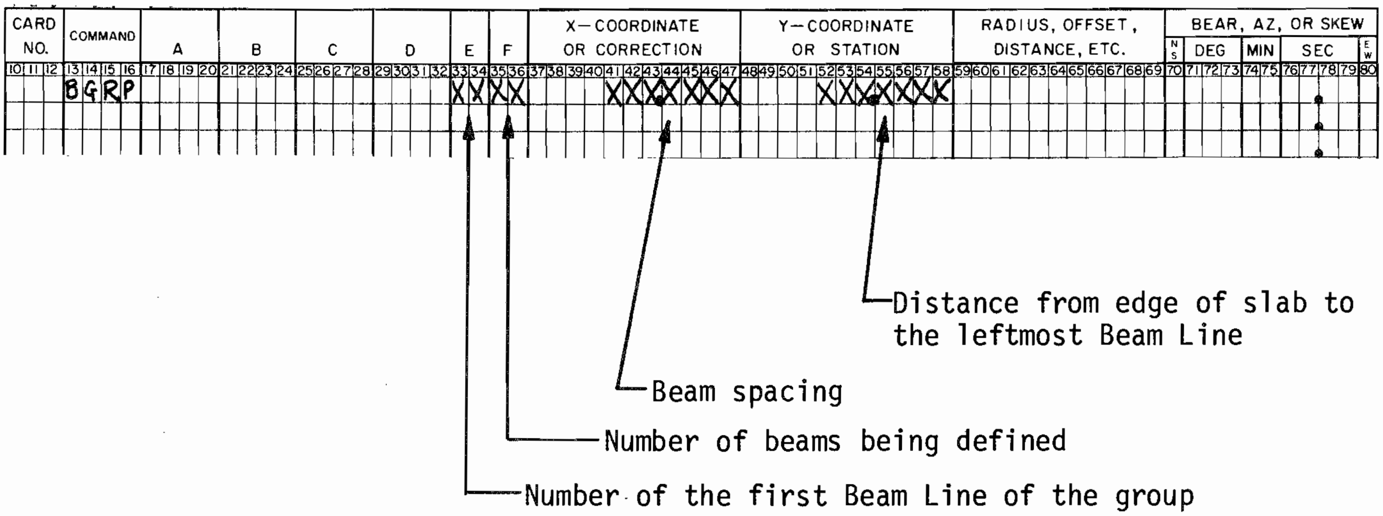
The three methods for defining beam groups are given below.

<u>To define a group of beams by specifying the number of beams, the beam spacing, and the station and offset distance to the leftmost beam line.</u>

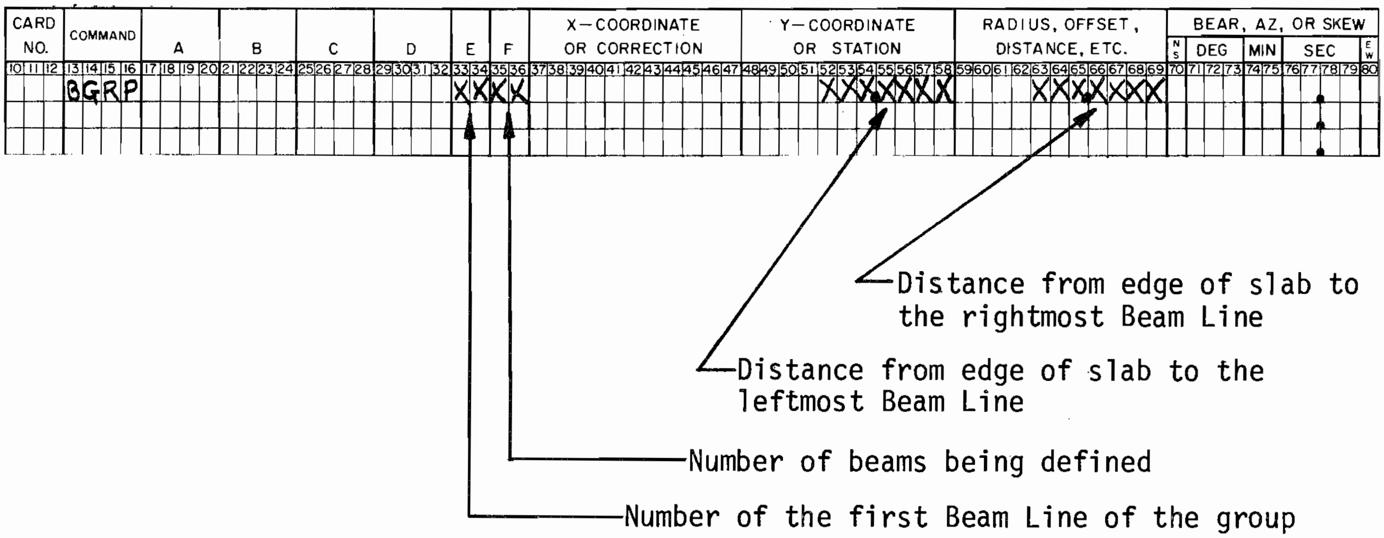


*If the offset is zero, a zero must be entered in the offset field.

To define a group of beams by specifying the number of beams, the beam spacing and the distance from the left edge of the slab to the leftmost Beam Line.



To define a group of beams by specifying the number of beams, the distance from the left edge of slab to the leftmost Beam Line and the distance from the right edge of slab to the rightmost Beam Line.



FOPT

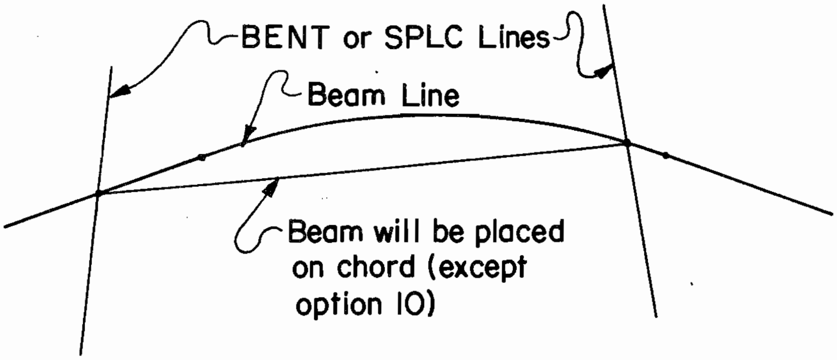
The FOPT command is used to request computation of bridge frame layout dimensions. In addition to producing several reports which present dimensional aspects of the bridge frame, it will cause the plan view of the frame layout to be plotted. The designer may select one of ten options for controlling the layout of beams. Seven of these options are for simple span units and three are for continuous units. In each option the designer specifies the beginning and ending bents for the unit and selects output options. In addition he gives information for controlling the geometry of the beams by one of four approaches. The discussion of input is grouped by these approaches which are as follows:

1. Give maximum and minimum overhang dimensions which establish the outside beams. Interior beams are automatically located according to the option selected.
2. Define all Beam Lines.
3. Define outside Beam Lines. Interior beams are automatically located according to the option selected.
4. Define outside Beam Lines and give maximum and minimum beam spacing. Interior beams are automatically located according to the option selected.

The FOPT process computes the intersections and all significant plan view frame dimensions taking into consideration specified bearing conditions. For this reason it is necessary for all of the pertinent transverse lines to be established prior to executing the FOPT commands.

Each FOPT command may apply to one or more consecutive simple spans (if option and data does not change) or to all of the spans of a continuous unit. It is advisable to define all the transverse and longitudinal elements that will be required for the entire structure and to enter FOPT commands for each unit from beginning to end.

It is important to remember that Beam Lines may consist of a straight line, a circle or a string of straight lines and/or circles defined by PSLB commands. If the Beam Line is a straight line, the beam will naturally coincide with the Beam Line. In the case of non-straight lines, the intersection of the Beam Lines with a bent or Splice Line determines points between which a straight beam will be located as illustrated below. (In Option 10 the beam coincides with the Beam Line in every case.)

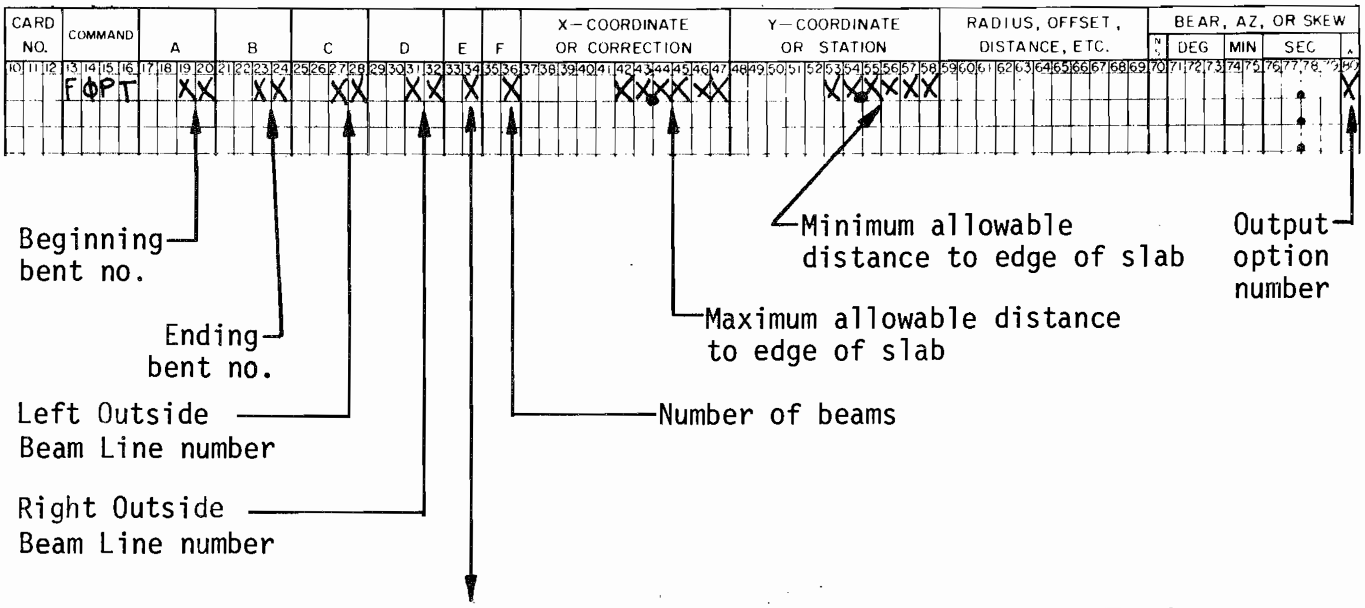


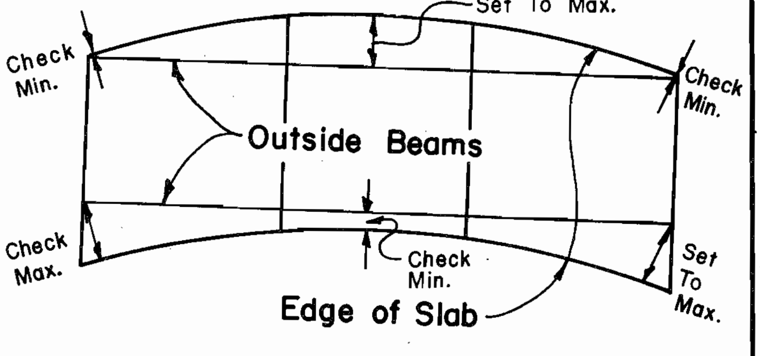
<u>An output option number must be selected for entry in the last column of each FOPT command</u>. The selections are as follows:

Zero or blank - Omit beam coordinate report
1 - Full output
2 - Omit plot of frame
3 - Omit beam coordinate report and plot of frame

Options where overhang defines outside beams, and interior beams are automatically located in accordance with option criteria. In these options the system attempts to place the outside Beam Lines between the two specified bents in such a manner that maximum and minimum distances from the edge of the slab are not violated. Slab edges must have been previously defined by the SLAB command. Outside Beam Line numbers may be any previously defined Beam Lines. Both outside and interior beams will be renumbered beginning with one for storage purposes. Beam Line numbers for interior beams need not be reserved. Outside beam numbers are used only for cases where no solution is possible and the system defaults to Option 3.

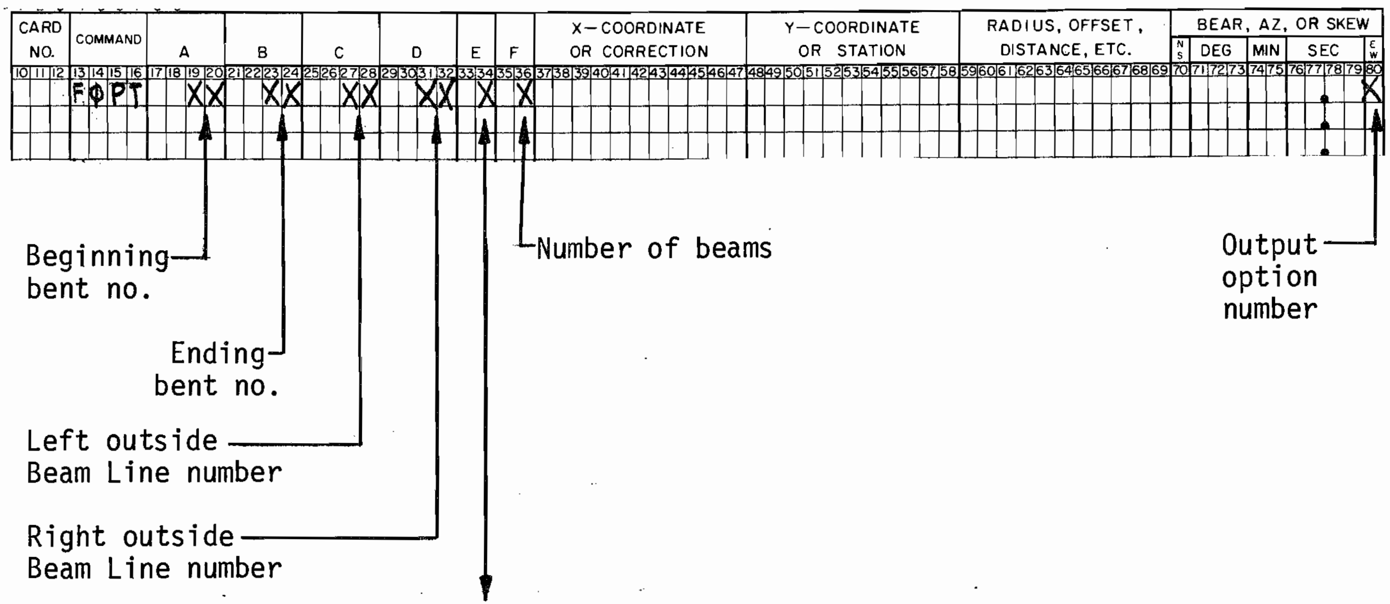
Options 1, 8 and 2.

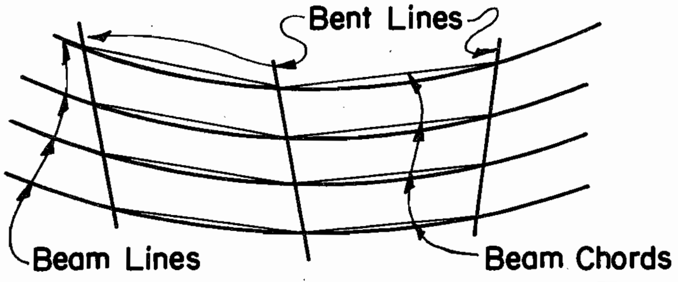
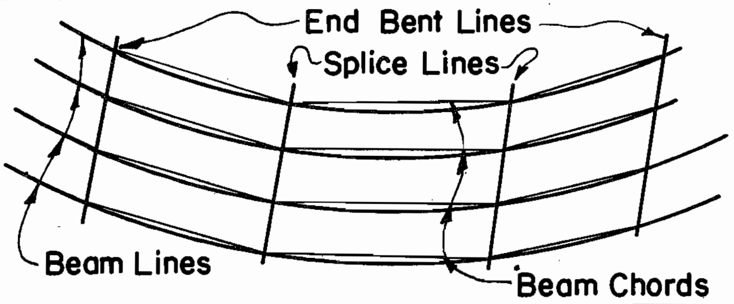
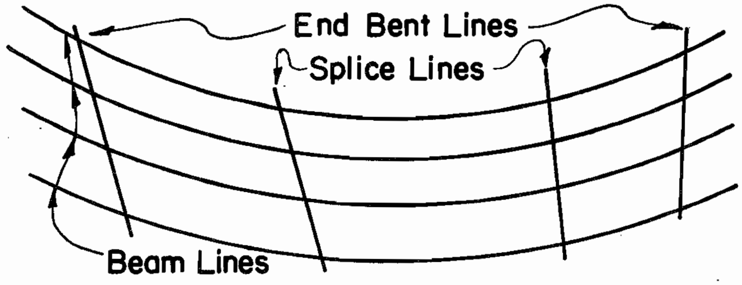


UNIT TYPE	OPTION	BEAM LOCATION CRITERIA
MULTIPLE SIMPLE SPANS	1	SHORT BRIDGE ON SMALL DEGREE CURVE  ALL BEAMS PARALLEL, EQUAL SPACING
CONTINUOUS UNIT	8	
SIMPLE SPAN	2	Same as above for one Span

Options where all Beam Lines are defined. All Beam Lines for the structure must be previously defined by one of the available methods and must be numbered consecutively from the left outside Beam to the right outside Beam. The beam placement is dependent on the intersection of the Beam Lines with bent or splice intersections in accordance with the options shown below.

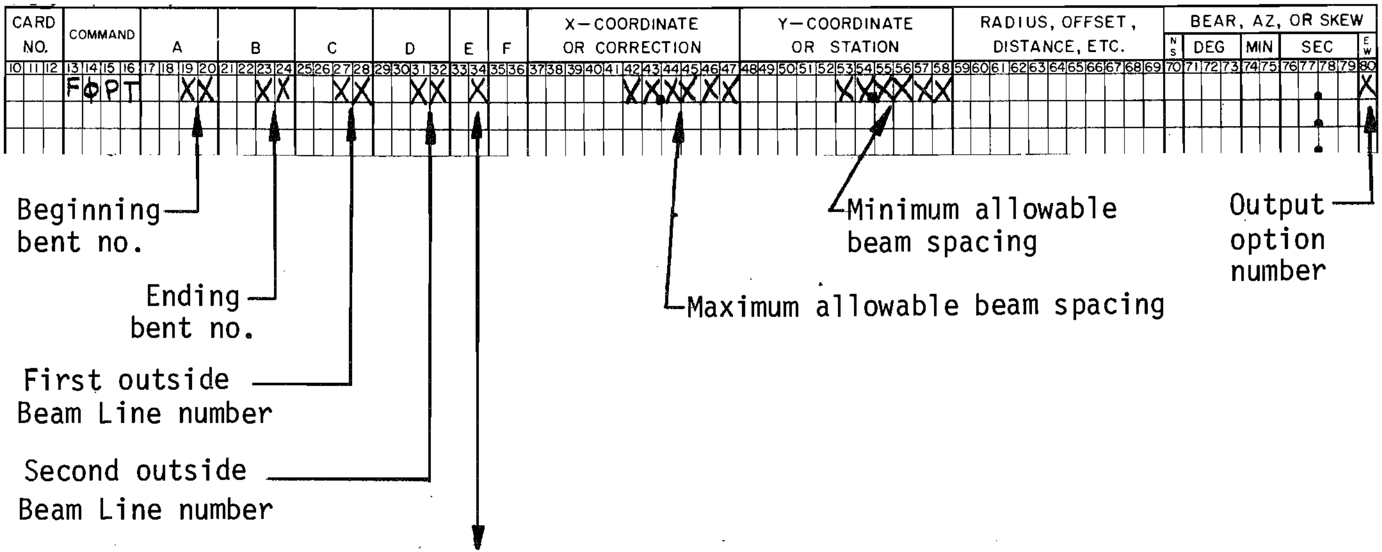
Options 4, 9 and 10.

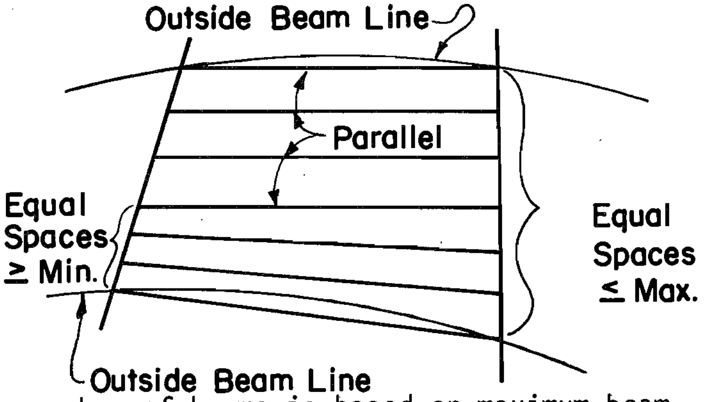
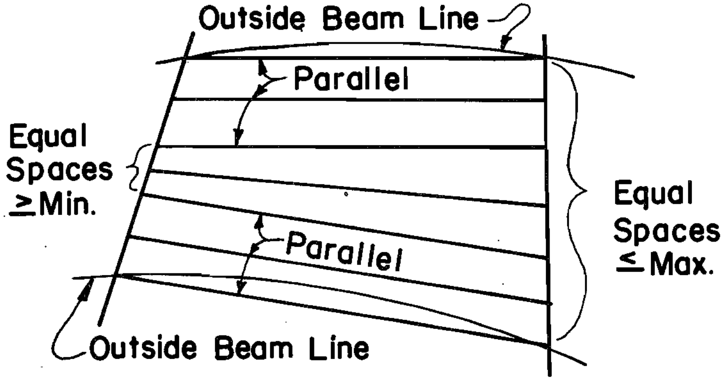


UNIT TYPE	OPTION	BEAM LOCATION CRITERIA
SIMPLE SPAN (Command may refer to more than I span if applicable)	4	
CONTINUOUS (Beams on Chords from Splice to Splice)	9	
CONTINUOUS (Beams follow Beam Lines)	10	

<u>Options where outside beams are defined and interior beams are automatically located based on maximum and minimum spacing in accordance with option criteria.</u> Outside beam numbers may be any previously defined Beam Lines. Both outside and interior beams will be renumbered beginning with one for storage purposes. Beam Line numbers for interior beams need not be reserved.

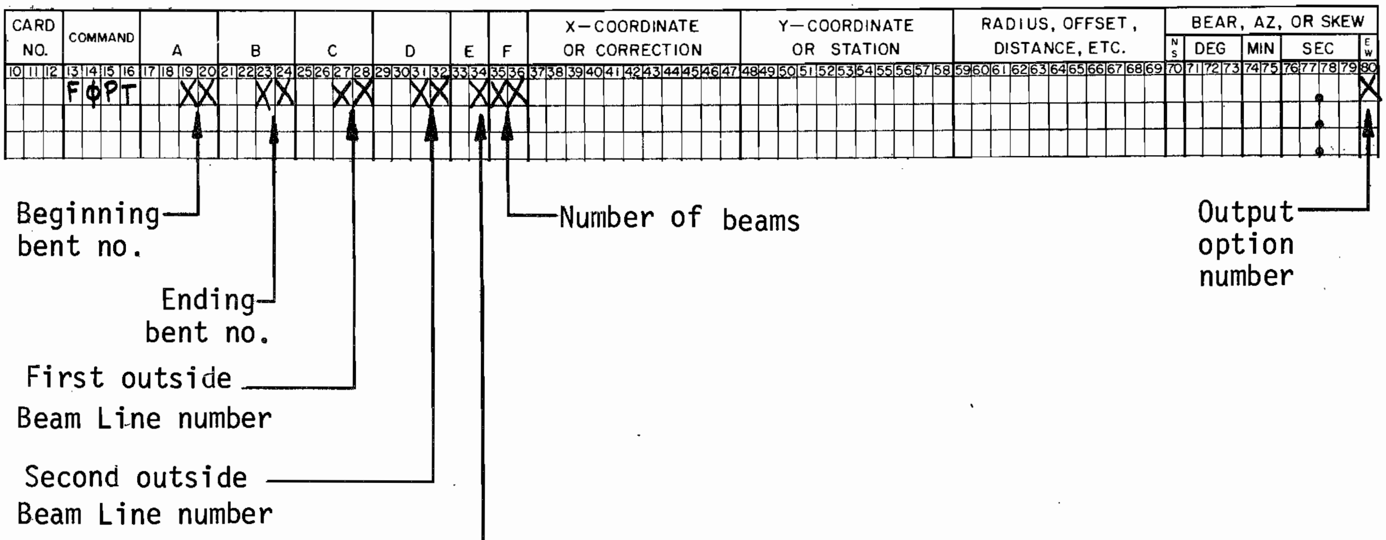
<u>Options 6 and 7.</u>

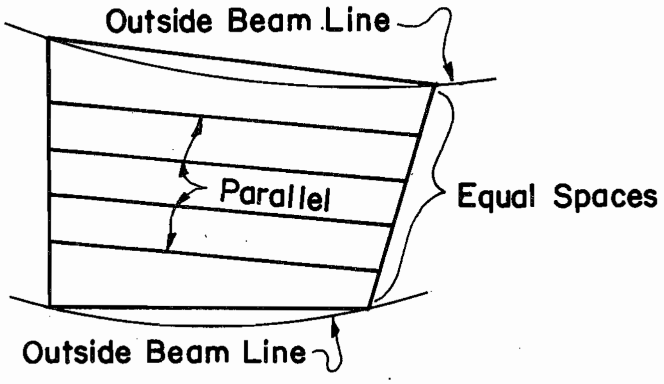
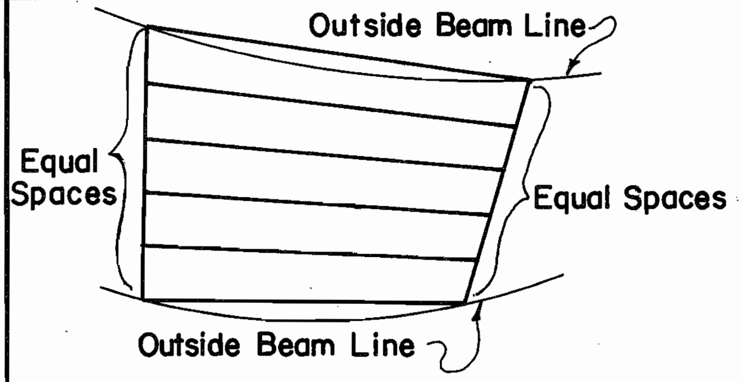


UNIT TYPE	OPTION	BEAM LOCATION CRITERIA
SIMPLE SPAN*	6	 The number of beams is based on maximum beam spacing on the longest bent. As many beams as possible are placed parallel to the first outside beam without violating minimum beam spacing. Remaining beams are flared.
SIMPLE SPAN* *(Command may refer to more than 1 span if applicable)	7	 The number of beams is based on maximum beam spacing on the longest bent. As many beams as possible are placed parallel to both outside beams without violating minimum beam spacing. Remaining beams are flared.

Options where outside beams are defined and interior beams are automatically located in accordance with option criteria. Outside Beam Line numbers may be any previously defined Beam Lines. Both outside and interior beams will be numbered beginning with one for storage purposes. Beam Line numbers for interior beams need not be reserved.

Options 3 and 5.



UNIT TYPE	OPTION	BEAM LOCATION CRITERIA
SIMPLE SPAN*	3	 Beams are spaced equally on the shortest bent. Interior beams are placed parallel to a line which joins the midpoints of the two bents.
SIMPLE SPAN* *(Command may refer to more than 1 span if applicable)	5	 Beams are equally spaced on both the back and forward bent.

GDES

The GDES command is used to transfer control to one of two programs for design of girders. In either case the bridge frame dimensions computed by the FOPT command will be used in the design of girder members of either simple or continuous units. A GDES command may specify the design of one or two beams of a unit and more than one GDES command may apply to the same unit.

The first design program is the Texas Highway Department Prestressed Concrete Girder Design Program. This program is a true design program which will take the computed span length and spacing and perform complete simple prestressed girder designs. The design will be for one of the standard Texas Highway Department shapes and will be based on the following criteria for slabs and beams.

SLAB TABLE

Slab Thickness	Max.Clear. to Flanges		Max.Clr.Flg.to Face of Rail			
			End of Span		Center of Span	
	H15	HS20	H15	HS20	H15	HS20
6 3/4	6.51	4.72	1.92	1.67	2.33	2.00
7	7.15	5.26	2.00	1.75	2.50	2.08
7 1/4	7.95	5.94	2.17	1.83	2.67	2.25
7 1/2	8.78	6.63	2.33	1.92	2.83	2.42
7 3/4		7.35	2.50	2.00	3.08	2.58
8		8.07	2.67	2.17	3.33	2.75
8 1/4		9.00	2.92	2.33	3.58	3.00

BEAM TABLE

Beam	Depth	Bear. Pad Thick.	Basic Span Limit
A	28"	3/4"	45'
B	34"	3/4"	60'
C	40"	1"	80'
54	54"	1 1/2"	100'
5M*	54"	1 3/4"	-
IV	54"	1 3/4"	125'
72	72"	1 3/4"	135'

The second design program provides for preliminary designs of continuous girders using the Continuous Beam Analysis (B-30) Program developed by the Georgia Highway Department and modified by the Texas Highway Department. The preliminary design procedure makes use of computed frame dimensions and will pre-establish some loading conditions and design criteria. The designer can override any of these criteria as will be discussed later. Since the design will be based on computed dimensions that are not available to the designer, he may express all span length ranges in terms of fractions of the span length in question. He may use any of the available

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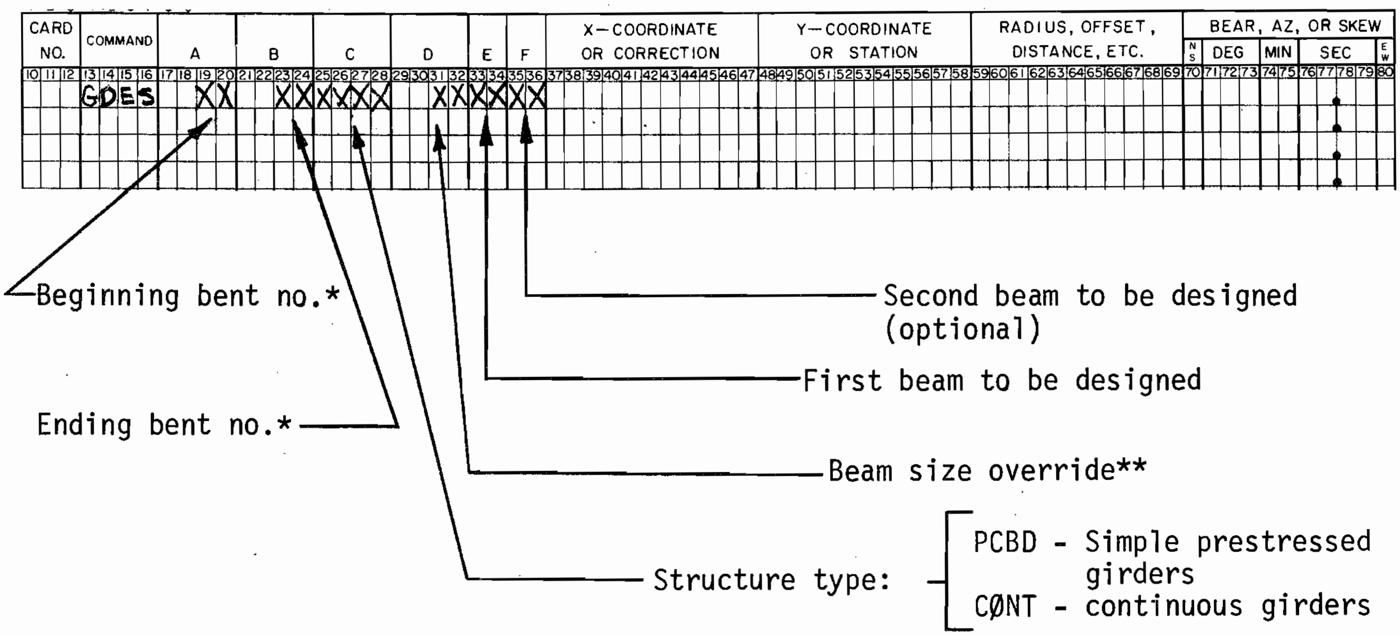
*This beam will not be selected by the program but may be used by the designer to obtain a prestressed beam design.

capabilities of the program in determining the girder configuration. These capabilities include rolled sections with or without plates, variable sections, plate girders, composite sections with or without plates, and variable section concrete girders and slabs. This provides the designer considerable flexibility but he will probably limit trial designs to less complex configurations. In the use of this program, the designer must provide supplementary data following the GDES command.

Input for the GDES command is shown below.



Beginning bent no.*

Second beam to be designed (optional)

First beam to be designed

Ending bent no.*

Beam size override**

Structure type:

PCBD - Simple prestressed girders
CØNT - continuous girders

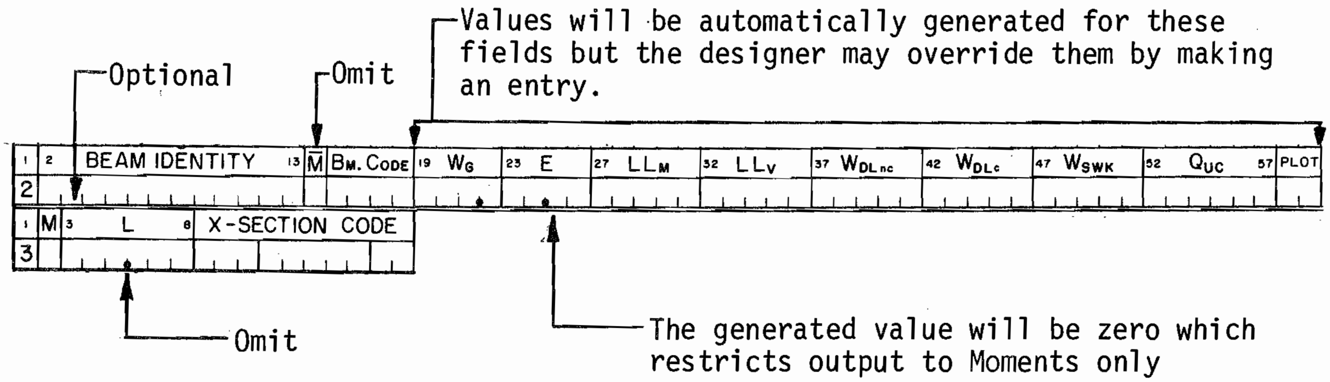
*May apply to one or more simple spans or one continuous unit.

**If the prestressed beam design program is used and the designer wishes to override the beam size selected by the program, any beam size from the BEAM TABLE on the preceding page may be entered here.

NOTE: If it is desired to design more than two beams for a set of simple spans or a continuous unit, this may be accomplished by entering additional GDES commands.

Additional data must follow a GDES command when it is for a continuous unit. The additional data for continuous units is essentially the same as the input for the Continuous Beam Analysis Program when used in a stand-alone mode. Familiarity with the use of this program is assumed and only the exceptions to the standard input will be discussed here.*

Card 1 is not essential and will be ignored if it is present. One Card 2 is required for each girder to be designed and a Card 3 is required for each span of the girder. Exceptions to completion of these cards are illustrated here.



Optional

Omit

Values will be automatically generated for these fields but the designer may override them by making an entry.

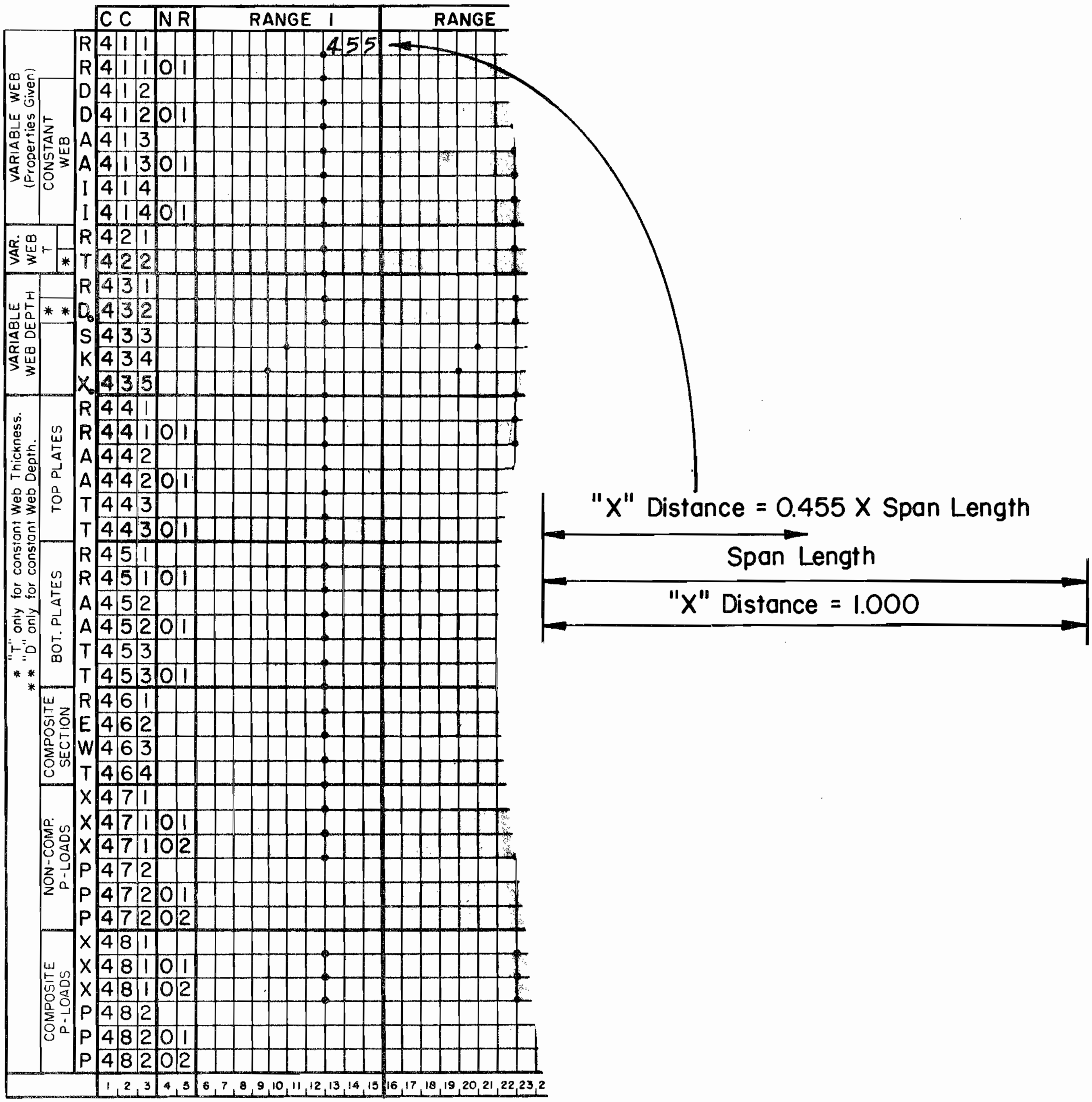
Omit

The generated value will be zero which restricts output to Moments only

NOTE: On Card 2 BM CODE must be entered, and on Card 3 M and X-SECTION CODE must be entered.

---

*A brief summary of the input to this program is shown in Appendix A.



				C C	N R	RANGE I	RANGE
VARIABLE WEB (Properties Given)	CONSTANT WEB		R	411		.455	
			R	411	01		
			D	412			
			D	412	01		
			A	413			
			A	413	01		
			I	414			
			I	414	01		
VAR. WEB T			R	421			
		*	T	422			
VARIABLE WEB DEPTH			R	431			
		* *	D	432			
			S	433			
			K	434			
			X	435			
* "T" only for constant Web Thickness. ** "D" only for constant Web Depth.	TOP PLATES		R	441			
			R	441	01		
			A	442			
			A	442	01		
			T	443			
			T	443	01		
	BOT. PLATES		R	451			
			R	451	01		
			A	452			
			A	452	01		
			T	453			
			T	453	01		
	COMPOSITE SECTION		R	461			
			E	462			
			W	463			
			T	464			
	NON-COMP. P-LOADS		X	471			
			X	471	01		
			X	471	02		
			P	472			
			P	472	01		
			P	472	02		
	COMPOSITE P-LOADS		X	481			
			X	481	01		
			X	481	02		
			P	482			
			P	482	01		
			P	482	02		

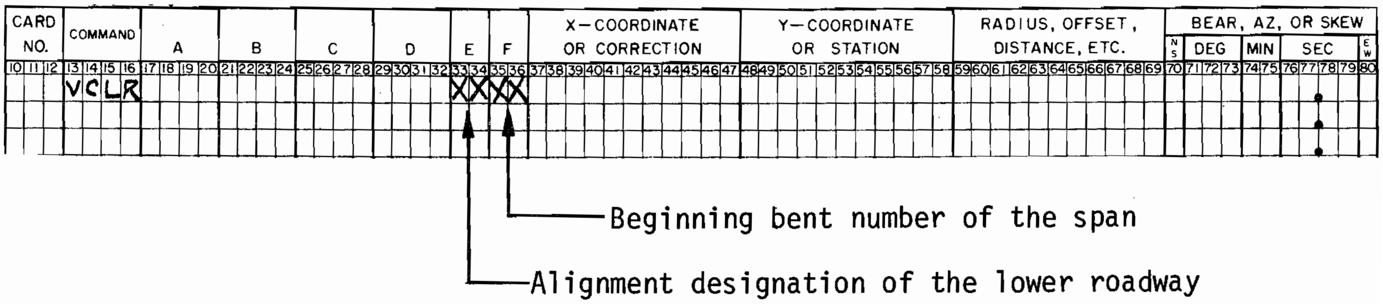
The remainder of the valid card types for a span may be used as the designer chooses with one general exception: the fraction of span length should be entered in <u>every case</u> where the standard entry would be in terms of "X" distance. This type of entry is illustrated here. In this scheme 1.000 would be entered for the total span length. (This scheme applies to card types 411, 421, 431, 435, 441, 451, 461, 471 and 481.)

The supplementary input for continuous units varies for specific cases, but a precise number of cards in proper order is required for each span for each condition. (If two girders are to be designed, two complete sets of data must be entered.) Another GDES command or any other command may follow this data.

The GDES command will produce a report showing the slab dimensions and other criteria used in the design. In addition the standard output of the specified design program will result.

VCLR

The VCLR command is used to request vertical clearances between structures and lower roadways. The span for which clearance is to be computed must be given by entering the beginning bent of the span and indicating the roadway in question as shown here.



Beginning bent number of the span

Alignment designation of the lower roadway

Vertical clearance to the lower roadway surface will be computed along Beam Lines. In the case of prestressed beams the clearance will be based on the straight line along the bottom of the beam. For continuous structures the clearance will be computed on the basis of distance from the Reference Line to the floor surface. (Reference Line is described under the SPLC command.) In either case the designer can modify the clearance as is necessary to take into account deflections or depths of the beam below the Reference Line.

CONT

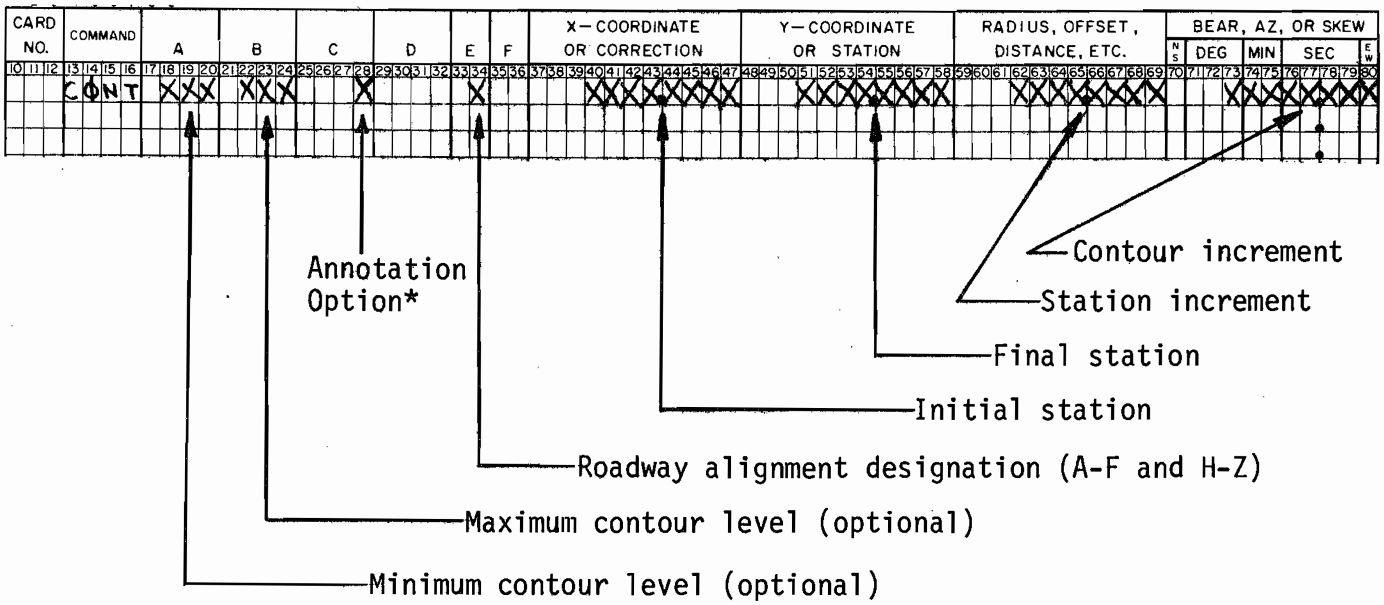
The CONT command produces contour plots of roadway surfaces for specified limits of roadways. It can be used by the bridge designer to determine roadway surface modifications needed in the area of ramp mergers by superimposing two sets of roadway surface contours on the same plot. It can also be used to examine drainage on bridge surfaces and for numerous other bridge design and roadway design applications.

Contours will be drawn at designated elevations; even-foot contour lines will be plotted with a symbol to identify them. Elevation values will appear at various places on the plot. The initial station of a contour plot will be drawn on the plot in an appropriate place. Symbols will be plotted to identify the ridge points. The area contoured will be all of the area defined by the templates in the region between the INITIAL STATION and the FINAL STATION.

The previously defined alignment is given in column E. The region to be contoured is specified by giving the INITIAL STATION and the FINAL STATION in columns X and Y. A STATION INCREMENT is given in the RADIUS, OFFSET, DISTANCE, ETC. column to specify the interval at which elevations are to be calculated for the contour interpolations. Since the contours are plotted as straight lines between interpolated points, the accuracy of the contour is dependent on the interval at which elevations are calculated. Therefore, large values of STATION INCREMENT should not be used except in regions where the contour lines are essentially straight lines. This value should not be too small either because this would increase the number of calculations that must be made and hence increase execution time. A value of 10.0 (feet) is generally satisfactory, although smaller values may be needed in extremely warped regions.

The CONTOUR INCREMENT value given in the BEARING column specifies the vertical interval at which contours are to be plotted. Normal values might be 0.1, 0.2, 1.0 (foot), etc. The user may specify the MAXIMUM CONTOUR LEVEL and/or the MINIMUM CONTOUR LEVEL in columns A and B if it is desired to omit contours above or below certain elevations. This is an optional feature; if no values are specified, the entire region will be contoured. The values entered in these columns must be integers (even feet).

An AXIS command must be given before any CONT commands are given. The contour plot will be drawn on the coordinate system and plotting field defined by the last AXIS command that precedes the CONT instruction. Plotting by other plot commands or by other CONT commands may be superimposed on the same plot.



*Options:

1 - Omit all annotations except station elevation summaries.
2 - Omit all annotations except beginning station.
Leave blank for standard annotation.

IV. Example Problems

Example problems 1 and 2 are for two ramps of a multi-level interchange which is shown on page 47. These structures were selected to illustrate a number of the possible options. The problems include command geometry computations to establish certain points and lines on the structures and computations of frame layout geometry, girder design, and vertical clearance. It should be noted that the horizontal alignments, vertical alignments and template data for these problems had been stored on tape on a previous run and only the input necessary for the above computations is included.

The first problem has two ramps (designated roadways H & I) merging together to form a flared, curved structure as shown on page 48. Five spans are included in this structure with a maximum of eight beams. Since all of the transverse lines needed for framing the structure can be established by stationing along roadway H, the designer has chosen to locate these items first. The geometry for the left and right slab lines is established next. For illustrative purposes a number of framing options have been used so that additional PSLB lines have been established parallel to the two slab lines. These PSLB lines are then designated as beam lines for the options requiring all beam lines to be previously defined. Each span has been framed using a different framing option. After the entire structure has been framed, the rightmost two beams of each span have been designed using the prestressed concrete beam design program. Complete input for problem 1 is shown on pages 50 to 54.

The second problem is a two-span continuous structure. The transverse lines needed to frame the structure have again been located first as shown on page 49. Both slab lines and all beam lines are parallel to roadway J, so that the beam group command has been used to establish the beam lines. The vertical clearance between span 2 and roadway K is determined by means of the VCLR command and an analysis of the preliminary design of girder number 4 is made using the Continuous Beam Analysis Program. Computer input for problem 2 is shown on pages 55 to 59.

The Bridge Geometry List output is shown on pages 60 to 65 for problem 1 and pages 66 to 69 for problem 2. This output closely follows the output of the RDS General Geometry List.

The Bent Report is similar for all options. For simple span options the number of beams may differ for the back and forward conditions, and the angle of the beam with the bent may differ for a given beam line. For continuous span options the number of beams is assumed to be the same for the back and forward conditions of a given bent in the area of continuity. The Bent Report contains the beam spacing along the centerline of the bent, the angles of the beams with the bent, and distances to facilitate the location of the center of bearing for each beam. The report also contains the directional bearing of the bent and the distance between the station line and beam number 1 as measured along the centerline of the bent. A sample Bent Report for a simple span option is shown on page 70; and for a continuous span option, on page 71.

For simple span options the Framing Report is by span with all beams of a given span in the same report. A sample of the Beam Report for simple spans is shown on page 72. A sample of the optional report giving the coordinates and elevations of the beam-bent intersections is shown on page 73.

For the continuous options, options 8-10, the Framing Report is given by beam line. All distances along a given beam line are printed in order beginning at the low station end. A sample Framing Report for a continuous option is shown on page 74. An optional report giving coordinates and elevations is shown on page 75.

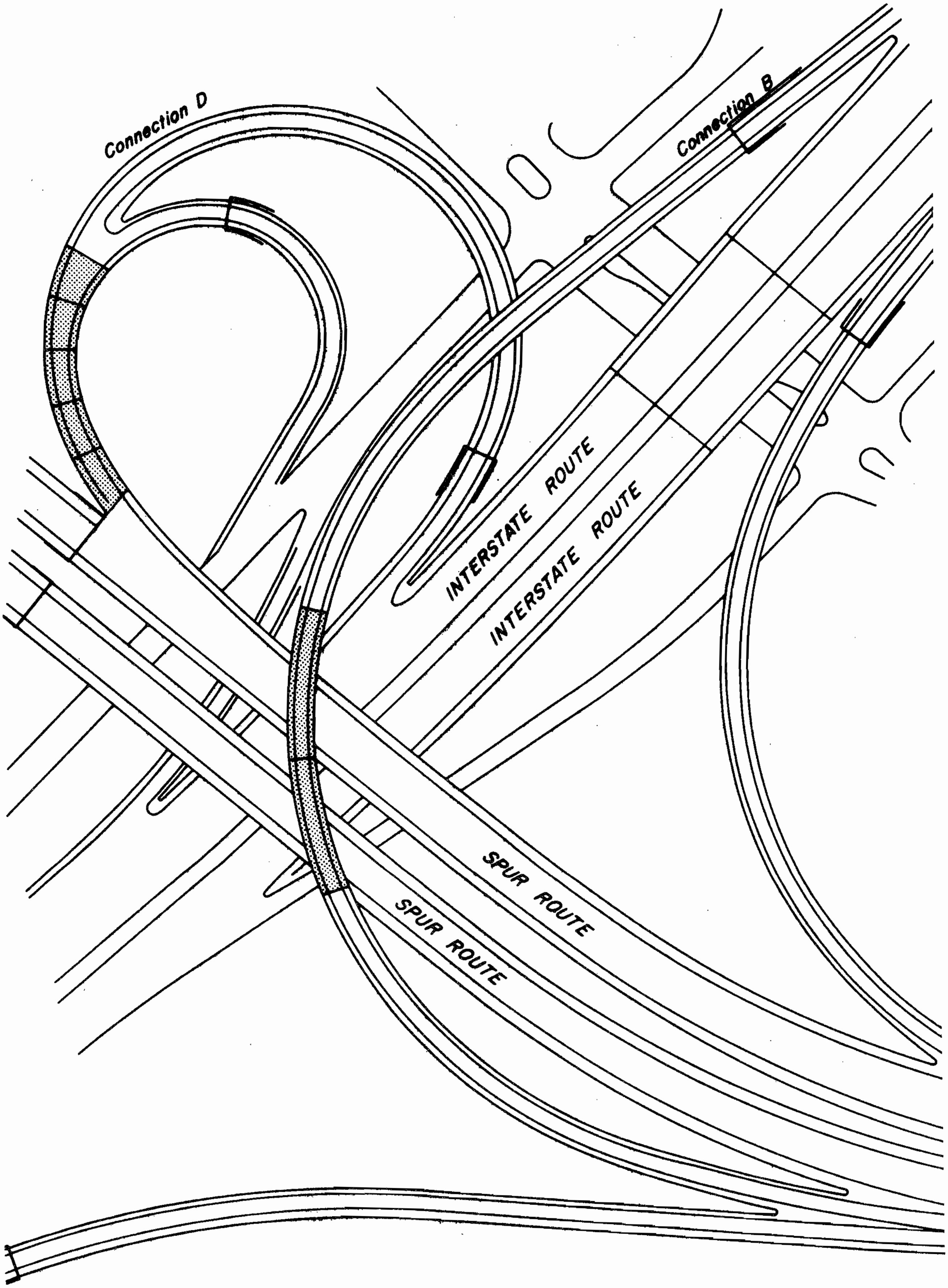
A Bearing Seat Elevation Report is given at the conclusion of the framing process. A sample of this report is given on pages 76 and 77 for problems 1 and 2 respectively.

Computed output from the framing option has been used as input to the Prestressed Concrete Girder Design program and the Continuous Beam Analysis program for problems 1 and 2, respectively. For the latter case, only moments have been computed because no Modulus of Elasticity was entered on card 2 of the supplemental input. Sample results are shown on page 78 for the prestressed girder program and pages 79 and 80 for the continuous beam analysis program.

To determine the vertical clearance between span 2 of roadway J and roadway K, each beam has been divided into ten parts. The vertical clearance between the previously established reference line of each beam and the roadway below has been computed at each of these points along the beam. It is up to the designer to determine the actual vertical clearance based on his knowledge of the geometrical configuration of the beam below the reference line. Sample output from the VCLR command is shown on page 81.

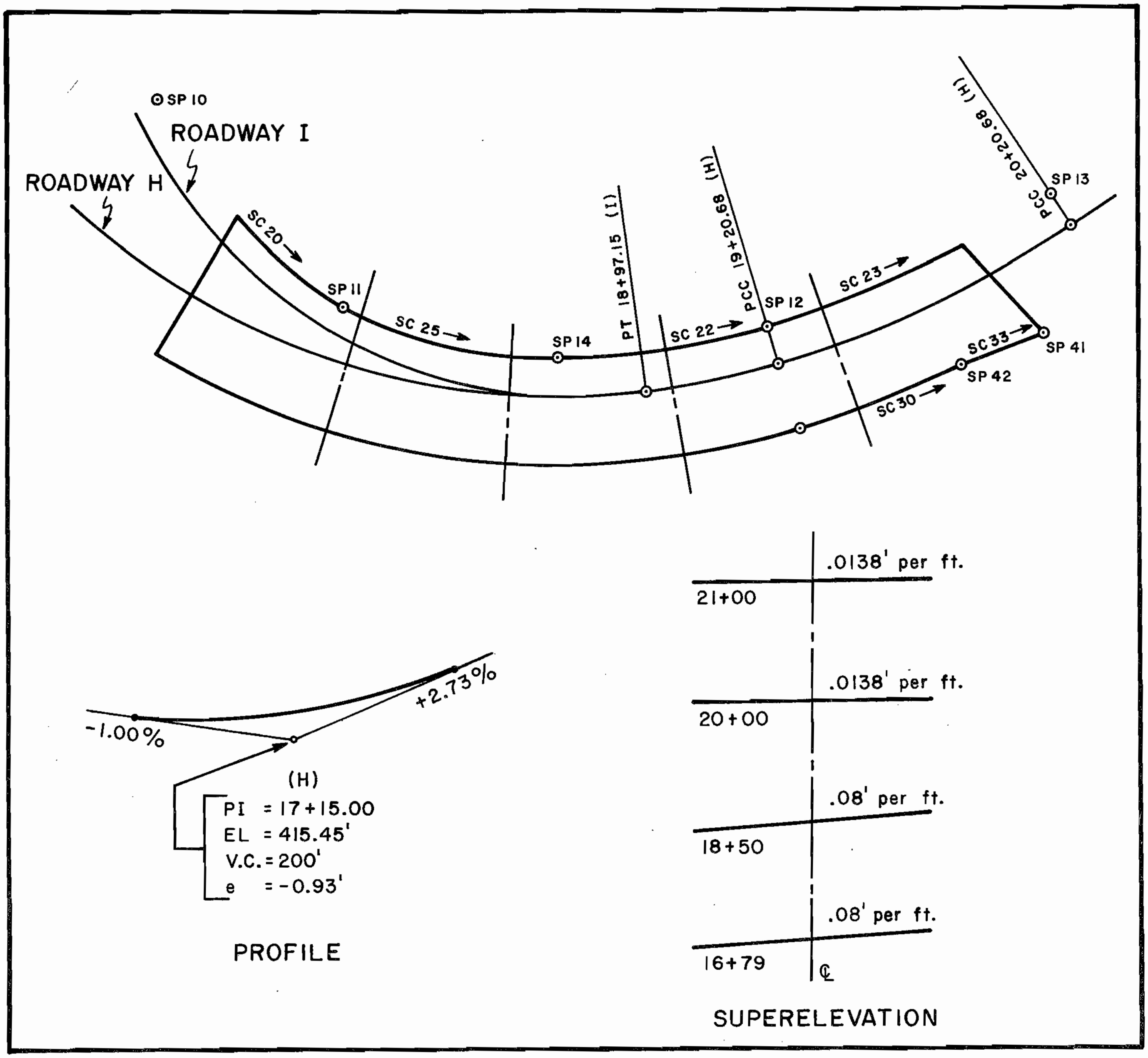
Bridge plots can be combined with any command structured plots or alignment plots as required by the designer. Only a new AXIS card needs to be input to begin a new plot page. For purposes of these example problems the slab and frame have been superimposed. While these framing plans were done on separate pages, the designer could have put them on the same page by using only one AXIS card. Sample plots of the bridges framed in problems 1 and 2 are shown on pages 82 and 83 respectively. A sample of a contour plot for problem 2 is shown on page 84.

For illustrative purposes, both bridges in the example problems have been framed in a single run. However, if the user chooses, he may design portions of the bridge on separate runs and store the results on tape. An engineering review can then be made before the final design.



Layout for Example Problems 1 and 2 for Two Ramps of a Multi-Level Interchange

EXAMPLE PROBLEM NUMBER ONE



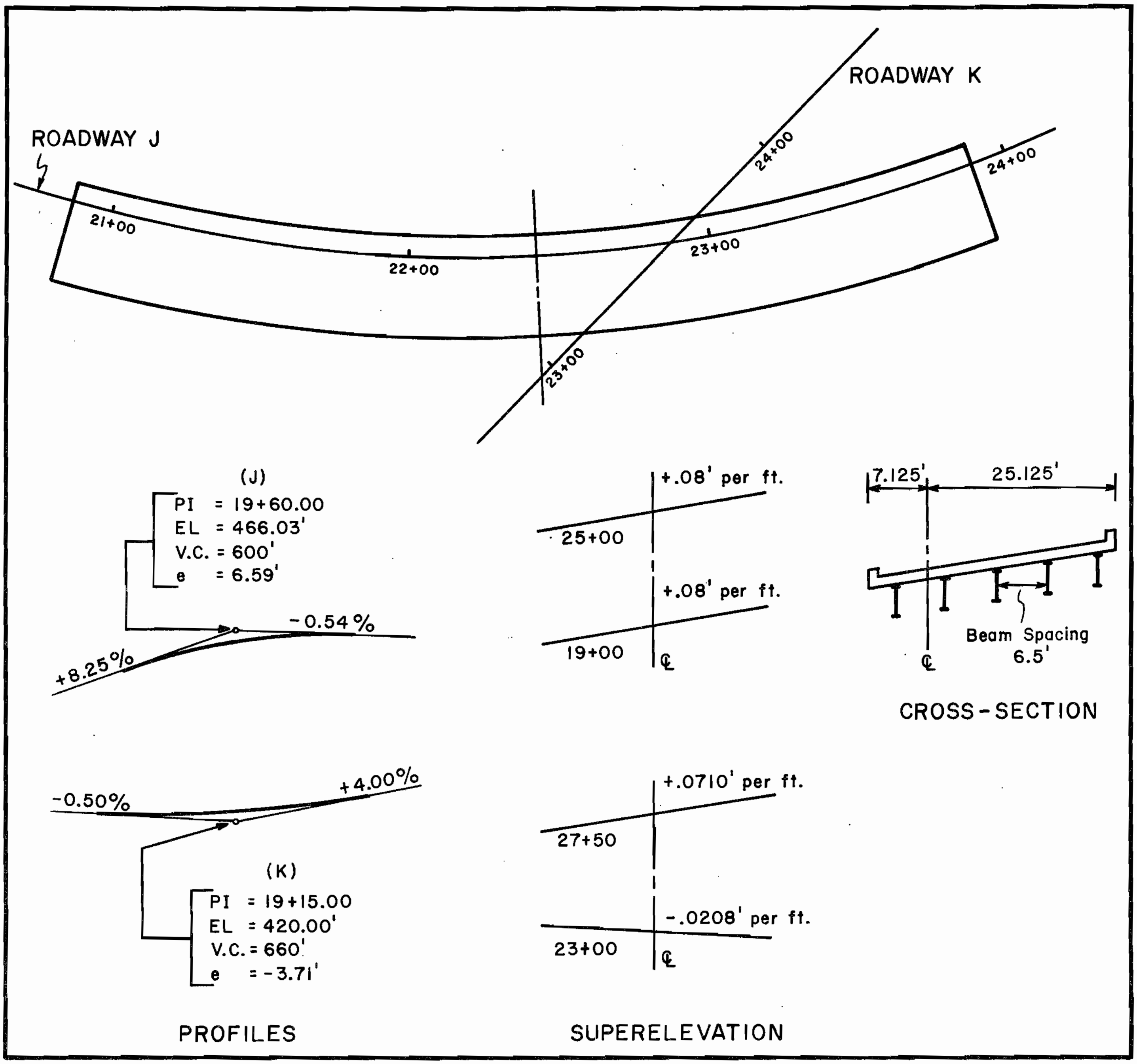
DIAPHRAGM AND BENT INFORMATION

Bent 6 is defined with a right forward skew of 16°37'36.00" at station 19+91.65. All other bents are radial to roadway H at the following stations:

17+31.00
17+83.00
18+35.00
18+87.00
19+39.00

A staggered diaphragm option has been used at station 17+57.00 in span 1; a radial diaphragm line is used at station 18+09.00 in span 2; and spans 3-5 have diaphragms at the mid-point of each span.

EXAMPLE PROBLEM NUMBER TWO


PROFILES

SUPERELEVATION

CROSS-SECTION

DIAPHRAGM AND BENT INFORMATION

All bent, diaphragm, and splice lines are radial to roadway J and cross the station line at the following stations:

Bents: 20+86.00, 22+41.04, 23+87.00

Diaphragms:
20+98.50
21+09.50
21+20.50
21+31.50
21+42.50
21+53.50
21+64.50
21+75.50
21+86.50
21+97.50
22+08.50
22+19.50
22+30.50
22+41.04
22+50.50
22+61.75
22+73.00
22+84.25
22+95.50
23+06.75
23+18.00
23+29.25
23+40.50
23+51.75
23+63.00
23+74.25

Splices: 21+88.00, 22+92.00

TEXAS HIGHWAY DEPARTMENT
TIES ROAD DESIGN SYSTEM
SYSTEM CARD

CONTROL & SECTION: 10101 (columns 1–7)

DISTRICT ________ RES. NO. ________
I.P.E. ________ PROJ. ________
CO. ________ HWY. ________

SHEET 1 OF 10
DATE MAY 27, 1973
PREPARED BY FA

	PROCESSES TO BE EXECUTED														JOB TYPE (OLD OR NEW)	KEEP (YES OR NO)	INIT. GEOM. FILES (YES OR NO)	INIT. DESIGN DATA FILES (YES OR NO)	INIT. BRG. FILES (YES OR NO)			COUNTY AND HIGHWAY	DATE
	CONTROL	COMMAND	TERRAIN	DESIGN DATA	ERWK DESIGN	VOLUMES	HAUL PLOT	XSEC PLOT	PROFILE PLOT	PERSP PLOT	BRIDGE												
SYSTEM		1									1				OLD	YES	NO	NO	NO			EXAMPLE PROBLEMS	
8–13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28–30	31–33	34–36	37–39	40–42	43–45	46–48	49–64	65–80

FORM 1322
REVISED 10/72

CONTROL & SECTION

1	2	3	4	5	6	7	8	9
	1	0	1	0	1	A	R	G

DISTRICT________ RES. NO.________
I. P. E.________ PROJ.________
CO.________ HWY.________

TEXAS HIGHWAY DEPARTMENT
TIES ROAD DESIGN SYSTEM
COMMAND STRUCTURED INPUT FORM

SHEET 2 OF 10
DATE MAY 27, 1973
PREPARED BY FH

CARD NO. (10-12)	COMMAND (13-16)	A (17-20)	B (21-24)	C (25-28)	D (29-32)	E (33-34)	F (35-36)	X—COORDINATE OR CORRECTION (37-47)	Y—COORDINATE OR STATION (48-58)	RADIUS, OFFSET, DISTANCE, ETC. (59-69)	N S (70)	DEG (71-73)	MIN (74-75)	SEC (76-79)	E W (80)
1	NAME	6	8	HS 20	ØVER	H		1600.	2100.	CØNNECTIØN	D	--	R	AMP	A
2	CMNT							LØCATE THE	TRANSVERSE	SLAB LINES.					
3	TSLB				1				1731.0						
4	TSLB				2				1783.0						
5	TSLB				3				1835.0						
6	TSLB				4				1887.0						
7	TSLB				5				1939.0						
8	TSLB			31	6				1991.65		R	16	37	36.	F
9	CMNT							LØCATE THE	BENTS.						
10	BENT				1		AB		1731.0	0.875					
11	BENT				2				1783.0	0.875					
12	BENT				3				1835.0	0.875					
13	BENT				4				1887.0	0.875					
14	BENT				5				1939.0	0.875					
15	BENT		31		6		TR			0.875					
16	CMNT							LØCATE THE	BEARING SEATS,	BEAM ENDS,			AND		
17	CMNT							REFERENCE	LINES FØR EACH	BENT.					
18	BRNG				1	2	FD	23.5	5.5	2.8958					
19	BRNG				2	2	BØ	23.5	5.5	2.8958					
20	BRNG				3	2	BØ	23.5	5.5	2.8958					
21	BRNG				4	2	BØ	23.5	5.5	2.8958					
22	BRNG				5	2	BØ	23.5	5.5	2.8958					
23	BRNG				6	2	BK	23.5	5.5	2.8958					
24	CMNT							LØCATE THE	DIAPHRAGMS.						
25	DIAF				1				1757.0		N	59	43	631	E
26	DIAF								1809.0		N	46	43	631	E
27	DIAF			3						2.0					
28	DIAF			4						2.0					
29	DIAF			5						2.0					
30	EJCT														

EXAMPLE PROBLEM 1

Page 1 of 4

Form 1323

CONTROL & SECTION

1	2	3	4	5	6	7	8	9
	1	0	1	0	1	A	R	G

DISTRICT
I. P. E.
CO.
RES. NO.
PROJ.
HWY.

TEXAS HIGHWAY DEPARTMENT
TIES ROAD DESIGN SYSTEM
COMMAND STRUCTURED INPUT FORM

SHEET 3 OF 10
DATE MAY 22, 1973
PREPARED BY FH

CARD NO. (10–12)	COMMAND (13–16)	A (17–20)	B (21–24)	C (25–28)	D (29–32)	E (33–34)	F (35–36)	X—COORDINATE OR CORRECTION (37–47)	Y—COORDINATE OR STATION (48–58)	RADIUS, OFFSET, DISTANCE, ETC. (59–69)	BEAR, AZ, OR SKEW N/S (70)	DEG (71–73)	MIN (74–75)	SEC (76–79)	E/W (80)
31	CMNT							ESTABLISH THE GEØMETRY NEEDED TØ DEFINE THE							
32	CMNT							LEFT EDGG ØF THE SLAB.							
33	PØNT	10				I			1700.	-7.125					
34	PØNT	11				I			1793.83	-7.125					
35	CURV	20				I			1700.	-7.125					
36	CURV	22				H			1851.	-10.125					
37	CURV	23				H			1921.	-10.125					
38	PØNT	12				H			1920.68	-10.125					
39	PØNT	13				H			2020.	-10.125					
40	PØNT	14				H			1850:08	-10.125					
41	CURV	11	21							120.					
42	CURV	14	24							120.					
43	ISCT	21	24	15		H									
44	CURV	15	11	25											
45	PSLB	1	10	20	11										
46	PSLB	1		25	14										
47	PSLB	1		22	12										
48	PSLB	1		23	13										
49	CMNT							ESTABLISH THE GEØMETRY NEEDED TØ DEFINE THE							
50	CMNT							RIGHT EDGE ØF THE SLAB.							
51	CURV	30				H			1971.	22.125					
52	PØNT	40				H			1991.65						
53	TRVS	40	31	41						25.998					
54	CURV	41	32							29.030					
55	ISCT	30	32		42										
56	BRDS	42	41	33											
57	PSLB	2				H		1650.	1920.68	22.125					
58	PSLB	2		30	42										
59	PSLB	2		33	41										

EXAMPLE PROBLEM 1

Page 2 of 4

CONTROL & SECTION
1 0 1 0 1 A R G

DISTRICT______ RES. NO.______
I. P. E.______ PROJ.______
CO.______ HWY.______

TEXAS HIGHWAY DEPARTMENT
TIES ROAD DESIGN SYSTEM
COMMAND STRUCTURED INPUT FORM

SHEET 4 OF 10
DATE MAY 27, 1973
PREPARED BY FH

CARD NO.	COMMAND	A	B	C	D	E	F	X—COORDINATE OR CORRECTION	Y—COORDINATE OR STATION	RADIUS, OFFSET, DISTANCE, ETC.	N/S	DEG	MIN	SEC	E/W
60	CMNT							DEFINE 'PSLB' LINES THAT WILL BE USED TØ							
61	CMNT							ESTABLISH BEAM LINES.							
62	PSLB	4					1			3.625					
63	PSLB	5					2			-21.886					
64	PSLB	6					2			-15.145					
65	PSLB	7					2			-8.404					
66	PSLB	8					2			-1.663					
67	CMNT							DESIGNATE 'PSLB' LINES 4 - 8 TØ BE BEAM							
68	CMNT							LINES 1 - 5.							
69	BEAM				4		1								
70	BEAM				5		2								
71	BEAM				6		3								
72	BEAM				7		4								
73	BEAM				8		5								
74	CMNT							ESTABLISH AN 'AXIS' CARD TØ SET UP FØR PLØT.							
75	AXIS	50	29					210800.	106800.	20.	N	90			E
76	CMNT							DEFINE THE SLAB AND DESIGN THE FRAME FØR							
77	CMNT							SPAN 1 USING ØPTIØN 7.							
78	SLAB	1	2	1	2			7.5							
79	FØPT	1	2	1	5	7		7.0	3.0						
80	CMNT							DEFINE THE SLAB AND DESIGN THE FRAME FØR							
81	CMNT							SPAN 2 USING ØPTIØN 6.							
82	SLAB	2	3	1	2			7.5							
83	FØPT	2	3	1	5	6		7.0	4.0						
84	CMNT							DEFINE THE SLAB AND DESIGN THE FRAME FØR							
85	CMNT							SPAN 3 USING ØPTIØN 5.							
86	SLAB	3	4	1	2			7.5							
87	FØPT	3	4	1	5	5	5								

EXAMPLE PROBLEM 1

Page 3 of 4

TEXAS HIGHWAY DEPARTMENT
TIES ROAD DESIGN SYSTEM
COMMAND STRUCTURED INPUT FORM

CONTROL & SECTION: 10101A RG

DISTRICT_____ RES. NO._____
I.P.E._____ PROJ._____
CO._____ HWY._____

SHEET 5 OF
DATE MAY 27, 1973
PREPARED BY FH

CARD NO.	COMMAND	A	B	C	D	E	F	X-COORDINATE OR CORRECTION	Y-COORDINATE OR STATION	RADIUS, OFFSET, DISTANCE, ETC.	BEAR, AZ, OR SKEW
88	CMNT							DEFINE THE	SLAB AND DE	SIGN THE FRA	ME FOR
89	CMNT							SPAN 4 USIN	G OPTION 4.		
90	SLAB	4	5	1	2			7.5			
91	FOPT	4	5	1	5	4	5				
92	CMNT							DEFINE THE	SLAB AND DE	SIGN THE FRA	ME FOR
93	CMNT							SPAN 5 USIN	G OPTION 3.		
94	SLAB	5	6	1	2			7.5			
95	FOPT	5	6	1	5	3	5				
96	EJCT										
97	CMNT							DESIGN THE	RIGHTMOST 2	GIRDERS IN	ALL SPANS.
98	GDES	1	2	PCBD		7	8				
99	GDES	2	3	PCBD		5	6				
100	GDES	3	6	PCBD		4	5				

EXAMPLE PROBLEM 1

Page 4 of 4

Form 1323

TEXAS HIGHWAY DEPARTMENT
TIES ROAD DESIGN SYSTEM
COMMAND STRUCTURED INPUT FORM

CONTROL & SECTION: 10101B RG

DISTRICT______ RES. NO.______
I.P.E.______ PROJ.______
CO.______ HWY.______

SHEET 6 OF 10
DATE MAY 27, 1973
PREPARED BY FH

CARD NO.	COMMAND	A	B	C	D	E	F	X-COORDINATE OR CORRECTION	Y-COORDINATE OR STATION	RADIUS, OFFSET, DISTANCE, ETC.	N/S	DEG	MIN	SEC	E/W
1	NAME	3	5	HS20	0VER	J		2000.0	2500.0	CONNECTION	B				
2	CMNT							LOCATE THE TRANSVERSE SLAB LINES.							
3	TSLB				1				2086.0						
4	TSLB				2				2387.0						
5	CMNT							LOCATE THE BENTS.							
6	BENT				1				2086.0	0.8958					
7	BENT				2				2241.04	0.8958					
8	BENT				3				2387.0	0.8958					
9	CMNT							LOCATE THE BEARING SEATS, BEAM ENDS, AND							
10	CMNT							REFERENCE LINES FOR EACH BENT.							
11	BRNG				1	1	FD	27.0	20.0	4.533					
12	BRNG				2	1	BO			4.645					
13	BRNG				3	1	BK	27.0	20.0	4.491					
14	CMNT							LOCATE THE SPLICES.							
15	SPLC				1				2188.0	0.8958					
16	SPLC				2				2292.0	0.8958					
17	CMNT							LOCATE THE DIAPHRAGMS.							
18	DIAF								2098.5						
19									2109.5						
20									2120.5						
21									2131.5						
22									2142.5						
23									2153.5						
24									2164.5						
25									2175.5						
26									2186.5						
27									2197.5						
28									2208.5						
29									2219.5						
30	DIAF								2230.5						

EXAMPLE PROBLEM 2

Page 1 of 5

TEXAS HIGHWAY DEPARTMENT
TIES ROAD DESIGN SYSTEM
COMMAND STRUCTURED INPUT FORM

CONTROL & SECTION ☐☐☐☐☐☐☐ RG

DISTRICT ______ RES. NO. ______
I. P. E. ______ PROJ. ______
CO. ______ HWY. ______

SHEET 7 OF 10
DATE MAY 27, 1973
PREPARED BY F H

CARD NO.	COMMAND	A	B	C	D	E	F	X–COORDINATE OR CORRECTION	Y–COORDINATE OR STATION	RADIUS, OFFSET, DISTANCE, ETC.	N/S	DEG	MIN	SEC	E/W
31	DIAF								2241.04						
32									2250.5						
33									2261.75						
34									2273.0						
35									2284.25						
36									2295.5						
37									2306.75						
38									2318.0						
39									2329.25						
40									2340.5						
41									2351.75						
42									2363.0						
43	DIAF								2374.25						
44	CMNT							DEFINE 'PSLB' LINES PARALLEL TO THE RØADWAY							
45	CMNT							AT ØFSETS ØF -7.125 AND 25.125 FEET.							
46	PSLB	1								-7.125					
47	PSLB	2								25.125					
48	CMNT							THE BEAMS ARE PARALLEL TØ THE RØADWAY AT A							
49	CMNT							UNIFØRM SPACING ØF 6.5 FEET.							
50	BGRP					1	5	6.5	2086.0	-4.0					
51	CMNT							ESTABLISH AN 'AXIS' CARD TØ SET UP FØR PLØT.							
52	AXIS	50	29					211200.	106800.	20.	N	90			E
53	CMNT							DEFINE THE SLAB AND DESIGN THE FRAME FØR							
54	CMNT							SPANS 1 & 2 USING ØPTIØN 10.							
55	SLAB	1	2	1	2			8.0							
56	FØPT	1	3	1	5	10	5								
57	CMNT							ESTABLISH AN 'AXIS' CARD AND CØNTØUR THE							
58	CMNT							SLAB.							
59	AXIS	50	29					211200.	106800.	20.	N	90			E
60	SLAB	1	2	1	2										

EXAMPLE PROBLEM 2

Page 2 of 5

CONTROL & SECTION

RG

DISTRICT________ RES. NO.________

I. P. E.________ PROJ.________

CO.________ HWY.________

TEXAS HIGHWAY DEPARTMENT
TIES ROAD DESIGN SYSTEM
COMMAND STRUCTURED INPUT FORM

SHEET 8 OF 10

DATE MAY 27, 1973

PREPARED BY FH

CARD NO.	COMMAND	A	B	C	D	E	F	X—COORDINATE OR CORRECTION	Y—COORDINATE OR STATION	RADIUS, OFFSET, DISTANCE, ETC.	BEAR, AZ, OR SKEW N/S	DEG	MIN	SEC	E/W
61	CONT					J		2086.	2387.	10.				0.2	
62	CMNT							DETERMINE THE VERTICAL CLEARANCE BETWEEN							
63	CMNT							SPAN 2 AND ROADWAY 'K'.							
64	VCLR					K	2								
65	CMNT							DESIGN GIRDER NO. 4.							
66	GDES	1	3	CONT		4									

EXAMPLE PROBLEM 2

Page 3 of 5

Form 1323

File 19.129C Form 1255 Rev. 7-68

TEXAS HIGHWAY DEPARTMENT
CONTINUOUS BEAM ANALYSIS

COUNTY
CONTROL NO. 101 SEC 01
HIGHWAY NO. I.P.E.

MADE BY FH Date 5/27/3
CHECKED BY Date
PROB. NO. B SHEET 9 of 10

B 30

1 PROB. NO. 6

1 2 BEAM IDENTITY 13 $\bar{M}$ BM. CODE 19 WG 23 E 27 LLM
2

1 M 3 L 8 X-SECTION CODE
3 1 1111 1

* "T" only for constant Web Thickness.
** "D" only for constant Web Depth.

		C	C		N	R	RANGE 1										RANGE 2										RA	
VARIABLE WEB (Properties Given) CONSTANT WEB	R	4	1	1																								
	R	4	1	1	0	1																						
	D	4	1	2		1						5	0															
	D	4	1	2	0	1																						
	A	4	1	3		1						2	8	1	2	5												
	A	4	1	3	0	1																						
	I	4	1	4		1				5	8	5	9	4														
	I	4	1	4	0	1																						
VAR. WEB T *	R	4	2	1																								
	T	4	2	2																								
VARIABLE WEB DEPTH * *	R	4	3	1																								
	D°	4	3	2																								
	S	4	3	3																								
	K	4	3	4																								
	X°	4	3	5																								
TOP PLATES	R	4	4	1		2								8									1	0				
	R	4	4	1	0	1																						
	A	4	4	2		2						2	5									5	4					
	A	4	4	2	0	1																						
	T	4	4	3		2							1	2	5								2	2	5			
	T	4	4	3	0	1																						
BOT. PLATES	R	4	5	1		2								8									1	0				
	R	4	5	1	0	1																						
	A	4	5	2		2						3	5									5	4					
	A	4	5	2	0	1																						
	T	4	5	3		2							1	7	5								2	2	5			
	T	4	5	3	0	1																						
COMPOSITE SECTION	R	4	6	1		2								7									1					
	E	4	6	2		2							3	7	5													
	W	4	6	3		2						7	7															
	T	4	6	4		2							7															
NON-COMP. P-LOADS	X	4	7	1																								
	X	4	7	1	0	1																						
	X	4	7	1	0	2																						
	P	4	7	2																								
	P	4	7	2	0	1																						
	P	4	7	2	0	2																						
COMPOSITE P-LOADS	X	4	8	1																								
	X	4	8	1	0	1																						
	X	4	8	1	0	2																						
	P	4	8	2																								
	P	4	8	2	0	1																						
	P	4	8	2	0	2																						
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27

File 19.129C Form 1255 Rev. 7-68

TEXAS HIGHWAY DEPARTMENT
CONTINUOUS BEAM ANALYSIS

COUNTY
CONTROL NO. 101 SEC 01
HIGHWAY NO. I.P.E.

MADE BY FH Date 5/27/73
CHECKED BY Date
PROB. NO. B SHEET 10 of 10

B 30

EXAMPLE PROBLEM 2

Page 5 of 5

* "T" only for constant Web Thickness.
** "D" only for constant Web Depth.

	COMPOSITE P-LOADS						NON-COMP. P-LOADS						COMPOSITE SECTION				BOT. PLATES						TOP PLATES						VARIABLE WEB DEPTH			**		VAR. WEB T *		VARIABLE WEB (Properties Given) CONSTANT WEB								
	P	P	P	X	X	X	P	P	P	X	X	X	T	W	E	R	T	T	A	A	R	R	T	T	A	A	R	R	X	K	S	D	R	T	R	I	I	A	A	D	D	R	R	
1	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	CC
2	8	8	8	8	8	8	7	7	7	7	7	7	6	6	6	6	5	5	5	5	5	5	4	4	4	4	4	4	3	3	3	3	3	2	2	—	—	—	—	—	—	—	—	
3	2	2	2	—	—	—	2	2	2	—	—	—	4	3	2	—	3	3	2	2	—	—	3	3	2	2	—	—	5	4	3	2	—	2	—	4	4	3	3	2	2	—	—	
4	0	0		0	0		0	0		0	0						0		0		0		0		0		0									0		0		0		0		NR
5	2	—		2	—		2	—		2	—		2	2	2	2	—	2	—	2	—	2	—	2	—	2	—	2								—	/	—	/	—	/	—		
6																																												RANGE 1
9																																					58594							
11																				54						54													28125		50			
12																		225						225																				
13																3						18						18																
16																																												RANGE 2
21														77						25						20																		
22													7		375	1						1		1				1																
23																		125																										
26																																												RA

1	3	1	2	1
2	2	M	2	PROB. NO.
3		3 L	BEAM IDENTITY	
6				6
8		8 X-SECTION CODE		
9	1			
10	1			
11	1			
13			13 $\bar{M}$	
14	1		Bm. CODE	
19			19 WG	
23			23 E	
27			27 LLM	

```
                                                                                                     11
    TEXAS HIGHWAY DEPARTMENT          T I E S  ROADWAY DESIGN SUBSYSTEM          *** BRIDGE GEOMETRICS ***
    CONNECTION D -- RAMP A                                                                 MAY 27, 1973
    CONTROL  101 SECTION 01                                            COUNTY & HIGHWAY - EXAMPLE PROBLEMS

                                          BRIDGE GEOMETRY LIST

CD COMMAND  A    B    C    D   E  F X-COORDINATE Y-COORDINATE RADIUS,OFFSET  ELEV.   BEAR,AZ,SKEW     STORE
NO                                 OR CORRECTION  OR STATION  DISTANCE,ETC.           D   M    S

  1 NAME     6    8 HS20 OVER  H  0    1600.0000    2100.0000 CONNECTION D -- RAMP A                  STR    1

   ****LOCATE THE TRANSVERSE SLAB LINES.

  3 TSLB     0    0    0    1  0  0       0.0       1731.0000       0.0                0  0  0.0
                                     211023.4041  106690.6279   1731.0000    0.0  S  66 13 10.23 W

  4 TSLB     0    0    0    2  0  0       0.0       1783.0000       0.0                0  0  0.0
                                     211049.5680  106645.8186   1783.0000    0.0  S  53 13 10.23 W

  5 TSLB     0    0    0    3  0  0       0.0       1835.0000       0.0                0  0  0.0
                                     211085.1413  106608.0435   1835.0000    0.0  S  40 13 10.23 W

  6 TSLB     0    0    0    4  0  0       0.0       1887.0000       0.0                0  0  0.0
                                     211128.3004  106579.2387   1887.0000    0.0  S  27 13 10.23 W

  7 TSLB     0    0    0    5  0  0       0.0       1939.0000       0.0                0  0  0.0
                                     211176.7590  106560.6280   1939.0000    0.0  S  15 52  5.09 W

  8 TSLB     0    0   31    6  0  0       0.0       1991.6500       0.0             R  16 37 36.00 F
                                     211228.2768  106550.0003   1991.6500    0.0  S   9 10 57.31 E  SC    31

   ****LOCATE THE BENTS.

 10 BENT     0    0    0    1    AB       0.0       1731.0000       0.8750             0  0  0.0
                                     211023.4041  106690.6279   1731.0000    0.0  S  66 13 10.23 W

 11 BENT     0    0    0    2             0.0       1783.0000       0.8750             0  0  0.0
                                     211049.5680  106645.8186   1783.0000    0.0  S  53 13 10.23 W

 12 BENT     0    0    0    3             0.0       1835.0000       0.8750             0  0  0.0
                                     211085.1413  106608.0435   1835.0000    0.0  S  40 13 10.23 W

 13 BENT     0    0    0    4             0.0       1887.0000       0.8750             0  0  0.0
                                     211128.3004  106579.2387   1887.0000    0.0  S  27 13 10.23 W
```

TYPICAL BRIDGE COMMAND OUTPUT FOR PROBLEM 1

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                                                                                                          12
     TEXAS HIGHWAY DEPARTMENT           T I E S  ROADWAY DESIGN SUBSYSTEM           *** BRIDGE GEOMETRICS ***
     CONNECTION D -- RAMP A                                                                  MAY 27, 1973
     CONTROL  101 SECTION 01                                               COUNTY & HIGHWAY - EXAMPLE PROBLEMS

                                                 BRIDGE GEOMETRY LIST

CD COMMAND   A    B    C    D   E  F X-COORDINATE Y-COORDINATE RADIUS,OFFSET  ELEV.   BEAR,AZ,SKEW     STORE
NO                                   OR CORRECTION  OR STATION  DISTANCE,ETC.           D   M   S

 14 BENT     0    0    0    5               0.0     1939.0000      0.8750              0   0  0.0
                                    211176.7590  106560.6280   1939.0000    0.0  S  15  52  5.09 W

 15 BENT     0   31    0    6     TR        0.0          0.0       0.8750              0   0  0.0
                                    211228.2768  106550.0003   1991.6500    0.0  S   9  10 57.31 E

    ****LOCATE THE BEARING SEATS, BEAM ENDS, AND

    ****REFERENCE LINES FOR EACH BENT.

 18 BRNG     0    0    0    1  2 FD     23.5000       5.5000       2.8958              0   0  0.0

 19 BRNG     0    0    0    2  2 BO     23.5000       5.5000       2.8958              0   0  0.0

 20 BRNG     0    0    0    3  2 BO     23.5000       5.5000       2.8958              0   0  0.0

 21 BRNG     0    0    0    4  2 BO     23.5000       5.5000       2.8958              0   0  0.0

 22 BRNG     0    0    0    5  2 BO     23.5000       5.5000       2.8958              0   0  0.0

 23 BRNG     0    0    0    6  2 BK     23.5000       5.5000       2.8958              0   0  0.0

    ****LOCATE THE DIAPHRAGMS.

 25 DIAF     0    0    0    1  0  0         0.0     1757.0000         0.0           N  59  43  6.31 E
                                    211035.2138  106667.4804   1757.0000    0.0  N  59  43  6.31 E

 26 DIAF     0    0    0    0  0  0         0.0     1809.0000         0.0           N  46  43  6.31 E
                                    211066.2822  106625.9211   1809.0000    0.0  N  46  43  6.31 E

 27 DIAF     0    0    3    0  0  0         0.0          0.0       2.0000              0   0  0.0

 28 DIAF     0    0    4    0  0  0         0.0          0.0       2.0000              0   0  0.0

 29 DIAF     0    0    5    0  0  0         0.0          0.0       2.0000              0   0  0.0
```

TYPICAL BRIDGE COMMAND OUTPUT FOR PROBLEM 1

```
                                                                                                                   12
      TEXAS HIGHWAY DEPARTMENT         T I E S  ROADWAY DESIGN SUBSYSTEM     *** GEOMETRICS ***
      GENERAL GEOMETRY PROCESS                                                                  MAY 27, 1973
      CONTROL   101 SECTION 01                                              COUNTY & HIGHWAY - EXAMPLE PROBLEMS
                                                   GENERAL GEOMETRY LIST

 CD COMMAND   A     B     C     D    E   F  X-COORDINATE Y-COORDINATE RADIUS,OFFSET   ELEV.    BEAR,AZ,SKEW       STORE
 NO                                          OR CORRECTION  OR STATION  DISTANCE,ETC.             D   M    S

     ****ESTABLISH THE GEOMETRY NEEDED TO DEFINE THE

     ****LEFT EDGE OF THE SLAB.

  33 PONT    10     0     0     0  I   0         0.0      1700.0000     -7.1250               0   0  0.0
                                            211050.4217  106747.4333     0.0          0.0      0   0  0.0       SP    10

  34 PONT    11     0     0     0  I   0         0.0      1793.8300     -7.1250               0   0  0.0
                                            211058.6366  106659.8949     0.0          0.0      0   0  0.0       SP    11

  35 CURV    20     0     0     0  I   0         0.0      1700.0000     -7.1250               0   0  0.0
                                            211189.8780  106716.3658   142.8750       0.0      0   0  0.0       SC    20

  36 CURV    22     0     0     0  H   0         0.0      1851.0000    -10.1250               0   0  0.0
                                            211233.1289  106783.0422   219.0581       0.0      0   0  0.0       SC    22

  37 CURV    23     0     0     0  H   0         0.0      1921.0000    -10.1250               0   0  0.0
                                            211274.6715  106905.0808   347.9736       0.0      0   0  0.0       SC    23

  38 PONT    12     0     0     0  H   0         0.0      1920.6800    -10.1250               0   0  0.0
                                            211162.5358  106575.6704     0.0          0.0      0   0  0.0       SP    12

  39 PONT    13     0     0     0  H   0         0.0      2020.0000    -10.1250               0   0  0.0
                                            211257.0175  106557.5553     0.0          0.0      0   0  0.0       SP    13

  40 PONT    14     0     0     0  H   0         0.0      1850.0800    -10.1250               0   0  0.0
                                            211102.9834  106606.8361     0.0          0.0      0   0  0.0       SP    14

  41 CURV    11    21     0     0      0         0.0         0.0       120.0000               0   0  0.0
                                            211058.6366  106659.8949   120.0000       0.0      0   0  0.0       SC    21

  42 CURV    14    24     0     0      0         0.0         0.0       120.0000               0   0  0.0
                                            211102.9834  106606.8361   120.0000       0.0      0   0  0.0       SC    24
```

TYPICAL BRIDGE COMMAND OUTPUT FOR PROBLEM 1

```
                                                                                                         13
     TEXAS HIGHWAY DEPARTMENT       T I E S  ROADWAY DESIGN SUBSYSTEM   *** GEOMETRICS ***
     GENERAL GEOMETRY PROCESS                                                            MAY 27, 1973
     CONTROL   101 SECTION 01                                         COUNTY & HIGHWAY - EXAMPLE PROBLEMS
                                          GENERAL GEOMETRY LIST

CD COMMAND   A    B    C    D   E  F X-COORDINATE Y-COORDINATE RADIUS,OFFSET  ELEV.   BEAR,AZ,SKEW     STORE
NO                                 OR CORRECTION  OR STATION  DISTANCE,ETC.           D   M   S

 43 ISCT    21   24   15    0  H  0          0.0          0.0          0.0            0  0  0.0
                                     211168.9798  106707.0582          0.0    0.0     0  0  0.0     SP   15
                                     210992.6402  106559.6728          0.0    0.0     0  0  0.0     NS    0
                                                    1835.1880    -129.7413  417.85                  SP   15

 44 CURV    15   11   25    0     0          0.0          0.0          0.0            0  0  0.0
                                     211168.9798  106707.0582     120.0000    0.0     0  0  0.0     SC   25

 45 PSLB     1   10   20   11     0          0.0          0.0          0.0            0  0  0.0

 46 PSLB     1    0   25   14     0          0.0          0.0          0.0            0  0  0.0

 47 PSLB     1    0   22   12     0          0.0          0.0          0.0            0  0  0.0

 48 PSLB     1    0   23   13     0          0.0          0.0          0.0            0  0  0.0

    ****ESTABLISH THE GEOMETRY NEEDED TO DEFINE THE

    ****RIGHT EDGE OF THE SLAB.

 51 CURV    30    0    0    0  H  0          0.0    1971.0000      22.1250            0  0  0.0
                                     211274.6715  106905.0808     380.2236    0.0     0  0  0.0     SC   30

 52 PONT    40    0    0    0  H  0          0.0    1991.6500          0.0            0  0  0.0
                                     211228.2768  106550.0003          0.0    0.0     0  0  0.0     SP   40

 53 TRVS    40   31   41    0     0          0.0          0.0      25.9980            0  0  0.0
                                     211232.4256  106524.3355          0.0    0.0     0  0  0.0     SP   41

 54 CURV    41   32    0    0     0          0.0          0.0      29.0300            0  0  0.0
                                     211232.4256  106524.3355      29.0300    0.0     0  0  0.0     SC   32

 55 ISCT    30   32    0   42     0          0.0          0.0          0.0            0  0  0.0
                                     211261.4459  106525.0873          0.0    0.0     0  0  0.0     NS    0
                                     211204.2760  106531.4306          0.0    0.0     0  0  0.0     SP   42
```

TYPICAL BRIDGE COMMAND OUTPUT FOR PROBLEM 1

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                                                                                                          14
      TEXAS HIGHWAY DEPARTMENT         T I E S  ROADWAY DESIGN SUBSYSTEM     *** GEOMETRICS ***
      GENERAL GEOMETRY PROCESS                                                              MAY 27, 1973
      CONTROL   101 SECTION 01                                          COUNTY & HIGHWAY - EXAMPLE PROBLEMS
                                            GENERAL GEOMETRY LIST

  CD COMMAND   A    B    C    D   E  F X-COORDINATE Y-COORDINATE RADIUS,OFFSET  ELEV.   BEAR,AZ,SKEW      STORE
  NO                                  OR CORRECTION  OR STATION  DISTANCE,ETC.           D   M   S

   56 BRDS    42   41   33    0      0      0.0          0.0          0.0                0  0  0.0
                                         211204.2760 106531.4306     29.0300     0.0  S  75 51 11.67 E   SC    33

   57 PSLB     2    0    0    0   H  0   1650.0000    1920.6800      22.1250             0  0  0.0

   58 PSLB     2    0   30   42      0      0.0          0.0          0.0                0  0  0.0

   59 PSLB     2    0   33   41      0      0.0          0.0          0.0                0  0  0.0

      ****DEFINE 'PSLB' LINES THAT WILL BE USED TO

      ****ESTABLISH BEAM LINES.

   62 PSLB     4    0    0    0      1      0.0          0.0          3.6250             0  0  0.0

   63 PSLB     5    0    0    0      2      0.0          0.0        -21.8860             0  0  0.0

   64 PSLB     6    0    0    0      2      0.0          0.0        -15.1450             0  0  0.0

   65 PSLB     7    0    0    0      2      0.0          0.0         -8.4040             0  0  0.0

   66 PSLB     8    0    0    0      2      0.0          0.0         -1.6630             0  0  0.0

      ****DESIGNATE 'PSLB' LINES 4 - 8 TO BE BEAM

      ****LINES 1 - 5.

   69 BEAM     0    0    0    4   0  1      0.0          0.0          0.0                0  0  0.0

   70 BEAM     0    0    0    5   0  2      0.0          0.0          0.0                0  0  0.0

   71 BEAM     0    0    0    6   0  3      0.0          0.0          0.0                0  0  0.0

   72 BEAM     0    0    0    7   0  4      0.0          0.0          0.0                0  0  0.0

   73 BEAM     0    0    0    8   0  5      0.0          0.0          0.0                0  0  0.0
```

TYPICAL BRIDGE COMMAND OUTPUT FOR PROBLEM 1

```
TEXAS HIGHWAY DEPARTMENT        T I E S  ROADWAY DESIGN SUBSYSTEM    *** GEOMETRICS ***
GENERAL GEOMETRY PROCESS                                                         MAY 27, 1973
CONTROL   101 SECTION 01                                       COUNTY & HIGHWAY - EXAMPLE PROBLEMS
                                      GENERAL GEOMETRY LIST

CD COMMAND  A    B    C    D    E   F X-COORDINATE Y-COORDINATE RADIUS,OFFSET  ELEV.   BEAR,AZ,SKEW      STORE
NO                                   OR CORRECTION  OR STATION  DISTANCE,ETC.            D   M   S

   ****ESTABLISH AN 'AXIS' CARD TO SET UP FOR PLOT.

 75 AXIS     50   29    0    0    0  210800.0000  106800.0000      20.0000          N  90  0  0.0  E

   ****DEFINE THE SLAB AND DESIGN THE FRAME FOR

   ****SPAN 1 USING OPTION 7.

 78 SLAB      1    2    1    2    0       7.5000       0.0
```

TYPICAL BRIDGE COMMAND OUTPUT FOR PROBLEM 1

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                                                                                                                 59
   TEXAS HIGHWAY DEPARTMENT          T I E S  ROADWAY DESIGN SUBSYSTEM            *** BRIDGE GEOMETRICS ***
   CONNECTION B                                                                                MAY 27, 1973
   CONTROL  101 SECTION 01                                                  COUNTY & HIGHWAY - EXAMPLE PROBLEMS

                                                 BRIDGE GEOMETRY LIST

CD COMMAND  A    B    C    D   E  F  X-COORDINATE Y-COORDINATE RADIUS,OFFSET  ELEV.   BEAR,AZ,SKEW     STORE
NO                                   OR CORRECTION  OR STATION  DISTANCE,ETC.          D   M   S

 1 NAME     3    5 HS20 OVER   J  0    2000.0000    2500.0000 CONNECTION B                                STR   2

   ****LOCATE THE TRANSVERSE SLAB LINES.

 3 TSLB     0    0    0    1   0  0       0.0       2086.0000      0.0                 0  0  0.0
                                     211485.2734  106607.3710   2086.0000    0.0  S   53  2 10.02 W

 4 TSLB     0    0    0    2   0  0       0.0       2387.0000      0.0                 0  0  0.0
                                     211727.8463  106437.6703   2387.0000    0.0  S   16 54 58.02 W

   ****LOCATE THE BENTS.

 6 BENT     0    0    0    1                0.0       2086.0000      0.8958              0  0  0.0
                                     211485.2734  106607.3710   2086.0000    0.0  S   53  2 10.02 W

 7 BENT     0    0    0    2                0.0       2241.0400      0.8958              0  0  0.0
                                     211596.8077  106500.6609   2241.0400    0.0  S   34 25 52.74 W

 8 BENT     0    0    0    3                0.0       2387.0000      0.8958              0  0  0.0
                                     211727.8463  106437.6703   2387.0000    0.0  S   16 54 58.02 W

   ****LOCATE THE BEARING SEATS, BEAM ENDS, AND

   ****REFERENCE LINES FOR EACH BENT.

11 BRNG     0    0    0    1   1 FD      27.0000      20.0000      4.5330                0  0  0.0

12 BRNG     0    0    0    2   1 BO       0.0          0.0        4.6450                0  0  0.0

13 BRNG     0    0    0    3   1 BK      27.0000      20.0000      4.4910                0  0  0.0

   ****LOCATE THE SPLICES.

15 SPLC     0    0    0    1   0  0       0.0       2188.0000      0.8958                0  0  0.0
                                     211554.8140  106533.0164   2188.0000    0.0  S   40 47 46.02 W
```

TYPICAL BRIDGE COMMAND OUTPUT FOR PROBLEM 2

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                                                                                                   60
   TEXAS HIGHWAY DEPARTMENT             T I E S  ROADWAY DESIGN SUBSYSTEM          *** BRIDGE GEOMETRICS ***
   CONNECTION B                                                                           MAY 27, 1973
   CONTROL  101 SECTION 01                                             COUNTY & HIGHWAY - EXAMPLE PROBLEMS

                                              BRIDGE GEOMETRY LIST

CD COMMAND  A    B    C    D   E  F X-COORDINATE Y-COORDINATE RADIUS,OFFSET  ELEV.    BEAR,AZ,SKEW      STORE
NO                                 OR CORRECTION  OR STATION  DISTANCE,ETC.            D   M    S

 16 SPLC     0    0    0    2  0  0      0.0        2292.0000      0.8958              0  0  0.0
                                    211640.2961  106474.1428    2292.0000    0.0  S  28 18 58.02 W

  ****LOCATE THE DIAPHRAGMS.

 18 DIAF     0    0    0    0  0  0      0.0        2098.5000      0.0                 0  0  0.0
                                    211492.9197  106597.4828    2098.5000    0.0  S  51 32 10.02 W

 19 DIAF     0    0    0    0  0  0      0.0        2109.5000      0.0                 0  0  0.0
                                    211499.8605  106588.9494    2109.5000    0.0  S  50 12 58.02 W

 20 DIAF     0    0    0    0  0  0      0.0        2120.5000      0.0                 0  0  0.0
                                    211506.9961  106580.5781    2120.5000    0.0  S  48 53 46.02 W

 21 DIAF     0    0    0    0  0  0      0.0        2131.5000      0.0                 0  0  0.0
                                    211514.3226  106572.3734    2131.5000    0.0  S  47 34 34.02 W

 22 DIAF     0    0    0    0  0  0      0.0        2142.5000      0.0                 0  0  0.0
                                    211521.8362  106564.3397    2142.5000    0.0  S  46 15 22.02 W

 23 DIAF     0    0    0    0  0  0      0.0        2153.5000      0.0                 0  0  0.0
                                    211529.5329  106556.4812    2153.5000    0.0  S  44 56 10.02 W

 24 DIAF     0    0    0    0  0  0      0.0        2164.5000      0.0                 0  0  0.0
                                    211537.4085  106548.8021    2164.5000    0.0  S  43 36 58.02 W

 25 DIAF     0    0    0    0  0  0      0.0        2175.5000      0.0                 0  0  0.0
                                    211545.4590  106541.3064    2175.5000    0.0  S  42 17 46.02 W

 26 DIAF     0    0    0    0  0  0      0.0        2186.5000      0.0                 0  0  0.0
                                    211553.6800  106533.9982    2186.5000    0.0  S  40 58 34.02 W

 27 DIAF     0    0    0    0  0  0      0.0        2197.5000      0.0                 0  0  0.0
                                    211562.0671  106526.8813    2197.5000    0.0  S  39 39 22.02 W

 28 DIAF     0    0    0    0  0  0      0.0        2208.5000      0.0                 0  0  0.0
                                    211570.6160  106519.9595    2208.5000    0.0  S  38 20 10.02 W
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TYPICAL BRIDGE COMMAND OUTPUT FOR PROBLEM 2

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                                                                                                                61
     TEXAS HIGHWAY DEPARTMENT           T I E S  ROADWAY DESIGN SUBSYSTEM           *** BRIDGE GEOMETRICS ***
     CONNECTION B                                                                               MAY 27, 1973
     CONTROL   101 SECTION 01                                                   COUNTY & HIGHWAY - EXAMPLE PROBLEMS

                                                  BRIDGE GEOMETRY LIST

CD COMMAND   A     B     C     D   E   F X-COORDINATE Y-COORDINATE RADIUS,OFFSET  ELEV.    BEAR,AZ,SKEW      STORE
NO                                      OR CORRECTION  OR STATION  DISTANCE,ETC.            D   M    S

 29 DIAF     0     0     0     0   0   0       0.0       2219.5000      0.0                  0   0  0.0
                                          211579.3221  106513.2365   2219.5000    0.0   S  37   0 58.02 W

 30 DIAF     0     0     0     0   0   0       0.0       2230.5000      0.0                  0   0  0.0
                                          211588.1807  106506.7158   2230.5000    0.0   S  35 41 46.02 W

 31 DIAF     0     0     0     0   0   0       0.0       2241.0400      0.0                  0   0  0.0
                                          211596.8077  106500.6609   2241.0400    0.0   S  34 25 52.74 W

 32 DIAF     0     0     0     0   0   0       0.0       2250.5000      0.0                  0   0  0.0
                                          211604.6628  106495.3897   2250.5000    0.0   S  33 17 46.02 W

 33 DIAF     0     0     0     0   0   0       0.0       2261.7500      0.0                  0   0  0.0
                                          211614.1379  106489.3251   2261.7500    0.0   S  31 56 46.02 W

 34 DIAF     0     0     0     0   0   0       0.0       2273.0000      0.0                  0   0  0.0
                                          211623.7533  106483.4855   2273.0000    0.0   S  30 35 46.02 W

 35 DIAF     0     0     0     0   0   0       0.0       2284.2500      0.0                  0   0  0.0
                                          211633.5036  106477.8741   2284.2500    0.0   S  29 14 46.02 W

 36 DIAF     0     0     0     0   0   0       0.0       2295.5000      0.0                  0   0  0.0
                                          211643.3834  106472.4939   2295.5000    0.0   S  27 53 46.02 W

 37 DIAF     0     0     0     0   0   0       0.0       2306.7500      0.0                  0   0  0.0
                                          211653.3872  106467.3480   2306.7500    0.0   S  26 32 46.02 W

 38 DIAF     0     0     0     0   0   0       0.0       2318.0000      0.0                  0   0  0.0
                                          211663.5095  106462.4392   2318.0000    0.0   S  25 11 46.02 W

 39 DIAF     0     0     0     0   0   0       0.0       2329.2500      0.0                  0   0  0.0
                                          211673.7446  106457.7702   2329.2500    0.0   S  23 50 46.02 W

 40 DIAF     0     0     0     0   0   0       0.0       2340.5000      0.0                  0   0  0.0
                                          211684.0868  106453.3437   2340.5000    0.0   S  22 29 46.02 W
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TYPICAL BRIDGE COMMAND OUTPUT FOR PROBLEM 2

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                                                                                                                 62
   TEXAS HIGHWAY DEPARTMENT             T I E S  ROADWAY DESIGN SUBSYSTEM              *** BRIDGE GEOMETRICS ***
   CONNECTION B                                                                                    MAY 27, 1973
   CONTROL   101 SECTION 01                                                  COUNTY & HIGHWAY - EXAMPLE PROBLEMS

                                                      BRIDGE GEOMETRY LIST

CD COMMAND  A    B    C    D   E   F X-COORDINATE Y-COORDINATE RADIUS,OFFSET  ELEV.   BEAR,AZ,SKEW      STORE
NO                                  OR CORRECTION  OR STATION  DISTANCE,ETC.           D   M    S

 41 DIAF     0    0    0    0  0   0       0.0      2351.7500       0.0                0   0   0.0
                                    211694.5305  106449.1620    2351.7500    0.0   S  21   8  46.02 W

 42 DIAF     0    0    0    0  0   0       0.0      2363.0000       0.0                0   0   0.0
                                    211705.0698  106445.2276    2363.0000    0.0   S  19  47  46.02 W

 43 DIAF     0    0    0    0  0   0       0.0      2374.2500       0.0                0   0   0.0
                                    211715.6989  106441.5426    2374.2500    0.0   S  18  26  46.02 W

    ****DEFINE 'PSLB' LINES PARALLEL TO THE ROADWAY

    ****AT OFFSETS OF -7.125 AND 25.125 FEET.

 46 PSLB     1    0    0    0      0       0.0          0.0        -7.1250             0   0   0.0

 47 PSLB     2    0    0    0      0       0.0          0.0        25.1250             0   0   0.0

    ****THE BEAMS ARE PARALLEL TO THE ROADWAY AT A

    ****UNIFORM SPACING OF 6.5 FEET.

 50 BGRP     0    0    0    0  1   5       6.5000    2086.0000     -4.0000             0   0   0.0

    ****ESTABLISH AN 'AXIS' CARD TO SET UP FOR PLOT.

 52 AXIS    50   29    0    0      0 211200.0000  106800.0000      20.0000         N  90   0   0.0  E

    ****DEFINE THE SLAB AND DESIGN THE FRAME FOR

    ****SPANS 1 & 2 USING OPTION 10.

 55 SLAB     1    2    1    2      0       8.0000       0.0
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TYPICAL BRIDGE COMMAND OUTPUT FOR PROBLEM 2

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                                                                                                        23
TEXAS HIGHWAY DEPARTMENT            T I E S  ROADWAY DESIGN SUBSYSTEM          *** BRIDGE GEOMETRICS ***
CONNECTION D -- RAMP A                                                                   MAY 27, 1973
CONTROL  101 SECTION 01                                          COUNTY & HIGHWAY - EXAMPLE PROBLEMS

                                               BENT REPORT

                                    BENT NO. 2   (S 53 13 10.23 W)

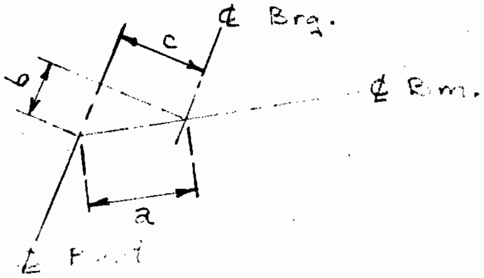
DISTANCE BETWEEN STATION LINE AND BEAM 1,    10.7387

                        BEAM SPAC.           BEAM ANGLE          DISTANCE FROM C.L. BENT TO C.L. BEARING
                       (C.L. BENT)            D  M   S          ALONG BEAM   ALONG C.L. BT   PERP. TO C.L. BT

SPAN 1     BEAM  1        0.0000            69 27  6.53            2.0914        0.7341          1.9583
           BEAM  2        6.5504            69 27  6.53            2.0914        0.7341          1.9583
           BEAM  3        3.6926            72 25 26.51            2.0542        0.6203          1.9583
           BEAM  4        3.6926            75 19 32.32            2.0244        0.5128          1.9583
           BEAM  5        3.6926            78  8 41.43            2.0010        0.4111          1.9583
           BEAM  6        3.6926            80 52 19.41            1.9834        0.3147          1.9583
           BEAM  7        3.6926            83 30  0.00            1.9710        0.2231          1.9583
           BEAM  8        6.1873            83 30  0.00            1.9710        0.2231          1.9583
            TOTAL        31.2007

SPAN 2     BEAM  1        0.0000            88 45  0.29            1.9588        0.0427          1.9583
           BEAM  2        6.2401            88 45  0.29            1.9588        0.0427          1.9583
           BEAM  3        6.2401            88 45  0.29            1.9588        0.0427          1.9583
           BEAM  4        6.2401            86 55 33.76            1.9612        0.1052          1.9583
           BEAM  5        6.2401            85 10 35.35            1.9653        0.1653          1.9583
           BEAM  6        6.2401            83 30  0.01            1.9710        0.2231          1.9583
            TOTAL        31.2007
```

a b c



TYPICAL BENT REPORT FOR PROBLEM 1

(SIMPLE SPAN UNIT)

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                                                                                                     73
TEXAS HIGHWAY DEPARTMENT           T I E S  ROADWAY DESIGN SUBSYSTEM          *** BRIDGE GEOMETRICS ***
CONNECTION B                                                                           MAY 27, 1973
CONTROL   101 SECTION 01                                            COUNTY & HIGHWAY - EXAMPLE PROBLEMS

                                            BENT REPORT

                                     BENT NO. 1   (S 53  2 10.02 W)

DISTANCE BETWEEN STATION LINE AND BEAM 1  4.0000

                   BEAM SPAC.          BEAM ANGLE             DISTANCE FROM C.L. BENT TO C.L. BEARING
                  (C.L. BENT)           D  M   S            ALONG BEAM  ALONG C.L. BT  PERP. TO C.L. BT

SPAN 1   BEAM 1      0.0000            90  0  0.00              2.2500        0.0000        2.2500
         BEAM 2      6.5000            90  0  0.00              2.2500        0.0000        2.2500
         BEAM 3      6.5000            90  0  0.00              2.2500        0.0000        2.2500
         BEAM 4      6.5000            90  0  0.00              2.2500        0.0000        2.2500
         BEAM 5      6.5000            90  0  0.00              2.2500        0.0000        2.2500
          TOTAL     26.0000
                                     BENT NO. 2   (S 34 25 52.74 W)

DISTANCE BETWEEN STATION LINE AND BEAM 1  4.0000

                   BEAM SPAC.          BEAM ANGLE             DISTANCE FROM C.L. BENT TO C.L. BEARING
                  (C.L. BENT)           D  M   S            ALONG BEAM  ALONG C.L. BT  PERP. TO C.L. BT

SPAN 2   BEAM 1      0.0000            90  0  0.00              0.0           0.0           0.0
         BEAM 2      6.5000            90  0  0.00              0.0           0.0           0.0
         BEAM 3      6.5000            90  0  0.00              0.0           0.0           0.0
         BEAM 4      6.5000            90  0  0.00              0.0           0.0           0.0
         BEAM 5      6.5000            90  0  0.00              0.0           0.0           0.0
          TOTAL     26.0000
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TYPICAL BENT REPORT FOR PROBLEM 2
(CONTINUOUS SPAN UNIT)

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                                                                                                                      24
TEXAS HIGHWAY DEPARTMENT          T I E S  ROADWAY DESIGN SUBSYSTEM          *** BRIDGE GEOMETRICS ***
CONNECTION D -- RAMP A                                                                   MAY 27, 1973
CONTROL  101 SECTION 01                                              COUNTY & HIGHWAY - EXAMPLE PROBLEMS

                              COORDINATES AT CENTERLINE OF BENTS AND BEARINGS, SPAN 2

                             COORDINATES, BENT 2          SURFACE        COORDINATES, BENT 3          SURFACE
                              X               Y          ELEVATION        X               Y          ELEVATION

BEAM 1   (BENT)          211058.1690     106652.2484     416.5420     211089.0907     106612.7138     418.2361
         (BRG.)          211059.3758     106650.7055     416.5835     211087.8584     106614.2893     418.1492

BEAM 2   (BENT)          211053.1711     106648.5122     417.0413     211084.9761     106607.8481     418.7458
         (BRG.)          211054.3779     106646.9692     417.0818     211083.7438     106609.4237     418.6606

BEAM 3   (BENT)          211048.1731     106644.7759     417.5405     211080.8615     106602.9825     419.2556
         (BRG.)          211049.3799     106643.2330     417.5798     211079.6292     106604.5580     419.1716

BEAM 4   (BENT)          211043.1752     106641.0396     418.0398     211077.8838     106599.4614     419.6245
         (BRG.)          211044.4320     106639.5341     418.0728     211076.6098     106600.9876     419.5466

BEAM 5   (BENT)          211038.1773     106637.3033     418.5388     211074.9062     106595.9403     419.9934
         (BRG.)          211039.4822     106635.8337     418.5662     211073.5926     106597.4197     419.9216

BEAM 6   (BENT)          211033.1793     106633.5670     419.0381     211071.9286     106592.4192     420.3623
         (BRG.)          211034.5306     106632.1321     419.0596     211070.5774     106593.8541     420.2959
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OPTIONAL TYPICAL COORDINATE REPORT FOR PROBLEM 1

(SIMPLE SPAN UNIT)

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                                                                                                          25
TEXAS HIGHWAY DEPARTMENT            T I E S  ROADWAY DESIGN SUBSYSTEM            *** BRIDGE GEOMETRICS ***
CONNECTION D -- RAMP A                                                                       MAY 27, 1973
CONTROL  101 SECTION 01                                              COUNTY & HIGHWAY - EXAMPLE PROBLEMS

                                                BEAM REPORT, SPAN 2

                                  HORIZONTAL DISTANCE     TRUE DISTANCE     BEAM
                                C-C BENT      C-C BRG.    BOT. BM. FLG.     SLOPE         BEAM BEARING

                      BEAM 1     50.1910       46.2320       47.1757       0.03387      S 38   1 49.49 E
                      BEAM 2     51.6248       47.6658       48.6090       0.03312      S 38   1 49.49 E
                      BEAM 3     53.0586       49.0995       50.0424       0.03242      S 38   1 49.49 E
                      BEAM 4     54.1612       50.2120       51.1506       0.02935      S 39 51 16.02 E
                      BEAM 5     55.3165       51.3728       52.3076       0.02638      S 41 36 14.42 E
                      BEAM 6     56.5213       52.5792       53.5107       0.02351      S 43 16 49.77 E


                                   DIAPHRAGM LOCATIONS, C.L. BENT TO C.L. BENT

                        DISTANCE TO         DISTANCE TO         DISTANCE TO         DISTANCE TO         DISTANCE TO
                      DIAPH.  BEAM END    DIAPH.  BEAM END    DIAPH.  BEAM END    DIAPH.  BEAM END    DIAPH.  BEAM END

             BEAM  1  24.8326  24.8326    25.3584  50.1910
             BEAM  2  25.5421  25.5421    26.0827  51.6248
             BEAM  3  26.2516  26.2516    26.8070  53.0586
             BEAM  4  26.8960  26.8960    27.2652  54.1612
             BEAM  5  27.5663  27.5663    27.7502  55.3165
             BEAM  6  28.2610  28.2610    28.2603  56.5213
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TYPICAL BEAM REPORT FOR PROBLEM 1

(SIMPLE SPAN UNIT)

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                                                                                                                69
TEXAS HIGHWAY DEPARTMENT           T I E S  ROADWAY DESIGN SUBSYSTEM              *** BRIDGE GEOMETRICS ***
CONNECTION B                                                                                 MAY 27, 1973
CONTROL   101 SECTION 01                                                  COUNTY & HIGHWAY - EXAMPLE PROBLEMS

                COORDINATES AND ELEVATIONS AT CENTERLINE OF BENTS AND BEARINGS, BEAM  4

                          COORDINATES                SURFACE      DEPTH TO    DEP. BELOW     REFERENCE
      LOCATION             X               Y         ELEVATION    REF. LINE    REF. LINE     ELEVATION

     CL. BENT  1      211472.8887     106598.0506    464.3728       0.8958       0.0          463.4768
     BEARING          211474.2457     106596.2559    464.4163       0.9121       4.5330       458.9709
     SPLICE  1        211544.6867     106521.2823    465.6599       0.8958       0.0          464.7639
     CL. BENT  2      211588.0437     106487.8764    465.7268       0.8958       4.6450       460.1858
     SPLICE  2        211632.9439     106460.4974    465.4785       0.8958       0.0          464.5825
     BEARING          211721.1850     106423.5005    464.9778       0.8962       4.4910       459.5903
     CL. BENT  3      211723.3362     106422.8409    464.9658       0.8958       0.0          464.0698
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OPTIONAL TYPICAL COORDINATE REPORT FOR PROBLEM 2

(CONTINUOUS UNIT)

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                                                                                                          70
TEXAS HIGHWAY DEPARTMENT           T I E S  ROADWAY DESIGN SUBSYSTEM            *** BRIDGE GEOMETRICS ***
CONNECTION B                                                                              MAY 27, 1973
CONTROL  101 SECTION 01                                                 COUNTY & HIGHWAY - EXAMPLE PROBLEMS

                                              FRAMING REPORT, BEAM  4

                                 HORIZONTAL DISTANCE             TRUE          VERTICAL
                 LOCATION      PREV. LOC.         SPLICE       DISTANCE        ORDINATE          SLOPE

                 END OF BM.        0.0000         0.0000         0.0000        0.0               0.0122
                 BEARING           0.5833         0.5833         0.5834        0.0071            0.0121
                 SPLICE          103.0612       103.6446       103.0689        1.2668            0.0122
                 CL. BENT         54.7618        54.7618        54.7619        1.3337            0.0012
                 SPLICE           52.6143       107.3762        52.6149        1.0854           -0.0047
                 BEARING          95.8340        95.8340        95.8353        0.5845           -0.0052
                 END OF BM.        0.5833        96.4173         0.5834        0.5813           -0.0052


                                             DIAPHRAGM LOCATIONS, BEAM  4

       DISTANCE TO               DISTANCE TO               DISTANCE TO               DISTANCE TO               DISTANCE TO
     DIAPH.     SPLICE         DIAPH.     SPLICE         DIAPH.     SPLICE         DIAPH.     SPLICE         DIAPH.     SPLICE

     9.5725     9.5725        11.3571    20.9296        11.3571    32.2866        11.3571    43.6437        11.3571    55.0008
    11.3571    66.3579        11.3571    77.7150        11.3571    89.0721        11.3571   100.4292        11.3571     8.1417
    11.3571    19.4988        11.3571    30.8559        11.3571    42.2130        10.8822    53.0952         9.7671    62.8623
    11.6152    74.4775        11.6152    86.0927        11.6152    97.7079        11.6152     1.9470        11.6152    13.5622
    11.6152    25.1774        11.6152    36.7926        11.6152    48.4078        11.6152    60.0230        11.6152    71.6382
    11.6152    83.2534
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TYPICAL BEAM REPORT FOR PROBLEM 2

(CONTINUOUS UNIT)

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                                                                                                                 58
TEXAS HIGHWAY DEPARTMENT             T I E S  ROADWAY DESIGN SUBSYSTEM                 *** BRIDGE GEOMETRICS ***
CONNECTION D -- RAMP A                                                                            MAY 27, 1973
CONTROL  101 SECTION 01                                                        COUNTY & HIGHWAY - EXAMPLE PROBLEMS

                                                 BEARING SEAT ELEVATIONS

                    BEAM  1    BEAM  2    BEAM  3    BEAM  4    BEAM  5    BEAM  6    BEAM  7    BEAM  8
BENT  1 (FWD)      410.9924   411.4871   411.9727   412.4592   412.9458   413.4329   413.9197   414.4141


                    BEAM  1    BEAM  2    BEAM  3    BEAM  4    BEAM  5    BEAM  6    BEAM  7    BEAM  8
BENT  2 (BK)       412.6697   413.1948   413.5002   413.8049   414.1091   414.4128   414.7158   415.2119
        (FWD)      412.8125   413.3108   413.8088   414.3018   414.7952   415.2886


                    BEAM  1    BEAM  2    BEAM  3    BEAM  4    BEAM  5    BEAM  6
BENT  3 (BK)       414.3782   414.8896   415.4006   415.7756   416.1506   416.5249
        (FWD)      414.5015   415.0325   415.5625   416.0928   416.6233


                    BEAM  1    BEAM  2    BEAM  3    BEAM  4    BEAM  5
BENT  4 (BK)       415.8862   416.3230   416.7590   417.1946   417.6301
        (FWD)      416.0083   416.4297   416.8516   417.2742   417.6968


                    BEAM  1    BEAM  2    BEAM  3    BEAM  4    BEAM  5
BENT  5 (BK)       417.4614   417.7429   418.0244   418.3049   418.5857
        (FWD)      417.5837   417.8528   418.1204   418.3887   418.6577


                    BEAM  1    BEAM  2    BEAM  3    BEAM  4    BEAM  5
BENT  6 (BK)       418.9902   419.2063   419.3821   419.5435   419.7100
```

BEARING SEAT ELEVATION REPORT FOR PROBLEM 1

(SIMPLE SPAN UNIT)

```
                                                                                                    77
TEXAS HIGHWAY DEPARTMENT          T I E S  ROADWAY DESIGN SUBSYSTEM          *** BRIDGE GEOMETRICS ***
CONNECTION B                                                                          MAY 27, 1973
CONTROL  101 SECTION 01                                              COUNTY & HIGHWAY - EXAMPLE PROBLEMS

                                           BEARING SEAT ELEVATIONS


                    BEAM  1    BEAM  2    BEAM  3    BEAM  4    BEAM  5
BENT  1 (FWD)      457.4121   457.9319   458.4514   458.9709   459.4907


                    BEAM  1    BEAM  2    BEAM  3    BEAM  4    BEAM  5
BENT  2            458.6257   459.1460   459.6658   460.1858   460.7058


                    BEAM  1    BEAM  2    BEAM  3    BEAM  4    BEAM  5
BENT  3 (BK)       458.0308   458.5508   459.0703   459.5903   460.1101
```

BEARING SEAT ELEVATION REPORT FOR PROBLEM 2

(CONTINUOUS UNIT)

```
                                                                                                          43
TEXAS HIGHWAY DEPARTMENT             T I E S  ROADWAY DESIGN SUBSYSTEM            *** BRIDGE GEOMETRICS ***
CONNECTION D -- RAMP A                                                                        MAY 27, 1973
CONTROL   101 SECTION 01                                                  COUNTY & HIGHWAY - EXAMPLE PROBLEMS

                                             SPAN   1   BEAM   7


*** INPUT DATA ***

BEAM TYPE           =   B           UNIT WT. BEAM CONC.     =  150.   PCF           L.L. DIST. FACTOR          =      0.50
SPAN LENGTH         =  51.18 FT     UNIT WT. SLAB CONC.     =  150.   PCF           COMP.SLAB WIDTH            =     66.33 IN
BEAM SPACING        =   5.53 FT     28-DAY ST.(SLAB CONC.) = 3600.   PSI           UNIF. D.L. ON COMP. SEC. =      0.0  KLF
SLAB THICKNESS      =   7.50 IN     E(BM.CONC.)             =    5.00E(06)PSI       BEAM INERTIA               =  43177.   IN
STRAND SIZE         =   1/2  IN     E(SLB.CONC.)            =    5.00.E(06)PSI      BEAM AREA                  =    360.31 IN2
STRAND ULT. STR.    =  270K         E(PSTR.) STL.)          =   28.00 E(06)PSI      BEAM DEPTH                 =     34.00 IN
NO.OF WEB STRNS.    =    2          AASHO L.L.              =   HS20                BEAM YB                    =     14.93 IN
GRID SIZE           =   2.    IN    RAILROAD L.L.           =    E- 0.              BEAM YT                    =     19.07 IN



*** BEAM DESIGN ***


TYPE OF BEAM                =    B                       D.L. DEFLECTION AT MID-SPAN =  0.031 FT (SLAB)       0.003 FT (DIAF)
NO. OF STRANDS              =   12.                      D.L. DEFLECTION AT 1/4 PT.  =  0.022 FT (SLAB)       0.002 FT (DIAF)
SIZE OF STRANDS             =   1/2
TYPE OF STRANDS             =   270K                     ULTIMATE MOMENT REQUIRED = 1489. FT-KIPS
ECCENTRICITY AT C.L.        =   12.26 IN                 ULTIMATE MOMENT PROVIDED = 1513. FT-KIPS   UNDER REINF. RECT. SECT.
ECCENTRICITY AT END         =    8.93 IN
NO. OF DEPRESSED STRANDS    =    4                       STIRRUP SPAC. (MIDDLE 1/2 SPAN) = NO. 3 (GR. 60) AT  12.0 IN
DEPRESS TOP 2 STRANDS TO POSITION A-14                   STIRRUP SPAC. (EXT. 1/4 SPAN)   = NO. 3 (GR. 60) AT  12.0 IN
CONCRETE RELEASE STRENGTH =   4000.    PSI
CONCRETE 28-DAY STRENGTH  =   5000.    PSI               TOP FIBER DESIGN STRESS (C.L.)    = 1796. PSI
                                                         BOTTOM FIBER DESIGN STRESS (C.L.) = 2165. PSI

                                                         MAXIMUM CAMBER =  1.05 IN
                                                         PRESTRESS LOSS = 14.21PERCENT


L.L. STRESS IN TOP FIBER OF SLAB AT MIDSPAN =  429. PSI


*** STRAND PATTERN ***
    (C.L. OF BEAM)
ROW  1 HAS  8. STRANDS
ROW  2 HAS  4. STRANDS
```

TYPICAL OUTPUT FROM PRESTRESSED BEAM DESIGN PROGRAM

```
                      BEAM PROPERTIES, SPAN 1/10 POINTS (BEAM ONLY)

SP     DW           I          YT         ST         YB         SB
11     50.00      44923.8     29.26     1535.5      23.74     1892.1
12     50.00      44923.8     29.26     1535.5      23.74     1892.1
13     50.00      44923.8     29.26     1535.5      23.74     1892.1
14     50.00      44923.8     29.26     1535.5      23.74     1892.1
15     50.00      44923.8     29.26     1535.5      23.74     1892.1
16     50.00      44923.8     29.26     1535.5      23.74     1892.1
17     50.00      44923.8     29.26     1535.5      23.74     1892.1
18     50.00      44923.8     29.26     1535.5      23.74     1892.1
19     50.00      79616.6     27.25     2921.7      27.25     2921.7
20     50.00      79616.6     27.25     2921.7      27.25     2921.7
21     50.00      79616.6     27.25     2921.7      27.25     2921.7
22     50.00      35052.0     27.79     1261.5      24.46     1432.8
23     50.00      35052.0     27.79     1261.5      24.46     1432.8
24     50.00      35052.0     27.79     1261.5      24.46     1432.8
25     50.00      35052.0     27.79     1261.5      24.46     1432.8
26     50.00      35052.0     27.79     1261.5      24.46     1432.8
27     50.00      35052.0     27.79     1261.5      24.46     1432.8
28     50.00      35052.0     27.79     1261.5      24.46     1432.8
29     50.00      35052.0     27.79     1261.5      24.46     1432.8
30     50.00      35052.0     27.79     1261.5      24.46     1432.8
                                                 SPAN PROPERTIES

S      DL            KL            KLM           CL        CLM       CRM       CR          KRM         KR         DR

1    0.0           0.0           0.0          0.0       0.0       0.0       0.0       0.011198      0.0       0.527562

2    0.472438      0.0           0.010028     0.0       0.0       0.0       0.0       0.0           0.0       0.0
```

TYPICAL BEAM PROPERTIES REPORT,
CONTINUOUS BEAM ANALYSIS PROGRAM

```
                         CONTINUOUS BEAM ANALYSIS OUTPUT DATA PROBLEM    0

                      MOMENTS(K-FT.) AND STRESSES(PSI), SPAN 1/10 POINTS.

        DEAD LOAD MOMENTS           *          LIVE LOAD MOMENTS           *  DL + LL MTS. *  + MT. STRESS *  - MT. STRESS *    R FACTOR

SP      G     P       W   TOT.DL    SW.+     SW.-     LL+I +     LL+I -    MAX.+    MAX.-       TS       BS       TS       BS       TS       BS

11    240     0     501      741       0        0      630 T     -103 L     1371      637    10715    -8695     4983    -4044    0.465    0.465
12    406     0     840     1246       0        0     1064 T     -207 L     2309     1038    18048   -14646     8117    -6587    0.450    0.450
13    497     0    1016     1514       0        0     1317 T     -310 L     2830     1203    22117   -17949     9402    -7630    0.425    0.425
14    514     0    1031     1545       0        0     1424 L     -414 L     2968     1131    23200   -18827     8838    -7173    0.381    0.381
15    455     0     884     1340       0        0     1394 L     -517 L     2733      822    21360   -17334     6426    -5215    0.301    0.301
16    322     0     576      898       0        0     1225 T     -621 L     2123      276    16592   -13465     2164    -1756    0.130    0.130
17    114     0     105      219       0        0      963 T     -724 L     1182     -504     9239    -7498    -3946     3202   -0.427   -0.427
18   -168     0    -528     -696       0        0      626 T     -844 L      -69    -1539     -540      439   -12033     9765    0.045    0.045
19   -541     0   -1322    -1863       0        0      245 M    -1276 L    -1617    -3139    -6644     6644   -12894    12894    0.515    0.515

20  -1029     0   -2279    -3307       0        0        0 L    -2013 L    -3307    -5320   -13583    13583   -21850    21850    0.622    0.622

21   -622     0   -1406    -2028       0        0      200 M    -1319 L    -1828    -3347    -7508     7508   -13748    13748    0.546    0.546
22   -318     0    -677     -995       0        0      502 T     -852 L     -492    -1846    -4681     4121   -17562    15462    0.267    0.267
23    -86     0     -91     -177       0        0      810 T     -685 L      632     -861     6020    -5300    -8197     7216   -0.734   -0.734
24     91     0     352      442       0        0     1063 T     -587 L     1505     -144    14320   -12608    -1373     1209   -0.096   -0.096
25    213     0     651      864       0        0     1224 T     -489 L     2087      374    19859   -17485     3565    -3139    0.180    0.180
26    280     0     807     1087       0        0     1275 T     -391 L     2362      696    22471   -19783     6621    -5829    0.295    0.295
27    292     0     820     1113       0        0     1201 T     -293 L     2313      819    22003   -19372     7792    -6860    0.354    0.354
28    250     0     690      940       0        0      980 T     -196 L     1919      744    18259   -16075     7078    -6232    0.388    0.388
29    152     0     417      569       0        0      586 T      -98 L     1154      471    10984    -9671     4481    -3945    0.408    0.408
```

TYPICAL MOMENT AND STRESS REPORT,
CONTINUOUS BEAM ANALYSIS PROGRAM

```
                                                                                                          4
TEXAS HIGHWAY DEPARTMENT            T I E S  ROADWAY DESIGN SUBSYSTEM           *** BRIDGE GEOMETRICS ***
CONNECTION B                                                                              MAY 27, 1973
CONTROL  101 SECTION 01                                                 COUNTY & HIGHWAY - EXAMPLE PROBLEMS

VERTICAL CLEARANCE BETWEEN SPAN  2 OF ROADWAY J WITH ROADWAY K

             0.0  L  0.10 L  0.20 L  C.30 L  C.40 L  0.50 L  0.60 L  0.70 L  0.80 L  0.90 L  1.00 L

BEAM  1       26.69   26.23   25.75   25.33   24.88   24.36   23.80   23.19   22.53   21.83   21.10

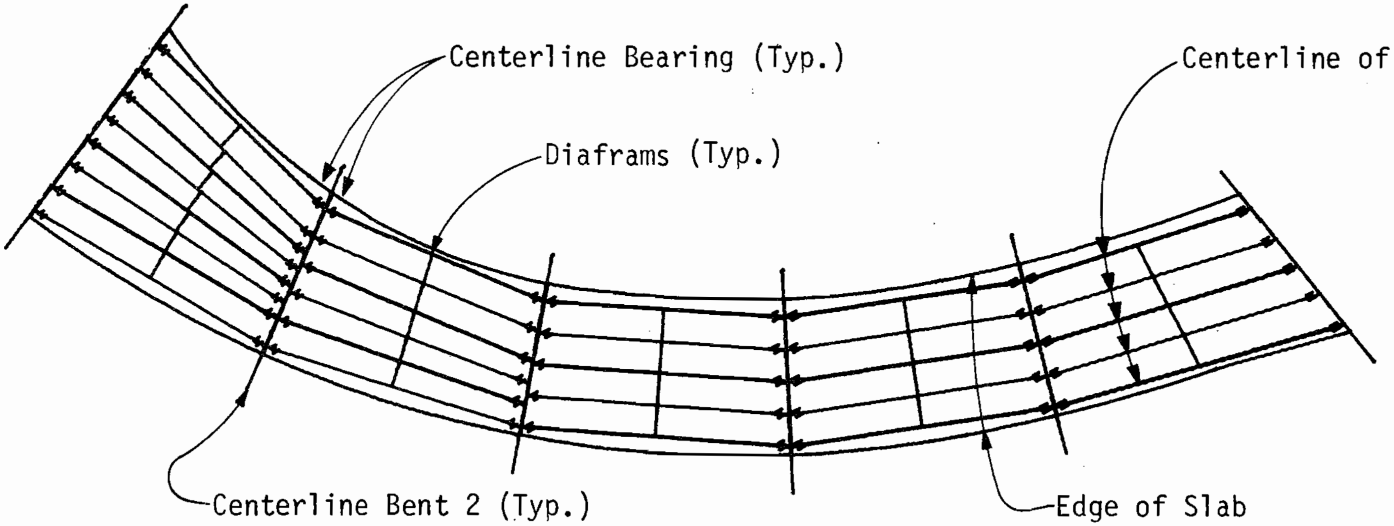
BEAM  2       27.38   26.51   26.48   26.06   25.59   25.07   24.50   23.87   23.19   22.48   21.76

BEAM  3       28.07   27.59   27.22   26.80   26.32   25.79   25.20   24.55   23.86   23.15   22.42

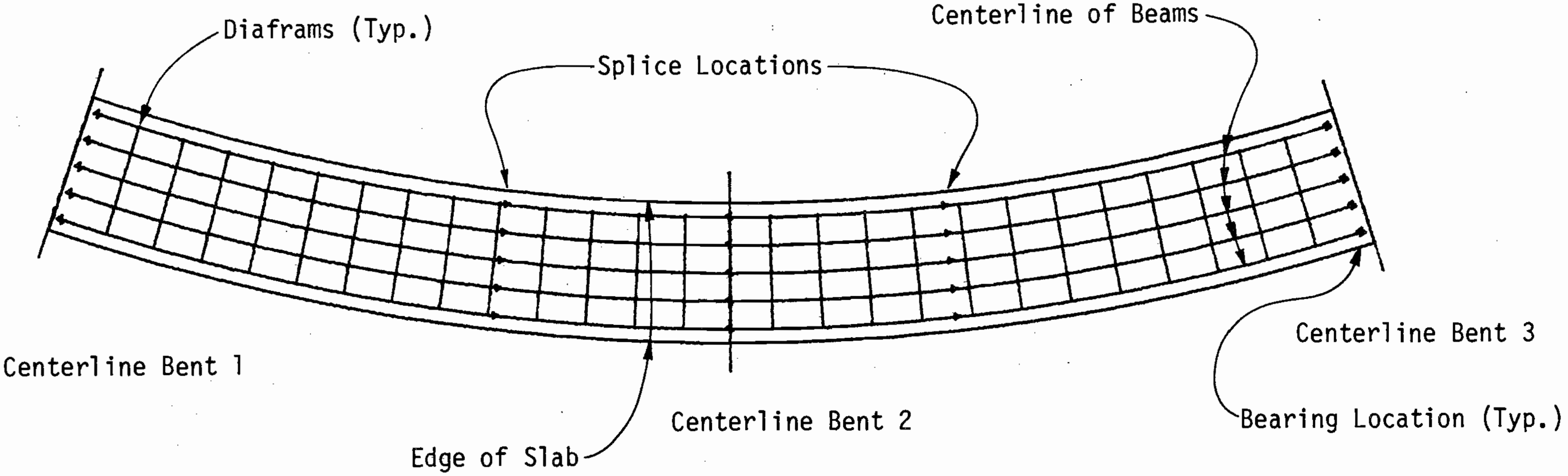
BEAM  4       28.76   28.35   27.98   27.55   27.06   26.51   25.91   25.25   24.54   23.82   23.09

BEAM  5       29.45   29.12   28.74   28.30   27.80   27.24   26.62   25.94   25.22   24.49   23.75
```

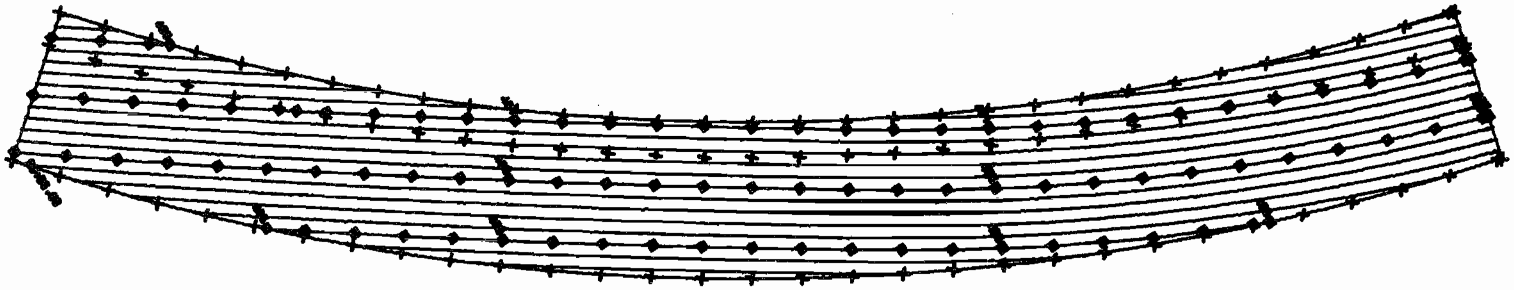
TYPICAL VERTICAL CLEARANCE REPORT



FRAMING PLOT FOR PROBLEM NUMBER ONE
(SIMPLE SPAN STRUCTURES)



FRAMING PLOT FOR PROBLEM NUMBER TWO
(CONTINUOUS SPAN STRUCTURE)



CONTOUR PLOT FOR PROBLEM NUMBER 2

APPENDIX

CONTINUOUS BEAM ANALYSIS PROGRAM

B-30

CONTINUOUS BEAM ANALYSIS PROGRAM - B-30

Program Description

The Continuous Beam Analysis Program currently being used by the Texas Highway Department is a modified version of the 1967 program developed by the Georgia Highway Department. This program will analyze continuous girders with from two to six spans. The minimum span length permitted is 15 feet. The program will analyze dead loads, AASHO lane and truck loads (with impact factors), interstate highway military loads, sidewalk loads, and composite and non-composite concentrated loads in a single computer run.

The original data input form has been modified and the ability to plot bending stresses for steel beams and moments for concrete beams has been added. A plot of total beam deflections will also be obtained when the plot option is exercised. Other modifications include computation of maximum negative live load reaction, computation of the range of shear values at tenth points of each span, computation of section properties and stress values if top and bottom plates are cut at tenth points on either side of the designated cut off point, and conversion of deflection values from inches to feet.

The output includes distribution factors, carryover factors, etc. for each span as well as moments, shears, deflections, and reactions for each form of dead and live load input. For steel beams the stresses, stress ratios, and shear connector spacings at tenth points of each span are also given.

Input

A copy of the input form is shown on the next page. A separate input form must be used for each span of the continuous unit. Only one card type 1 and one card type 2 are permitted for each problem. A card type 3 and all other required card types to complete the data must be furnished for each span. Where more than one card of a given type is permitted in a span, the total number of ranges of

TEXAS HIGHWAY DEPARTMENT
CONTINUOUS BEAM ANALYSIS

MADE BY__________ Date__________
CHECKED BY__________ Date__________
PROB. NO.__________ SHEET______ of______

COUNTY__________
CONTROL NO.__________ SEC.__________
HIGHWAY NO.__________ I.P.E.__________

File 19.129C Form 1255 Rev. 7-68

B 30

Card		
1	PROB. NO. (1)	REMARKS (6–80)

Card	2	13		19	23	27	32	37	42	47	52	57
2	BEAM IDENTITY	$\bar{M}$	Bm. Code	W_G	E	LL_M	LL_V	W_{DLnc}	W_{DLc}	W_{SWK}	Q_{UC}	PLOT

Cards 1 and 2 to be filled in on first sheet only.

Card	1	3	8
3	M	L	X-SECTION CODE

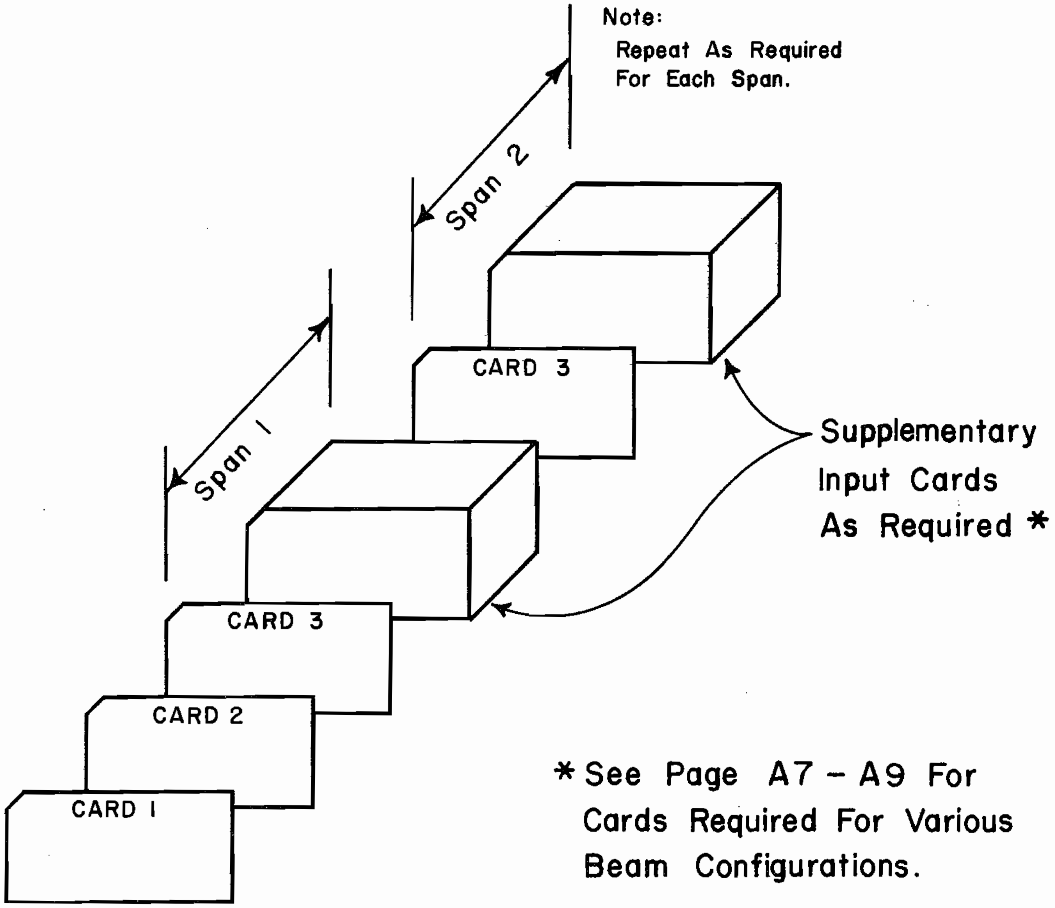
SPAN DATA

		C C	N R	RANGE 1	RANGE 2	RANGE 3	RANGE 4	RANGE 5	RANGE 6	RANGE 7	
VARIABLE WEB (Properties Given) CONSTANT WEB	R	4 1 1									ft
	R	4 1 1	0 1								
	D	4 1 2									in
	D	4 1 2	0 1								
	A	4 1 3									in²
	A	4 1 3	0 1								
	I	4 1 4									in⁴
	I	4 1 4	0 1								
VAR. WEB T *	R	4 2 1									ft
	T	4 2 2									in
VARIABLE WEB DEPTH **	R	4 3 1									ft
	D_o	4 3 2									in
	S	4 3 3									in/ft
	K	4 3 4									in/ft²
	X_o	4 3 5									ft
TOP PLATES	R	4 4 1									ft
	R	4 4 1	0 1								
	A	4 4 2									in²
	A	4 4 2	0 1								
	T	4 4 3									in
	T	4 4 3	0 1								
BOT. PLATES	R	4 5 1									ft
	R	4 5 1	0 1								
	A	4 5 2									in²
	A	4 5 2	0 1								
	T	4 5 3									in
	T	4 5 3	0 1								
COMPOSITE SECTION	R	4 6 1							▨	▨	ft
	E	4 6 2							▨	▨	in
	W	4 6 3							▨	▨	in
	T	4 6 4							▨	▨	in
NON-COMP. P-LOADS	X	4 7 1									ft
	X	4 7 1	0 1								
	X	4 7 1	0 2							▨	
	P	4 7 2									lbs
	P	4 7 2	0 1								
	P	4 7 2	0 2							▨	
COMPOSITE P-LOADS	X	4 8 1									ft
	X	4 8 1	0 1								
	X	4 8 1	0 2							▨	
	P	4 8 2									lbs
	P	4 8 2	0 1								
	P	4 8 2	0 2							▨	
		1 2 3	4 5	6 7 8 9 10 11 12 13 14 15	16 17 18 19 20 21 22 23 24 25	26 27 28 29 30 31 32 33 34 35	36 37 38 39 40 41 42 43 44 45	46 47 48 49 50 51 52 53 54 55	56 57 58 59 60 61 62 63 64 65	66 67 68 69 70 71 72 73 74 75	

* "T" only for constant Web Thickness.
** "D" only for constant Web Depth.

values used (NR) must be entered on the first card of the type. The maximum number of entries permitted for each card type is indicated by the number of blank ranges provided on the form.

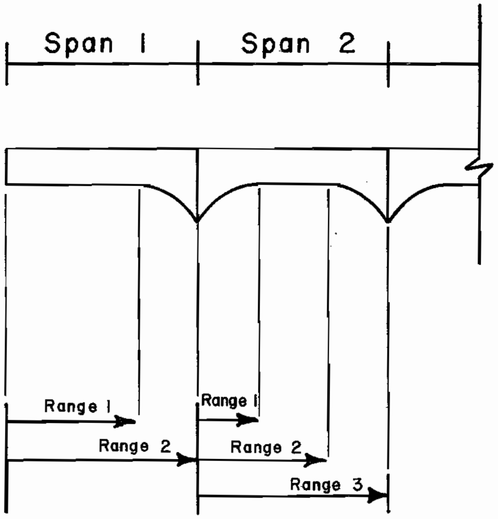
A brief description of the card types required for each beam configuration and the input variables required on each card type are contained on the following pages. For negative values, a minus sign (-) should be entered in front of the first significant digit. Blanks may be used in lieu of zeros.



Note:
Repeat As Required
For Each Span.

Supplementary
Input Cards
As Required *

* See Page A7 – A9 For Cards Required For Various Beam Configurations.



Fill Out A Column For Each Range On Supplementary Cards.

DATA DECK CONFIGURATION

IDENTIFICATION CARD (One per problem)

1	PROB. NO.	6 REMARKS 80
1		

Card Identification Code - 1
Prob.No. - Alphameric problem number
Remarks - Alphameric remarks

BEAM CONSTANTS CARD (One per problem)

1	2 BEAM IDENTITY 13	M	BM. CODE	19 W_G	23 E	27 LL_M	32 LL_V	37 W_{DLnc}	42 W_{DLc}	47 W_{SWK}	52 Q_{UC} 57	PLOT	*Cards 1 and 2 to be filled in on first sheet only.*
2													

"1" = H loading
"0" = HS loading

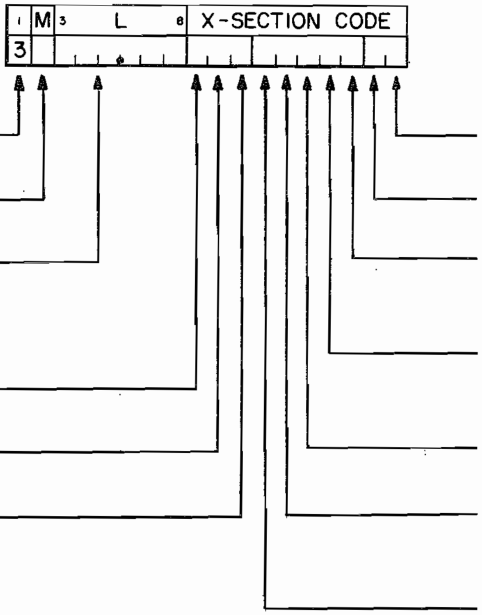
"1" = no military
"0" = military

"1" = concrete beam
"0" = steel beam

"1" = non-composite
"0" = composite

Card Identification Code - 2
Beam Identity - Alphameric identifying remarks
M - Number of spans ($2 \leq M \leq 6$)
W_G - Weight of beam material, lbs/ft^3
E - Modulus of elasticity, lbs/in^2 x 10^6
LL_M - Truck rear wheel distributed for moment, lbs
LL_V - Truck rear wheel distributed for shear, lbs
W_{DLNC} - Uniform non-composite dead load, lbs/ft
W_{DLC} - Uniform composite dead load, lbs/ft
W_{SWK} - Uniform sidewalk live load, lbs/ft
Q_{UC} - Shear connector capacity, one transverse row including safety factor, lbs
PLOT - Plot scale factor, ft/in - Examples: 20 = 20 ft/in
0 = no plot

SPAN DATA CARD (one per span)



Card Identification Code

Span Number

Span Design Length

Is there a composite concrete slab in addition to the basic cross-section?

Are there any bottom plates?

Are there any top plates?

Are there any composite P-loads?

Are there any non-composite P-loads?

* Are the cross-section properties constant throughout the span?

* Are the web properties constant throughout the span?

* Are the properties of a variable web given?

* Is the web thickness constant throughout the span?

* Is the web depth constant throughout the span?

*In any one span not more than one of the entries may be yes.

Answers to the X-SECTION CODE: Yes = 1
No = 0 or blank

Supplementary Input Cards

The beam cross-section determines the X-SECTION CODE which in turn indicates which supplemental card types are required and which are optional. Changes of cross-section should be avoided at exact 1/40th points of the span. A group of supplemental cards must follow the SPAN DATA card for each span of the continuous unit. Permissible beam cross-section configurations with corresponding X-SECTION CODES and supplemental card types are as follows:

Constant Section, Properties Given*

X-SECTION CODE										
0	0	0	0	0	0	0	0	1	1/0	0

Required Card Codes	Load Card Input Data
412	D = Depth of beam, inches
413	A = Area of beam, in.^{2}
414	I = Moment of inertia of beam, in.^{4}

Constant Web, Properties Given**

X-SECTION CODE										
1/0	1/0	1/0	0	0	0	1	0	1/0	1/0	

Required Card Codes	Load Card Input Data
412	D = Depth of web, inches
413	A = Area of web, in.^{2}
414	I = Moment of inertia of web, in.^{4}

Variable Web, Properties Given**

X-SECTION CODE										
1/0	1/0	1/0	0	0	1	0	0	1/0	1/0	

Required Card Codes	Load Card Input Data
411	R = Range of web properties, i.e., distance from end of span to point where values of properties change, ft
412	D = Depth of web, inches
413	A = Area of web, in.^{2}
414	I = Moment of inertia of web, in.^{4}

---

*In addition Card Codes 471 & 472 may be entered.

**In addition Card Codes 441-443, 451-453, 461-464, 471, 472, 481 & 482 may be entered.

Constant Web Thickness**

<table><tr><th colspan="10">X-SECTION CODE</th></tr><tr><td>1/0</td><td>1/0</td><td>1/0</td><td>0</td><td>1</td><td>0</td><td>0</td><td>0</td><td>1/0</td><td>1/0</td></tr></table>

Required Card Codes	Load Card Input Data
422	T = Thickness of web, in. (only one range required).
431	R = Range of web depth variation, ft
432	D_o= Depth of web at origin of equation, inches
433***	S = Slope of tangent of equation at origin, in/ft
434***	K = Parabolic constant of equation of variable web depth, in/ft^2
435	X_o= Distance from end of span to origin of equation for variable web depth.

Constant Web Depth**

<table><tr><th colspan="10">X-SECTION CODE</th></tr><tr><td>1/0</td><td>1/0</td><td>1/0</td><td>1</td><td>0</td><td>0</td><td>0</td><td>0</td><td>1/0</td><td>1/0</td></tr></table>

Required Card Codes	Load Card Input Data
421	R = Range of web thickness, ft
422	T = Thickness of web, inches
432	D_o= Depth of web, inches

Variable Web Depth and Thickness**

<table><tr><th colspan="10">X-SECTION CODE</th></tr><tr><td>1/0</td><td>1/0</td><td>1/0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>1/0</td><td>1/0</td></tr></table>

Required Card Codes	Load Card Input Data
421	R = Range of web thickness, ft
422	T = Thickness of web, inches
431	R = Range of web depth variation, ft
432	D_o= Depth of web at origin of equation, inches
433***	S = Slope of tangent of equation at origin, in/ft
434***	K = Parabolic constant, in/ft^2
435	X_o= Distance to origin, ft

Top Plates

<table><tr><th colspan="10">X-SECTION CODE</th></tr><tr><td>1/0</td><td>1/0</td><td>1</td><td>1/0</td><td>1/0</td><td>1/0</td><td>1/0</td><td>0</td><td>1/0</td><td>1/0</td></tr></table>

Required Card Codes	Load Card Input Data
441	R = Range of top plate, feet
442	A = Area of top plate, in.^{2}
443	T = Thickness of top plate, inches.

Bottom Plates

<table><tr><th colspan="10">X-SECTION CODE</th></tr><tr><td>1/0</td><td>1</td><td>1/0</td><td>1/0</td><td>1/0</td><td>1/0</td><td>1/0</td><td>0</td><td>1/0</td><td>1/0</td></tr></table>

Required Card Codes	Load Card Input Data
451	R = Range of bottom plate, feet
452	A = Area of bottom plate, in.^{2}
453	T = Thickness of bottom plate, inches

**In addition Card Codes 441-443, 451-453, 461-464, 471, 472, 481 & 482 may be entered.

***S(433) & K(434) are negative when they tend to decrease the depth.

Composite Section

X-SECTION CODE									
1	1/0	1/0	1/0	1/0	1/0	1/0	0	1/0	1/0

Required Card Codes	Load Card Input Data
461	R = Range of composite section, feet
462	E = Distance from top of web to bottom of slab, inches
463	W = Width of composite slab, inches
464	T = Thickness of composite slab, inches

Non-Composite P-loads*

X-SECTION CODE									
1/0	1/0	1/0	1/0	1/0	1/0	1/0	1/0	1	1/0

Required Card Codes	Load Card Input Data
471	X = Distance from left end of span to P-load, feet
472	P = Magnitude of P-load, pounds

Composite P-loads*

X-SECTION CODE									
1	1/0	1/0	1/0	1/0	1/0	1/0	0	1/0	1

Required Card Codes	Load Card Input Data
481	X = Distance from left end of span to P-load, feet
482	P = Magnitude of P-load, pounds

*Only one P-load may be entered within any 1/20th segment of the span.