March 14, 1975

A NOTE TO USERS WHO ARE NOT IN THE GEORGIA DOT . . .

This is a reprint of the User's Manual as prepared in 1968. It remains technically up to date.

However, there was a reorganization of Georgia State Government in July, *1972. Therefore, all queries concerning this manual or the program should be addressed to*

OFFICE OF SYSTEMS DEVELOPMENT
GEORGIA DEPARTMENT OF TRANSPORTATION
NO. 2 CAPITOL SQUARE
ATLANTA, GA 30334

FOREWORD

During the past decade the electronic computer has played an ever increasing role in Highway Engineering, especially in the field of Bridge Design. The great motivation for this role was the National Interstate Highway Act passed in 1956. The impact of this new system of super highways with their complex interchanges created the need for a new approach in the design and construction of highways. The high-speed electronic computer has proved to be the answer, particularly in the solution of bridge geometry.

Before the computer age, the geometry of a bridge was a major factor used to determine the location and type of structure. The voluminous amount of computations required for the geometric solution of curved bridges in transition often made it more feasible to use an otherwise uneconomical straight bridge. Usually the time required for the geometric computations proved to be greater than the time required for design. Today, the computer has assumed the geometric burden-and much of the design also-and thereby freed the Engineer from these time-consuming tasks. The Bridge Engineer, using the computer as a design aid, can devote more of his time to the economics and esthetics of design. This time saving-including other areas of Highway Engineering-not only has resulted in more economical structures but, in a larger sense, it will make possible the completion of the Interstate and other highway systems at an earlier date.

"The Geometric Solution of Highway Bridges" presented in this report is a problem oriented computer program that can solve nearly all the geometric requirements for the design, detailing, and construction of highway bridges. This program is actually the third in a series of bridge geometry programs. The first geometry program was written in 1957 for an IBM 650 computer using machine language. This program proved so successful that an effort was made immediately to apply data processing to other areas of Bridge Engineering. The second geometry program, written in 1963, was a complete revision of the first program; however, many improvements were incorporated into the new program. The IBM 1620 computer was being used at that time, so the computer oriented Symbolic Programming System language (SPS) was used. Now the program has been rewritten in Fortran IV programming_language. Again, the program has been made more versatile with revisions and additional features. It is significant to note the evolution of the programming language with each succeeding computer generation. This, however, is not the ultimate geometry program. Although the pace at which data processing has been applied to Highway Engineering has exceeded the expectations of a decade ago, the surface appears only to have been scratched.

"The Geometric Solution of Highway Bridges" computer program is more commonly referred to as the "Skewed Bridge" program, primarily for the sake of brevity. In fact, this is the name that is shown on the input data form and in the output data of the program.

This write-up is primarily a user's manual and does not include flow charts, a program listing, nor a comprehensive report on the method of solution. However, the method of solution is discussed in general terms so that the user will be able to get a general idea of the method of solution used by the program. Since a source deck can be obtained by request, a program listing can be obtained by listing or compiling the source deck. Also, since the program is written in Fortran IV programming language, and contains numerous comment cards that describe the program functions, the flow charts are not really essential in order to understand the procedure of the program solution.

The reader is assumed to be familiar with the standard terminology of Highway Engineering, and such terms as Station, Superelevation, Transition, Survey line, Degree-of-Curvature, etc., will not be defined in this report. It should be noted that the term "Mainline" as used in this report is synonymous with the survey line, and the term "Bent" is used to designate a substructure unit, i.e., pier, abutment, etc.

This report, then., explains in detail the functions of the program and how the program can be effectively applied in order to solve the geometric requirements of a highway bridge.

Glenn H. Sikes
Atlanta., Georgia
September 16, 1968

ACKNOWLEDGMENT

The programming of "The Geometric Solution of Highway Bridges" computer program was undertaken by the direction and under the authority of Mr. Russell L. Chapman, Jr., State Highway Bridge Engineer. Mr. Chapman is a pioneer in the field of application of electronic computation to problems related to the design and construction of bridges and assisted in developing the method of solution used by the original "Skewed Bridge" computer program. His encouragement and support has been a vital factor in the application of data processing to Bridge Engineering.

A special acknowledgment is due Mr. Jose M. Nieves-Olmo, formerly Assistant Highway Bridge Engineer with The State Highway Department of Georgia, who developed the method of solution and wrote the IBM 650 and IBM 1620 versions of the "Skewed Bridge" computer program. His accomplishments in the field of data processing has been-and continues to be-of immeasurable benefit to The State Highway Department of Georgia and many other States as well.

Mr. Thomas S. Moss, Jr., developed and wrote a considerable part of the program presented in this write-up before leaving the employment of The State Highway Department. His excellent work was very beneficial in the final completion of this work.

Many employees of The State Highway Department of Georgia assisted in the preparation of this manual. Their criticisms, suggestions, and assistance in drawing the figures has made possible the editing of this program write-up. And a special acknowledgment and "Thanks" go to Mrs. Faye Bates who had the task of typing the entire manuscript.

DISCLAIMER

Although this program has been subjected to many rigorous tests - all with excellent results - no warranty, expressed or implied, is made by The State Highway Department of Georgia as to the accuracy and functioning of the program,, nor shall the fact of distribution constitute any such warranty, and no responsibility is assumed by The State Highway Department of Georgia in any connection therewith.

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I. PROGRAM ABSTRACT

TITLE: THE GEOMETRIC SOLUTION OF HIGHWAY BRIDGES

AUTHOR: Glenn H. Sikes
Highway Bridge Engineer

PURPOSE/DESCRIPTION: The purpose of this program is to solve the geometries that are required in the design, detailing and construction of highway bridges and, thereby, relieve the Engineer of this time-consuming task and, in addition, remove the geometric limitations in the design of bridge structures. The program solves the geometries by intersecting a series of longitudinal lines, that run basically parallel to the bridge, with a series of transverse lines that lie basically across the bridge. The computed data (including the finished grade elevation) at each intersection point is reported as the output data. The longitudinal lines may be composed of beams, gutters, curbs, railings, etc., whereas the transverse lines can be bents, centerline bearings, diaphragms, construction joints, splice points, etc. The input data is entered on forms provided for the Engineer.

METHOD OF SOLUTION: The bridge is oriented on a user-defined coordinate system of X and Y axes. The longitudinal and transverse lines are set up in equation form and intersected by computing the solutions of simultaneous equations. The data given in the output at the intersection points of the longitudinal and transverse lines is computed using the basic concepts of analytic geometry.

RESTRICTIONS/RANGE: The bridge may be located in one, two or three combinations of horizontal curves and tangents. The horizontal curves may be compound but not reverse curves (work as two problems). The survey line cannot be a spiral for the purpose of computing stations. Vertical alignment is limited to two vertical curves with corresponding tangents. The surface of the bridge may be level, superelevated (with one to six lanes in constant or transition superelevation), or parabolic. The maximum number of longitudinal lines is thirty, and the maximum number of T-Lines is twenty per span with no limitation on the number of spans.

PROGRAMMING LANGUAGE: The program is written in Basic Fortran IV programming_language primarily to obtain computer independency. The long form of floating-point data representation is used for all arithmetical computations, thereby insuring sufficient accuracy.

ADDITIONAL REMARKS: Core Storage requirements are approximately 58,000 positions (bytes). The processing time will vary depending on the amount of input data, with the average problem requiring approximately one and one-half minutes (IBM 360, Mod. 30). All input is from punched cards, and the output is listed by the printer. No other intermediate I/0 devices are used.

DIRECT INQUIRIES TO: Russell L. Chapman, Jr.
State Highway Bridge Engineer
State Highway Department of Georgia
#2 Capitol Square
Atlanta, Georgia 30334
Telephone No. 688-5201, Ext. 371

II. DESCRIPTION OF PROGRAM

"The Geometric Solution of Highway Bridges" is a problem oriented computer program that can be used effectively to compute the geometric requirements for the design, detailing and construction of highway bridges. Actually, the program is not limited to highway bridges since the geometry of railroad and pedestrian bridges is easily solved by this program. The geometric solution of a problem fundamentally consists of intersecting a series of longitudinal lines that run basically parallel to the bridge, with a series of transverse lines that run basically across the bridge. Actually, the transverse lines may be series of points (centerline of bearings, etc.) located on the longitudinal lines (beams, etc.) and do not necessarily have to lie on a straight line. At the intersections of the longitudinal and transverse lines, the program computes the following types of data.

Stations

The station of each intersection point computed by the program is given in the output data. In addition to the station, the output data will contain the radial or perpendicular distance from the point to the survey line. This distance, together with the station, completely locates each intersection point for the Engineer.

Elevations

The elevations computed by the program at the intersection points are finished grade elevations, i.e., top of bridge surface elevation at the intersection points. These elevations which are essential in all phases of Bridge Engineering form an important part of the output data of each problem.

Distances and Lengths

The distances or lengths between intersection points measured along the longitudinal and transverse lines are computed by the program and listed in the output. This information is of considerable benefit in the detailing process.

Angles

The angles between the longitudinal and transverse lines, or skew angles, are computed by the program and listed in the output data. These angles can also be of considerable benefit when detailing the bridge.

Coordinates

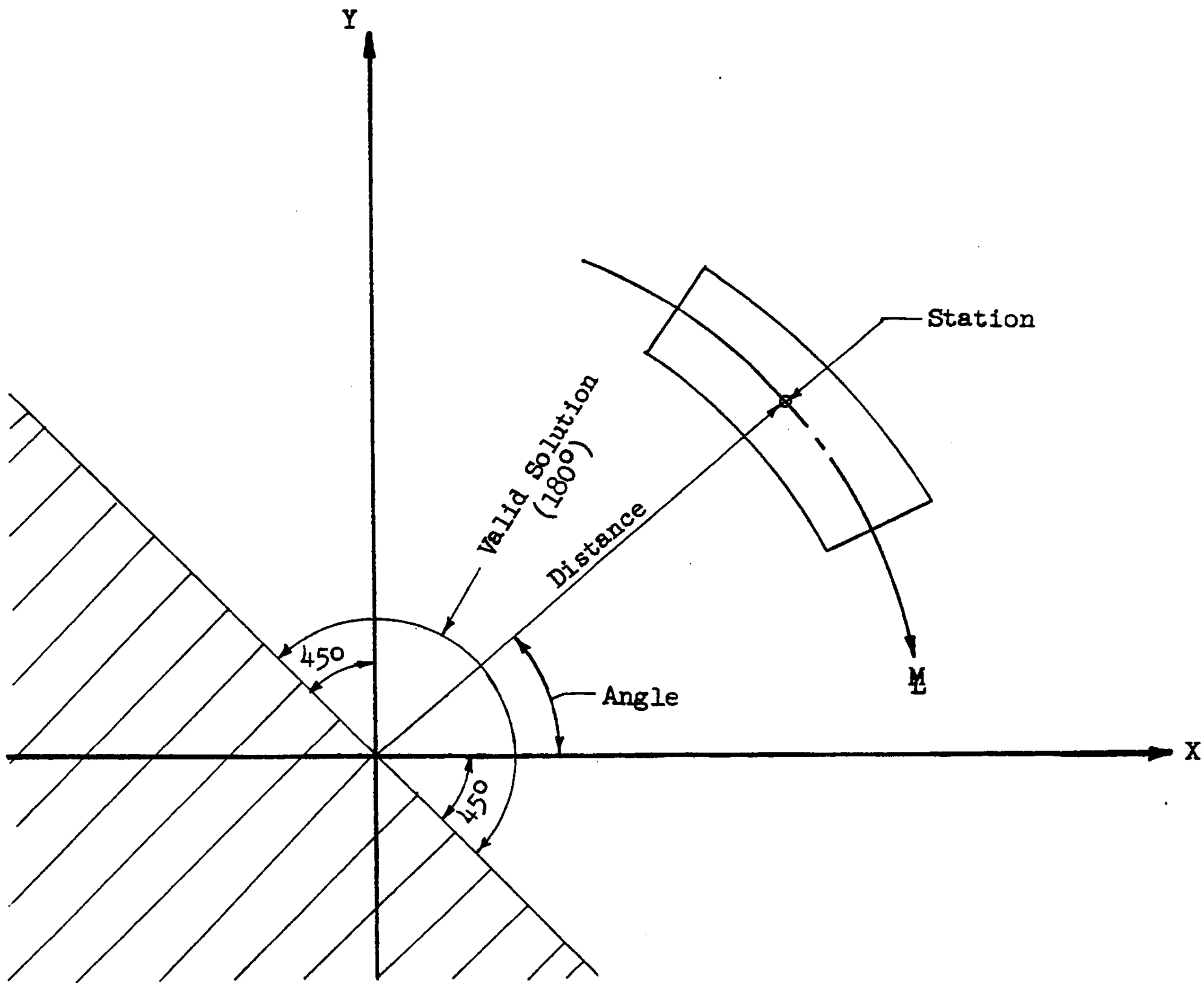
The X and Y Coordinates of each point of intersection are computed by the program in the solution of the longitudinal and transverse line equations in order to compute the aforementioned data. These coordinates are the result of the orientation of the bridge on a system of coordinate axes in order to facilitate the solution of the problem.

BRIDGE LAYOUT

In order to solve the geometric requirements, the bridge must be placed on a coordinate system of X and Y axes. After the Engineer has defined the orientation of the bridge in the input data, the longitudinal and transverse lines can be set up in equation form by the program, and the solution of the problem then becomes basically one of solving simultaneous equations.

Bridge Location

The location of the bridge on the coordinate system is defined by a Distance, Angle, and Station. In addition, the range or extent of the problem is controlled by the Limiting Stations, i.e., a protection feature. The data used to define the location of the bridge is shown in the sketch below. Note that by varying the Distance, Angle, and Station, the bridge can be placed in almost any position on the coordinate system. However, the location of the bridge must be defined so that the survey line does not pass through the origin. Note, also, that the portion of the coordinate system in which a program solution is valid is designated in the sketch.



Horizontal Alignment

The horizontal alignment is defined by giving the degree-of-curvature of each range of horizontal curve, and the P.C. and P.T. Stations that separate the range of the curves. The program has the capacity for three ranges of horizontal curves and tangents. Following is a list of the possible combinations of tangents and circular curves that may be used to define the horizontal alignment.

One Range:

1. Tangent
2. Curve

Two Ranges:

1. Tangent-Curve
2. Curve-Tangent
3. Curve-Curve (compound curve)

Three Ranges:

1. Tangent-Curve-Curve
2. Curve-Tangent-Curve
3. Curve-Curve-Tangent
4. Tangent - Curve - Tangent
5. Curve-Curve-Curve

A tangent is defined as a curve with a degree-of-curvature equal to zero.

The horizontal alignment defines the line that the stations are measured along, commonly called the survey line or mainline. Only one survey line can be defined with each problem, and that survey line must be a tangent (straight), circular curve, or a combination as shown above. The program has no provision for a spiral survey line, although the longitudinal lines may be defined as spirals (curve taper). The horizontal alignment may be composed of compound curves; however, the program has no provision for reverse curves. This presents no problem, however, since a bridge on a reverse curve can be solved by dividing the bridge at the point of reverse curvature into two problems.

The program solves a problem with a curve mainline regardless whether the mainline is curving to the left or right. Actually, the solution of the problem is independent of the direction of the curve since a left curve is a mirror image of a right curve, and vice versa. In the sketch on the following page, a right curve is shown at the top and a left curve is shown at the bottom. Note that the direction of the plus and minus Y-axis has been reversed in the sketch of the left curve; and, in addition, the positions of the normally first and fourth quadrant have been interchanged. If the sketch is rotated about the X-axis and viewed from the back, the left and right curves will appear to have reversed their direction. In other words, when a right curve is viewed from underneath it appears as a left curve. Therefore., since the direction from which a bridge is viewed has no physical effect on the alignment, the solution of the problem should be-and is-completely independent of the direction of the curve.

Vertical Alignment

In order for the program to compute the elevation of the various points on the bridge, the vertical alignment (Grade Data) must be defined as part of the input data. The bridge may be entirely on a tangent (constant slope), partly or wholly in a vertical curve, or occupy a portion of two vertical curves. The Grade Data consists of the lengths of existing vertical curves, slope of the tangents, station and elevation of an origin point, and the stations at which the tangents intersect to form a vertical curve.

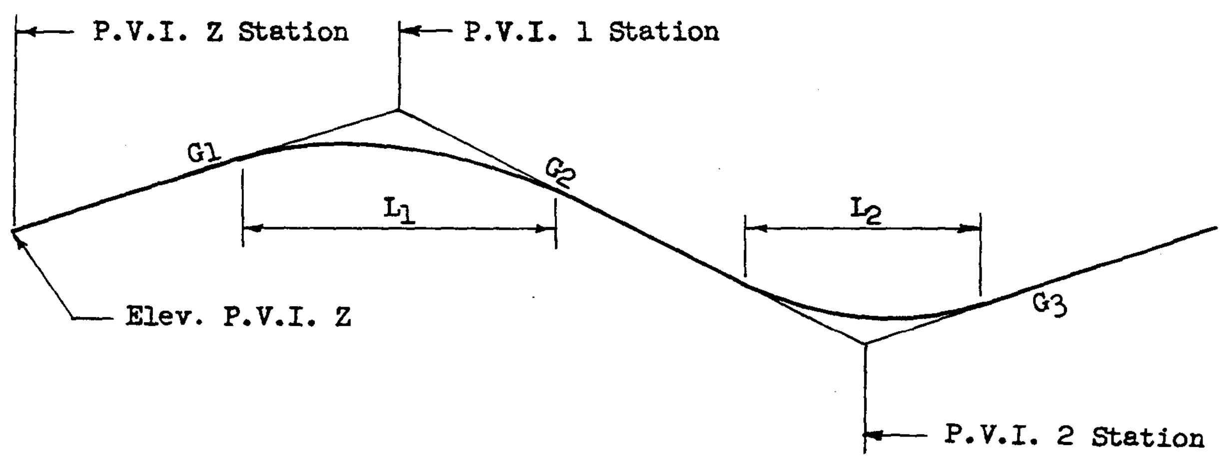
The vertical alignment defines the profile grade line which is also referred to as the pivot point line. In contrast to the limitation of the horizontal alignment to one survey line, the vertical alignment may consist of two pivot lines provided the bridge cross section is made up of superelevated lanes. However, the two pivot lines have the same elevation, and both are defined by the vertical alignment input data. This makes it possible for the Engineer to set up so-called twin or double bridges as one problem (rather than solving the bridges individually) provided, of course, that the vertical alignment is the same for both bridges. Following are the three possible variations in the vertical alignment.

1. Tangent

2. Tangent-Curve-Tangent

3. Tangent-Curve-Tangent-Curve-Tangent

It should be noted that any of the tangent portions may have a zero length (range). Following is a sketch showing the vertical alignment.



Bridge Cross Section

The "Skewed Bridge" computer program provides for three types of bridge cross sections: superelevation level, and parabolic crown. The user must define one of these types in order for the program to be able to compute the finished grade elevations. No other type of cross section is allowed by the program.

The program has the capacity for one, two, or three lanes of superelevation with each pivot line when the bridge is superelevated. The lanes of superelevation must be defined, and the rate of superelevation for each lane given, as part of the input data. Each lane of superelevation must have a constant width throughout the range of the bridge; however, the width and rate of superelevation of any lane is completely independent of any other lane. One of the most important functions of the program is the ability to compute finished grade elevations within a varying rate of superelevation, commonly called transition. Like the width and superelevation rate, the transition of any superelevated lane is completely independent of any other lane.

The program has the capacity to compute finished grade elevations when the roadway surface is a parabolic crown. However, a parabolic crown cannot be defined in the same problem with superelevated lanes, and only one parabolic crown is allowed per problem.

In lieu of the superelevation or parabolic crown, the bridge cross section can be defined as level. In this case, the program ignores the crown corrections, and the elevations given in the output data will be profile grade elevations.

LONGITUDINAL LINES

The beams, gutters, curbs, railings, structure lines, center lines, etc., of the bridge are defined in the input data as longitudinal lines. These lines may extend throughout the range of the problem, or the longitudinal lines may be defined for one or more particular spans. In other words, the longitudinal lines may vary from span to span. A minimum of one longitudinal line must be defined in each problem. The maximum number of longitudinal lines is thirty. There are ten types or codes by which the longitudinal lines may be defined. These will be discussed in detail in the section on "Preparing The Input Data".

TRANSVERSE LINES

The bents, substructure lines, centerline-of-bearings, diaphragms, splice points, construction joints, etc. of the bridge are defined as transverse lines. These transverse lines are defined in units of a span; that is, a span will consist of two transverse lines representing the two bents defining the span and a number of transverse lines within the span. The number of transverse lines may vary from zero to twenty per span, excluding the two bent lines. There is no limit on the number of spans that may be defined in a problem.

USING THE PROGRAM

The Engineer can effectively use the "Skewed Bridge" computer program in the preliminary and final design of a bridge. In the preliminary phase, stations, skew angles, distances, etc., that are unknown can be computed by the program to assist in the preliminary layout. In the final design phase, the lengths of beams and diaphragms, position of diaphragms, elevations for determining beam seat elevations and many other types of pertinent data can be computed by this program, thereby assisting the Engineer in the design and detailing of the bridge. In the construction phase, the Engineer can easily use the program to obtain the elevations used to set the construction forms, etc.

It is important to note that any bridge may be set up as a number of separate problems and processed at different times. For example, the geometric requirements in the design stage are quite different from the geometry that an Engineer requires in the construction of the same bridge. However, it is usually more beneficial to have all the geometric requirements in the design process computed in a single run of the problem. Later, the Construction Engineer can compute his geometric requirements in another run of the problem.

The information required by the program in order to process the problem must be given by the Engineer on a set of input data forms. First, it is important to determine all the different types of information the user desires the program to compute. This may eliminate the possibility of having to run the problem again to compute data not included in the first run of the problem. Next, the input data required by the program to compute the desired output must be determined. This involves choosing the number and types of longitudinal and transverse lines, etc. Finally, this data must be entered on the input data forms and forwarded to the Data Processing Center.

The output data which contains a listing of the input data is fully edited with numerous headings for ease in interpretation. The accuracy of the output data depends directly on the accuracy of the input data. That is, if an error is made in the input data, it surely will result in erroneous answers appearing in the output data. It cannot be overemphasized that the entire input data should be thoroughly checked before processing, and it is suggested that the input data forms be compared to the listing of the input data that is given in the output data as a further check.

METHOD OF SOLUTION

The geometric solution of a problem is based on the concepts of analytic geometry, i.e., coordinate system, line equations, etc. The program solution has three basic functions and following is a discussion of each function.

1. Compute Line Equations.

The mainline, longitudinal lines and transverse lines are set up in equation form by the program. Three basic types of line equations are used to describe these lines: straight, circular curve and spiral.

Straight Lines

The equation of a straight line is set up in slope intercept form:

$$Y = M*X + B$$

Where "M" is the slope of the line and "B" is the Y-Coordinate of the point where the line crosses the Y-axis.

However, if the absolute value of the slope (M) is greater than one (1), the equation of the straight line is in the following form:

$$X = N*Y + C$$

Where "N" is the slope of the line in relation to the Y-axis (N = l/M), and "C" is the X-Coordinate of the point where the line intersects the X-axis (C = -B/M).

Circular Curve Lines

The equation of a circle is set up in the following form:

$$(X-X_0)^2 + (Y-Y_0)^2 = R^2$$

Where "X_0" and "Y_0" are the coordinates of the center of the circle, and "R" is the radius of the circle.

Spiral lines

The equation of a spiral (curve taper) is set up in polar coordinate form as follows:

$$R = K\Theta$$

Where "R" is the radius of the curve when a radial line is rotated an angle equal to "Θ", and "K" is a constant representing the change in radius per unit of angle rotation.

2. Intersect Lines.

The program intersects each longitudinal line with the transverse lines. In addition, the mainline is intersected with all bent lines. The equations are solved simultaneously and, thereby, the X and Y coordinates are determined. When solving for the intersection of a spiral and straight line, the program uses a process of “approximations”.

3. Compute Intersection Data.

After solving for the X and Y coordinates, the program computes the station of the point and the distance from the point to the mainline. Using this data, the elevation of the point can be computed. In addition, other distances and angles are computed and printed in the output data.

Solution Sequence

Following is a brief outline of the sequence of the program solution with comments to indicate the functions of each part of the program solution.

1. Read and Process Layout Data (one time per problem).

   a. Location Data.

   The coordinates of the Reference Point Station are computed and stored along with the Limiting Stations, Reference Angle and Reference Point Station.

   b. Horizontal Data.

   The equation of the mainline, P.C. and P.T. Station coordinates, and Reference Angles are computed and stored along with the degree-of-curvature and radius of each range of horizontal curve.

   C. Vertical Curve Data.

   The vertical curve alignment is divided into ranges of parabolic curves and tangents, and the equation of the profile grade line is computed for each range and stored for future reference.

   d. Crown and lane Definitions.

   If the roadway is a parabolic crown, the program computes the parabolic constant and stores this constant along with the limits and position of the parabolic crown. When the bridge surface is superelevated, the program computes the width of each lane and stores this data along with the position of the lanes and profile grade lines.

   e. Superelevation Data.

   If the bridge surface is superelevated, the rate of superelevation of each lane is read and stored. If the bridge is in a varying rate of transition, the rates of change of the superelevation rates are computed for each lane and stored along with the stations of the breaks in the transition rates. This enables the program to compute the rate of superelevation in any lane at any station.

2. Read and Process Longitudinal Lines.

The program reads the longitudinal line data and computes and stores the equation of each longitudinal line that does not vary within the range of the problem. This is repeated each time a set of longitudinal lines is defined in the input data.

3. Read and Process Span.

The following program steps are repeated for each span in the bridge.

a. Span Identification.

The program reads and prints the information used to describe the span, i.e., remarks, etc.

b. Bent Data.

The input data of each bent is read and printed. Then, the program computes the equation of each bent and intersects the two bents with the mainline in order to find the bent station and skew angle (if this data is not given in the input data). The bent station and skew angle are stored for future listing.

4. Intersect Bents with Longitudinal Lines.

The program solves for the intersection of each bent with each longitudinal line. The intersection data (coordinates, angles, stations, etc.) is stored for future reference and listing. In addition, the equations of the variable longitudinal lines are computed, i.e., chords, etc.

5. Read and Process Transverse Lines in Span.

The program reads and prints the input data of each transverse line in the span. At the same time, the equations of the transverse lines are computed. These equations are stored temporarily so that these lines can be intersected with the longitudinal lines.

6. Intersect Longitudinal and Transverse Lines.

Beginning with the first longitudinal line, the program intersects the longitudinal lines with each transverse line. After each intersection point is found, the program computes the various output data (station, elevation, distances, angles). After processing all longitudinal lines, the program proceeds to a new span or terminates operation.

III. PREPARING THE INPUT DATA

In the following discussion, refer to the blank input data forms on pages 188, 189, 190, and 191.

FORM OF INPUT DATA

The input data required by the program is entered on four types of input forms. Following is a discussion of each type of input form.

A. LAYOUT DATA (page 188). H.D. 498-D

The LAYOUT DATA must be the first input sheet of each problem. Only one sheet *of* this type is required per problem. The LAYOUT DATA input form consists of the following input data:

1. Identification
2. Location Data
3. Horizontal Curve Data
4. Vertical Curve Data
5. Crown and lane Definitions
6. Superelevation Data

B. LONGITUDINAL LINES (page 189). H.D. 498-L

This input data form is used to define the longitudinal lines (beams, gutters, curbs, railings, etc.) that are to be intersected with the bent and transverse lines of each span. At least one sheet of this type must be used with each problem.

Usually, only one sheet of LONGITUDINAL LINES is required per problem. However, on some occasions the longitudinal lines will not be continuous from span to span (for instance, when one span has five beams and an adjacent span has six beams), and it will be advantageous to enter a LONGITUDINAL LINE input sheet preceding each span that has a different set of longitudinal lines.

C. SPAN DATA (page 190). H.D. 498-S

The SPAN DATA input data form is used to describe a span, the bents that define the span, and the transverse lines that are in the span. One sheet of this type is used with each span in the bridge. However, it is possible in some cases to combine several spans of the bridge and enter them as one span, thus eliminating a number of SPAN DATA input sheets. In this case, the intermediate bents can be defined and entered as transverse lines.

D. COORDINATE INPUT (page 191). H.D. 498-c

The COORDINATE INPUT form may be used in lieu of or in conjunction with the SPAN DATA input forms. This type of input sheet is used when the coordinates of the points on the bridge are known, and the stations, elevations, etc. are desired. Since the coordinates must be known (computed by some other method or program), this type of input will have limited use.

Sequence of the Input Data

The input data forms for each problem should be in the following order:

1. LAYOUT DATA (one sheet)
2. LONGITUDINAL LINES (one* sheet)
3. SPAN DATA and/or COORDINATE INPUT (variable number of sheets)

*An exception has been noted on page 50.

INPUT DATA REQUIREMENTS

In the following discussion, the required input data will be described in detail and examples used to illustrate the data that is entered on the input forms. Refer to the example problems for more illustrations.

Each line on the input data forms represents a card; and, this writeup will refer to the card columns (c.c.) of each line. Note that the card column numbers are given in the formats (headings) on the input forms. Each position (card column) of the input line is for entering one character, a number, letter, or special character; and, a group (field) of these positions is used to enter an item of data.

A negative quantity is indicated by placing a minus sign (-) before the first significant digit of the data field. In the absence of a minus sign, all quantities are considered positive. The entire data field to the right of the first significant digit should be filled in even though all the digits may be zero, i.e., the card columns to the right of a digit or digits in a data field should not be left blank.

The position of the decimal is shown on the input forms. Note that the decimal does not occupy a card column. However, the position of the decimal may be overridden by entering a decimal in the desired card column as part of the input data. This may be done to enter greater accuracy in the input data.

Plus signs (+) are shown in the data fields, where stations are required, to facilitate the entering of stations on the input forms. Note, however, that the plus sign does not occupy a card column.

Stations and distances are to be given in feet to four decimal positions unless noted otherwise. The first digit(s) in the first card column(s) of each input data line is for identification purposes, and of no significance to the Engineer.

LAYOUT DATA

The LAYOUT DATA input form must always be filled in as the first sheet of each problem.

A. IDENTIFICATION (* in c.c. 1).

The Identification line is used to enter any pertinent identifying remarks about the bridge that the Engineer wishes to head the output listing. The project number, county, date, and name or initials should always be entered.

Card columns 2-5 of the first line are reserved for the problem number. This space should always be left blank by the Engineer since a number will be assigned to the problem from the log book of computer runs. The problem number will be associated with any error messages and will appear in the output listing.

Any number of Identification lines may be used to enter remarks, etc. However, when an additional line (card) is to be used., the code "CONT" must be entered in card columns 77-80 to indicate to the program that another Identification card is to follow. Therefore, the last Identification line will not require the continuation code. Also, if only one Identification line is used for remarks, the code "CONT" is not required.

B. LOCATION DATA (1 in c.c. 1).

The Location Data consists of the data required to locate the bridge on a system of coordinate axes.

1. Limiting Stations (c.c. 2-11, 12-21). Form: xxxx+xx.xxxx feet.

The Back and Ahead Limiting Stations define the range of the problem; that is, every point computed on the bridge must lie on or between these two stations. Both of these stations are always required as part of the input data. The purpose of the Limiting Stations is to protect against errors in the input data. For example, if an error is made when entering a transverse line (or key-punch error), the intersection of the transverse line and some longitudinal line might fall outside the Limiting Stations, thus causing an error message and bringing it to the attention of the Engineer. In order for this safety feature to function properly, the Limiting_Stations should be placed near the ends of the bridge. The Limiting Stations serve other purposes that will be discussed more conveniently on subsequent pages. The Limiting Stations may be of negative magnitude.

2. Station of Reference Point (c.c. 22-31). Form: xxxx+xx.xxxx feet.

The Reference Point Station is an arbitrary station used to orient the bridge on a system of coordinate axes. This point is usually on the bridge; however, this is not a program requirement. Whenever the bridge crosses a road, it is common practice to use the point of intersection of the two survey center-lines as the Reference Point.

It is an absolute program requirement that the Station of Reference Point be in the range of horizontal curve two. This requirement will be noted in more detail in the discussion of the Horizontal Curve Data. In addition, the Reference Point must be on the survey centerline, i.e., mainline. The Reference Point Station may have a negative value.

3. Reference Angle α (c-c- 32-40). Form: xxx deg.,xx min.,xx.xx sec.

The Reference Angle is the angle between the X-axis and the radial line from the origin to the Reference Point. This is an arbitrary angle that may be varied from zero (0) to ninety (90) degrees. However, in order to keep the entire bridge in the first quadrant, Reference Angle values of zero or ninety degrees can be used only when the Reference Point is ahead or back of the bridge, respectively. The Reference Angle is entered by giving the degrees, minutes, and seconds of the angle according to the input data format. The degrees and minutes are entered as whole numbers, and the seconds are entered to the nearest hundredth. The Reference Angle cannot be entered in radians or decimals of degrees. Although the program will accept a negative Reference Angle, under normal circumstances the Reference Angle should always be positive.

If horizontal curve range two (curve that contains the Reference Point) is actually a tangent (straight), a Reference Angle value of zero would place curve two parallel to the Y-axis. A value of ninety degrees would orient curve two parallel to the X-axis. If the bents of the bridge are parallel, a Reference Angle value can be entered so that the bents will be parallel to either the X or Y-axis. This will be discussed further in the discussion of SPAN INPUT DATA.

However, it should be understood that the Reference Angle is completely independent of any bent or reference line skew angle.

4. Distance from Origin to Reference Point (c.c. 41-50).
Form: xxxxxx.xxxx feet.

The Reference Distance is the radial distance from the origin to the Reference Point. If horizontal curve two is a circular curve, this distance need not be given since the program will automatically assign the radius of the curve to this distance, thus placing the center of the curve at the origin.

If horizontal curve range two is a tangent, the Reference Distance should always be given a value greater than zero. If a value of zero is entered, or the space is left blank, the program will assume a value of ten thousand feet (10,000.0000). A negative Reference Distance is not acceptable. Note that the line from the origin to the Reference Point is always perpendicular to the tangent. The Reference Distance is actually an arbitrary distance that is used in conjunction with the Reference Angle and Reference Point Station to orient the bridge on a system of coordinate axes.

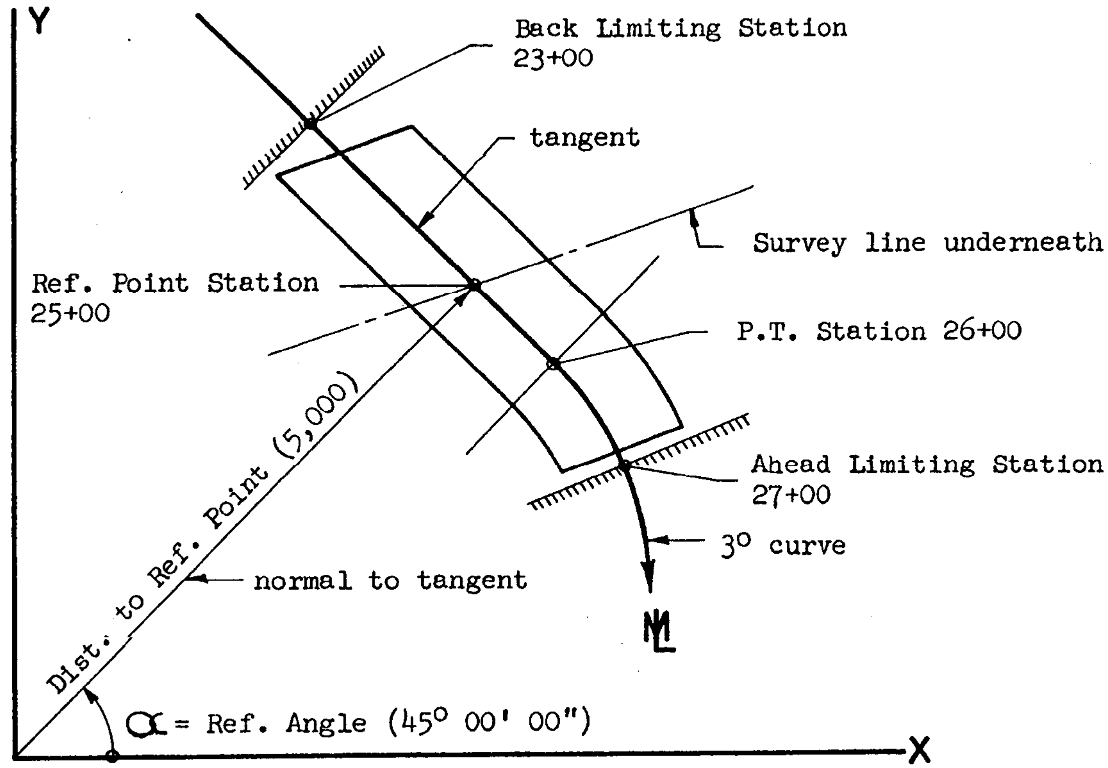
Location Data Examples

Three examples of the location Data required to orient a bridge on a system of coordinate axes are shown on the following three pages.

LOCATION DATA

EXAMPLE: 1-1. Layout Data

This example shows how a bridge is oriented on a system of coordinate axes. All the stations, distances, etc., are assumed and used for the purpose of illustrating the Layout Data input requirements. Note that the major portion of the bridge is on a tangent, and the remaining portion is on a circular curve. The tangent portion which contains the majority of the bridge will be set up as curve two. Therefore, the Reference Point must be in the tangent portion. The Reference Point will be arbitrarily defined as the intersection point of the survey lines of the bridge and road underneath. Note that the skewed corners at the ends of the bridge must be taken into account when selecting the Limiting Stations.



FORM OF INPUT

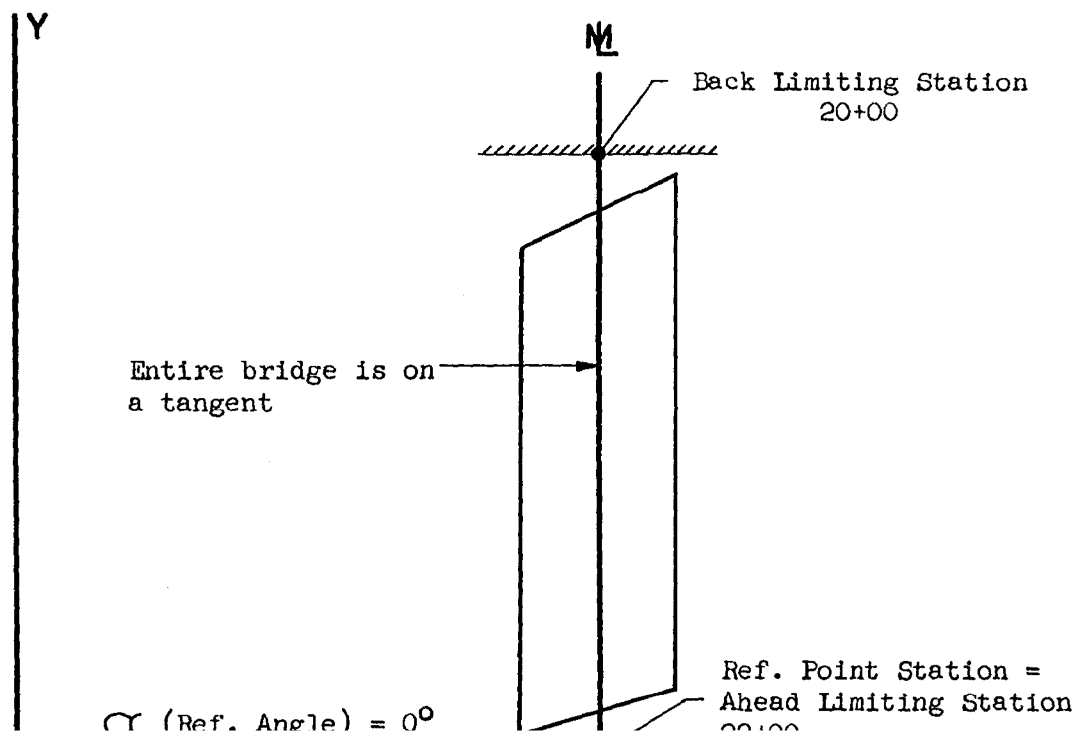
LOCATION DATA

	LIMITING STATIONS BACK (2)	LIMITING STATIONS AHEAD (12)	STATION OF REFERENCE POINT (22)	REF. ANGLE α DEG. (32)	MIN. (35)	SEC. (37)	DIST. FR. ORIGIN X_0, Y_0 TO REFERENCE POINT (41–50)
1	23+000000	27+000000	25+000000	45	00	0000	50000000

LOCATION DATA (continued)

EXAMPLE 1-2. Layout Data

This example shows how a bridge that is entirely on a tangent can be oriented parallel to the Y-axis. Note that the Reference Angle is zero in this case. The Station of the Reference Point is ahead of the bridge so that all the bridge will lie in the first quadrant. The Reference Distance is assumed to be 1,000 feet, and the assumed stations are shown in the sketch.



FORM OF INPUT

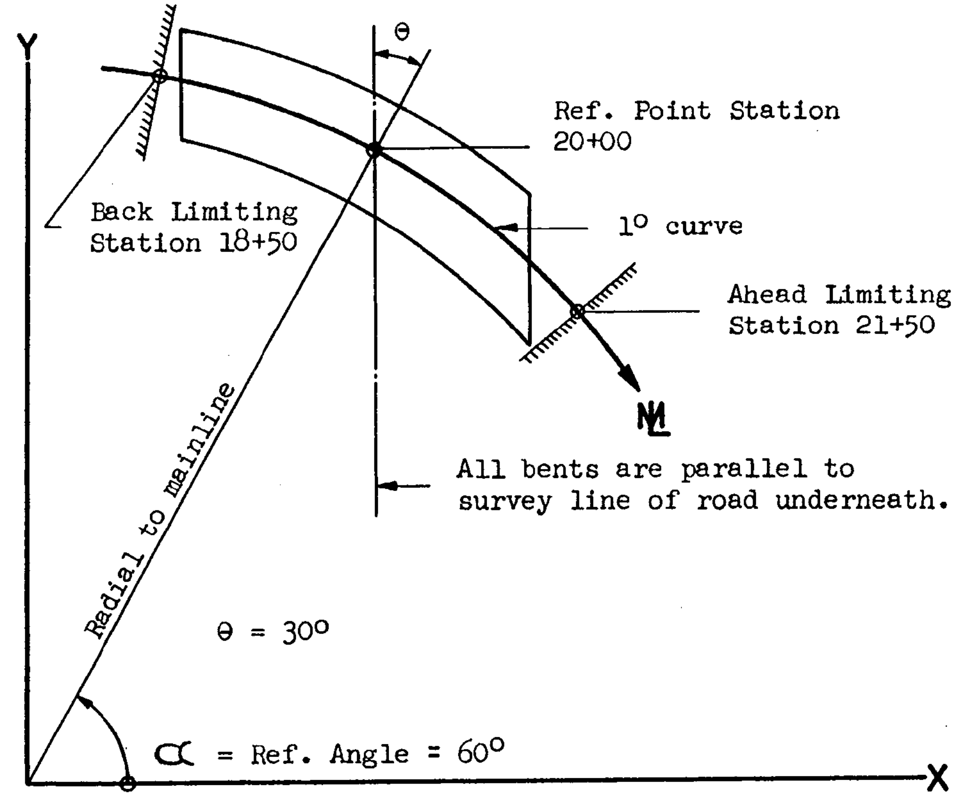
LOCATION DATA

	LIMITING STATIONS		STATION OF REFERENCE POINT	REF. ANGLE α			DIST. FR. ORIGIN X_o, Y_o TO REFERENCE POINT
	BACK	AHEAD		DEG.	MIN.	SEC.	
1	2	12	22	32	35	37	41 — 50
1	20+00.0000	22+00.0000	22+00.0000	0	00	00.00	1000.0000

LOCATION DATA (continued)

EXAMPLE 1-3. Layout Data

This example shows how the bents of a bridge may be set up parallel to the Y-axis provided, of course, the bents are parallel. In this case, all the bents are parallel to the road underneath, which is common practice. Note that if the Ref. Angle (α) is made equal to the complement of the skew angle (Θ), the bents and survey line underneath will be parallel to the Y-axis. The skew angle should be known in each case. In this example, a value of thirty (30) degrees is assumed. Therefore, the Reference Angle (α) should have a value of sixty (60) degrees. Note that the Reference Distance is not required in this case, i.e., the radius of the curve will be used as the Reference Distance.



FORM OF INPUT

LOCATION DATA

	LIMITING STATIONS		STATION OF REFERENCE POINT	REF. ANGLE α			DIST. FR. ORIGIN X_0, Y_0 TO REFERENCE POINT
	BACK	AHEAD		DEG.	MIN.	SEC.	
1	2	12	22	32	35	37	41 … 50
1	18+50.00000	21+50.00000	20+00.00000	60	00	00.00	

C. HORIZONTAL CURVE DATA (2 in c.c. 1).

Since the bridge may be located in as many as three horizontal curves, the Horizontal Curve Data is used to enter the degree-of-curvature of each curve, and the P.C. and P.T. Stations that separate the curve ranges. Note that any of the three curves may actually be a tangent (straight), i.e., a curve with an infinite radius.

The degree-of-curvature of each range is entered on the input form in degrees, minutes, and seconds. Note that the curvatures may be entered to the hundredth of a second. A tangent range of horizontal curve is defined by entering a degree-of-curvature of zero (0). In actual practice, the bridge will very rarely be on three ranges of horizontal curves, and bridges on two ranges of horizontal curves are infrequent. The vast majority of bridges will be completely in only one range of horizontal curve. Therefore, in order to save the Engineer's time, it is necessary to define only the ranges of curvature in which the bridge is located. For example, if the bridge is entirely in one curve (or tangent), only one degree-of-curvature is required. Likewise, if the bridge is located in two curves (or curve and tangent), it is necessary to define only two degree-of-curvatures, etc.

Adjoining curves, or adjoining curve and tangent, are assumed to be tangent at the P.C. and P.T. Stations.

If there is only one range of curvature, it must always be defined as Curve No. 2. In this case, Curve No. 1 and Curve No. 3 would not exist. If there are two ranges of curvature, one of the ranges must always be defined as Curve No. 2 and the other curve as either Curve No. 1 or Curve No. 3. For greater program efficiency,, Curve No. 2 should be the range that contains the major portion of the bridge. This is the reason that the tangent portion of the bridge in example 1-1 (page 17) was selected as Curve No. 2.

1. Curve No. 1 (c.c. 2-9). Form: xx deg.,xx min.,xx.xx sec.

    The degree-of-curvature of curve range one should be entered in this space. If this curve does not exist, leave this space blank. The beginning station of Curve No. 1 is assumed to be the Back Limiting Station, and the ending station is the P.C. Station of curve range two.

2. P.C. Station (c.c. 10-19). Form: xxxx+xx.xxxx feet.

    The P.C. Station is the station that begins Curve No. 2 and, therefore, ends Curve No. 1. This station is not required if only one range of horizontal curve exists. The program will assign this station the value of the Back Limiting Station, i.e., the P.C. Station in this case is arbitrary. However, the P.C. Station should always be given if two or three ranges of horizontal curvature exist. If Curve No. 1 does not exist when Curve No. 3 does exist, the P.C. Station can conveniently be set equal to the Back Limiting Station since the P.C. Station is in this instance an arbitrary station.

3. Curve No. 2 (c.c. 20-27). Form: xx deg.,xx min.,xx.xx sec.

This space is for entering the degree-of-curvature of horizontal curve range two. Curve No. 2 is considered the main curve and, therefore, must always be defined. The range of Curve Vo. 2 must always contain the Reference Point Station that is given in the Location Data. The range of Curve No. 2 is from the P.C. Station to the P.T. Station.

4. P.T. Station (c.c. 28-37). Form: xxxx+xx.xxxx feet.

The P.T. Station is the station that ends the range of Curve No. 2 and begins Curve No. 3. If only one range (Curve No. 2) of horizontal curve exists, this station is not required, i.e., leave blank. The program will assign this station the value of the Ahead Limiting Station, i.e., the P.T. Station in this case is arbitrary. However, the P.T. Station should always be given if two or three ranges of horizontal curvature exist. If curve range three does not exist when Curve No. 1 does exist, the P.T. Station can conveniently be set equal to the Ahead Limiting Station since the P.T. Station is - in this instance - an arbitrary station.

5. Curve No. 3 (c.c. 38-45). Form: xx deg.,xx min.,xx.xx sec.

Enter in this space the degree-of-curvature of horizontal curve range three. If this range of mainline curve does not exist, this space should be left blank. The beginning station of Curve No. 3 is the P.T. Station, and the ending station is assumed to be the Ahead Limiting Station.

Horizontal Curve Data Examples

The following page contains the Horizontal Curve Data required for the three examples (1-1, 1-2, 1-3) shown to illustrate the Location Data.

HORIZONAL CURVE DATA

EXAMPLE 2-1. Layout Data

This example shows the Horizontal Curve Data requirements of Example 1-1 on page 17.

FORM OF INPUT

HORIZONTAL CURVE DATA

	CURVE NO. 1			CURVE NO. 2 (MUST CONTAIN THE REFERENCE POINT)					CURVE NO. 3		
	DEG.	MIN.	SEC.	P.C. STATION**	DEG.	MIN.	SEC.	P.T. STATION**	DEG.	MIN.	SEC.
1	2	4	6	10	20	22	24	28	38	40	42 45
2				23+00.0000	0	00	00.00	26+00.0000	3	00	00.00

EXAMPLE 2-2. Layout Data

This example shows the Horizontal Curve Data requirements of Example 1-2 on page 18.

FORM OF INPUT

HORIZONTAL CURVE DATA

	CURVE NO. 1			CURVE NO. 2 (MUST CONTAIN THE REFERENCE POINT)					CURVE NO. 3		
	DEG.	MIN.	SEC.	P.C. STATION**	DEG.	MIN.	SEC.	P.T. STATION**	DEG.	MIN.	SEC.
1	2	4	6	10	20	22	24	28	38	40	42 45
2					0	00	00.00				

EXAMPLE 2-3. Layout Data

This example shows the Horizontal Curve Data requirements of Example 1-3 on page 19.

FORM OF INPUT

HORIZONTAL CURVE DATA

	CURVE NO. 1			CURVE NO. 2 (MUST CONTAIN THE REFERENCE POINT)					CURVE NO. 3		
	DEG.	MIN.	SEC.	P.C. STATION**	DEG.	MIN.	SEC.	P.T. STATION**	DEG.	MIN.	SEC.
1	2	4	6	10	20	22	24	28	38	40	42 45
2					1	00	00.00				

D. VERTICAL CURVE DATA

The Vertical Curve Data consists of two lines (cards) on the input form. The first line is for entering P.V.I. Stations; and, the second line is used to enter the beginning Elevation, Grades (slopes) and Length of Vertical Curves.

1. P.V.I. Stations (3in c.c. l).

The P.V.I. Station is defined as the station of the intersection of the tangents of a parabolic vertical curve. These stations are required in order to properly position the vertical curves. The P.V.I. Stations may be of negative magnitude. These stations should be given on the input form according to the following requirements.

a. P.V.I. Z Station (c.c. 2-11). Form: xxxx+xx.xxxx feet.

The P.V.I. Z Station is not actually a P.V.I. Station, but rather the station of the beginning of the Vertical Curve Data. Therefore, this station must be located before the beginning of the bridge since the program will not compute the elevation of a point located back of this station. In essence, this station is the origin of the grade data. The P.V.I. Z Station should be on a tangent grade and not within a vertical curve. The P.V.I. Z Station is an arbitrary station and should always be defined by entering a value on the input form.

The end of the Vertical Curve Data is assumed to be the Ahead Limiting Station.

b. P.V.I. 1 Station (c.c. 12-21). Form: xxxx+xx.xxxx feet.

If a portion (or all) of the bridge is in a vertical curve, it is necessary to give as the P.V.I. 1 Station the station of the intersection of the two grades (Gl and G2) that define the first vertical curve. This station is not required if the entire bridge is on a tangent.

C. P.V.I. 2 Station (c.c. 22-31). Form: xxxx+xx.xxxx feet.

The program has the capacity for two vertical curves. If a portion of the bridge lies in a second vertical curve, it is necessary to give as the P.V.I. 2 Station the station of the intersection of the two grades (G2 and G3) that define the second vertical curve. This station is not required if the entire bridge is on a tangent, nor when there is only one vertical curve.

2. Elevation, Grades and Lengths of Vertical Curves (4 in c.c. 1).

The Grades (slopes) that define the Vertical Curve Data are given in per cent, i.e., one hundred times the tangent of the slope angle. Each slope may be positive or negative. A positive grade increases the profile grade elevation as the station increases. A negative slope decreases the profile grade elevation as the station increases. The Grades can be entered to six decimal positions of per cent. A Vertical Curve Length equal to zero is invalid.

The lengths of Vertical Curves can be entered to three decimal positions. A negative Vertical Curve Length has no meaning and, therefore, a negative value is not permitted.

a. Elevation F.V.I. Z (c.c. 2-9). Form: xxxx.xxxx feet.

Enter in this space the profile (pivot point or elevation control line) grade elevation of the F.V.I. Z Station. This Elevation of the beginning of the grade data must always be given on the input form. The Elevation of the P.V.I. Z Station can be given to the nearest ten-thousandth of a foot (four decimal positions) and may be of negative magnitude.

b. % Grade Z-1 (c.c. 10-18). Form: xxx.xxxxxx %.

This grade (Gl) is the slope of the tangent from the P.V.I. Z Station to the P.V.I. 1 Station. This grade should always be given on the input form. If the P.V.I. 1 Station is not defined (no vertical curve) the requirements of this grade are unchanged, and this grade is then assumed to hold true from the P.V.I. Z Station to the Ahead Limiting Station.

C. L.V.C. 1 (c.c. 19-25). Form: xxxx.xxx feet.

Enter in this space the length of the first (or only) vertical curve. This vertical curve is assumed to be symmetrical about the P.V.I. 1 Station. Leave this space blank if the grade data contains no vertical curves.

d. % Grade 1-2 (c.c. 26-34). Form: xxx.xxxxxx %

This grade (G2) is the slope of the tangent from the P.V.I. 1 Station to the P.V.1. 2 Station. Enter this grade only when the grade data contain a vertical curve(s). In the case of one vertical curve, this grade is continuous from the P.V.I. I Station to the Ahead Limiting Station.

e. L.V.C. 2 (c.c. 35-41). Form: xxxx.xxx feet.

The length of the second vertical curve is entered in this space. However, if there is no requirement for a second vertical curve, this space should be left blank. This vertical curve is assumed to be symmetrical about the P.V.I. 2 Station.

f. % Grade 2-3 (c.c. 42-50). Form: xxx.xxxxxx %

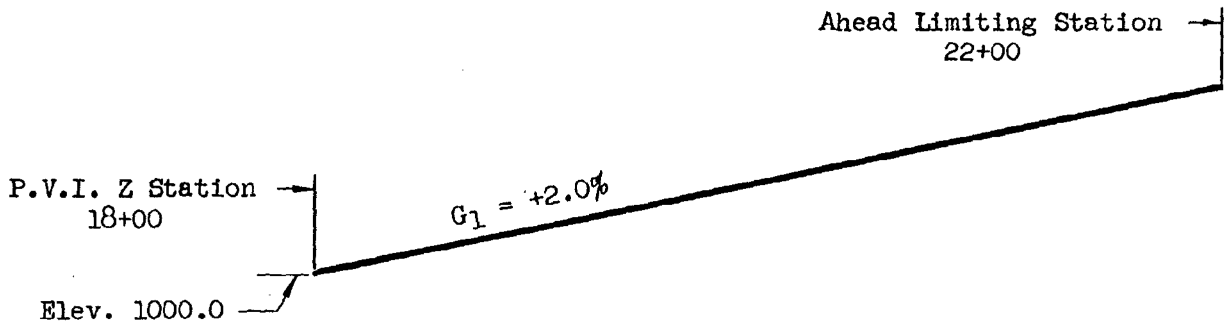
This grade (G3) is the slope of the tangent from the P.V.I. 2 Station to the Ahead Limiting Station and should be entered on the input form only when the grade data contains two vertical curves.

Vertical Curve Data Examples

Three examples of the input data necessary to define the Vertical Curve Data are shown on the following three pages.

VERTICAL CURVE DATA

EXAMPLE 3-1.



In this example, the bridge is assumed to be entirely on a tangent (straight grade). The only data that will be required are the P.V.I. Z Station, the Grade (G_1), and the beginning Elevation. Note that the grade is assumed to extend to the Ahead Limiting Station.

FORM OF INPUT

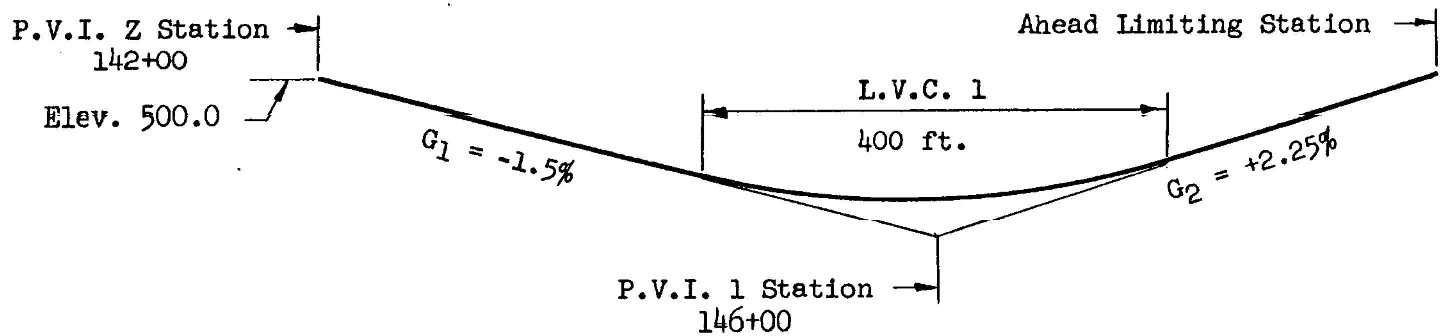
VERTICAL CURVE DATA**

	P.V.I. Z STA.	P.V.I. 1 STA.	P.V.I. 2 STA.
3	18+00.0000	+ .	+ .

	ELEV. P.V.I. Z	% GRADE Z-1	LVC 1	% GRADE 1-2	LVC 2	% GRADE 2-3
4	1000.0000	2.0000000	.	.	.	.

VERTICAL CURVE DATA (continued)

EXAMPLE 3-2.



This example shows the required input data when the bridge is located in a vertical curve, either partly or wholly. Note that the beginning station of the actual vertical curve is 144+00, and the ending station is 148+00.

FORM OF INPUT

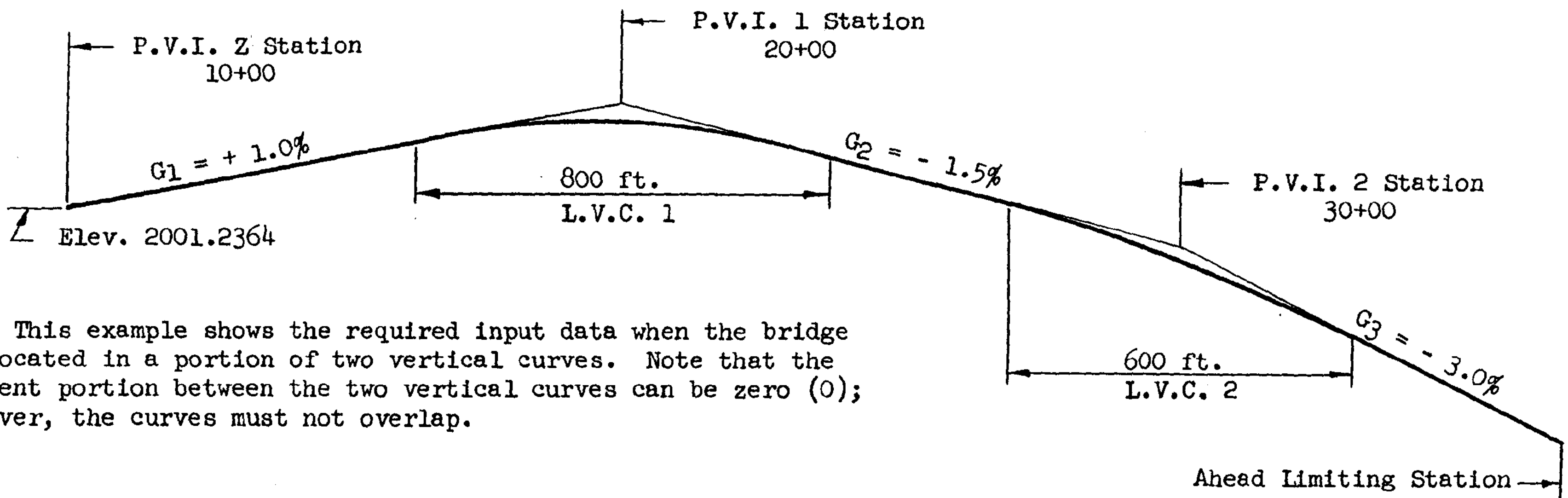
VERTICAL CURVE DATA**

	P.V.I. Z STA. (2)	P.V.I. 1 STA. (12)	P.V.I. 2 STA. (22)
3	142+00.00	146+00.0000	+ .

	ELEV. P.V.I. Z (2)	% GRADE Z-1 (10)	LVC 1 (19)	% GRADE 1-2 (26)	LVC 2 (35)	% GRADE 2-3 (42–50)
4	500.0000	-1.500000	400.00	2.250000	.	.

VERTICAL CURVE DATA (continued)

EXAMPLE 3-3.



This example shows the required input data when the bridge is located in a portion of two vertical curves. Note that the tangent portion between the two vertical curves can be zero (0); however, the curves must not overlap.

FORM OF INPUT

VERTICAL CURVE DATA**

1	P.V.I. Z STA. (2)	P.V.I. 1 STA. (12)	P.V.I. 2 STA. (22)
3	10+00.0000	20+00.0000	30+00.0000

1	ELEV. P.V.I. Z (2)	% GRADE Z-1 (10)	LVC 1 (19)	% GRADE 1-2 (26)	LVC 2 (35)	% GRADE 2-3 (42)
4	2001.2364	1.000000	800.000	-1.500000	600.000	-3.000000

E. CROWN AND LANE DEFINITIONS (5 in c.c. 1).

The Crown and Lane Definitions input line is used to enter the data that is necessary to completely define the type and limits of the transverse bridge surface (finished grade). The bridge roadway surface may be parabolic, superelevated, or level (no crown correction). The input form has two formats for reference when entering the input data. The format used to enter a parabolic crown is the topmost format to the left, and the superelevated format is immediately below the parabolic format and encompasses the entire line on the input data form. Since the required input to define a parabolic crown is entirely different from the data that is required to define superelevated lanes, the two types of roadway surfaces will be discussed separately. A level crown is a special case and will be discussed separately also.

No provision is made for a circular crown; however, a circular crown can be defined in most cases as a parabola with negligible error.

PARABOLIC CROWN

The program has the capacity for only one parabolic roadway crown, and all points outside the range of the parabolic surface will be leveled off from the edge or extent of the parabola. The profile grade control line is assumed to be along the crown point, i.e., apex of the parabola. The parabolic crown is assumed to be symmetrical about a vertical axis through the parabola apex.

Card columns 45-79 and 5-12 of the input form should be ignored since no data is required in these spaces. Also, the Superelevation Data (6 in c.c. 1) which follows the Crown and Lane Definitions is not required and should be completely ignored. Following is the required input data for a parabolic crown.

1. Crown Code (c.c. 2-4).

   In order to indicate to the computer the type of finished grade surface the program is to consider, a Crown Code must be given in card columns 2-4 of the input form. If the roadway crown is parabolic,, the Crown Code required is "PAR".

2. Distance From Crown To R/L Gutter (c.c. 13-20). Form: xxxx.xxxx feet.

   This dimension is the distance from the apex of the parabola to the extent of the parabolic surface, usually the gutter line. The distance is measured perpendicular to the center line of the bridge. This distance is assumed to be the same for both left and right sides of the bridge and should never be given a negative value, nor a value of zero. A negative value is meaningless, and a zero dimension indicates a level crown which can be defined by an easier method.

3. Δ R From Mainline To Crown (c.c. 21-28). Form: xxxx.xxxx feet.

This dimension is the distance from the mainline (survey control line) to the apex (crown Point) of the parabolic crown. The distance is measured perpendicular to the center line of the bridge. This dimension may be negative, zero, or of positive magnitude. Therefore, the survey line is not required to be along the crown point of the surface. If the distance from the mainline to the crown point is toward the origin, the dimension is negative; otherwise (away from origin), the dimension is positive. Probably, in most cases, the survey line will be along the center line of the crown surface and, therefore, this dimension will usually be zero.

4. Distance From Crown To Control Point (c.c. 29-36).
Form: xxxx.xxxx feet.

This dimension is the perpendicular distance (horizontal) from the crown point to a point on the parabolic surface at which the vertical ordinate (drop from crown point) of the curve is known. This usually turns out to be the gutter line since most parabolic crowns are detailed at this point. This distance should never be negative or zero.

5. Drop From Crown To Control Point (c.c. 37-44). Form: xxxx.xxxx inches.

This dimension is the vertical ordinate from the crown point to the point on the surface at the dimension, "Distance From Crown To Control Point". This dimension should always be given in INCHES. A value of zero should not be used because this would define a level crown. A negative value will produce a concave parabola (sag),and a positive value will produce a convex parabola (hump).

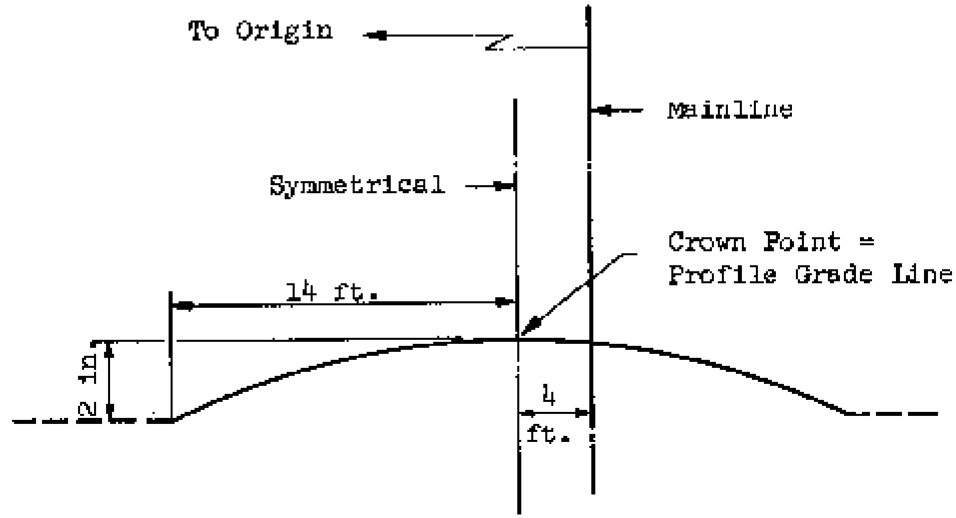
Parabolic Crown Example

An example of a parabolic crown roadway and the required input data is shown on the following page.

CROWN AND LANE DEFINITIONS

EXAMPLE 4-1. PARABOLIC CROWN

This example shows a typical parabolic roadway crown and the input data requirements. Note that if the origin had been to the right of the mainline, the dimension from the mainline to the crown point (4 feet) would have been positive.



FORM OF INPUT

CROWN AND LANE DEFINITIONS

			DIST. FROM CROWN TO R/L GUTTER	ΔR FROM ℄ TO CROWN	DIST. FROM CROWN TO CONTROL PT.	DROP (INCHES) FROM CROWN TO CONTROL PT.
	CROWN CODE	ΔR TO BEGIN INSIDE S.E.	ΔR'S FROM ℄ TO INSIDE LANES: S.R. 1	INSIDE PIVOT	S.R. 2	S.R. 3
1	2	5	13	21	29	37
5	PAR		14.0000	-4.0000	14.0000	2.0000

ΔR TO BEGIN OUTSIDE S.E.	ΔR'S FROM ℄ TO OUTSIDE LANES: S.R. 4	OUTSIDE PIVOT	S.R. 5	S.R. 6
45	52	59	66	73 — 79

SUPERELEVATION

The program has the capacity for six lanes of superelevation which are grouped into two bands, each containing three adjoining lanes. Each band is controlled independently by a pivot line; therefore, the bands will not necessarily be adjoining. However, the vertical curve data is the same for both pivot lines. Three lanes are always associated with each pivot line even though only one or two may actually exist. When the bridge is being defined as superelevated, it is required that at least one pivot line and three lanes be defined. If three lanes are not sufficient, then two pivot lines and six lanes must be defined. Each pivot line can have no more, or less, than three lanes. When lanes must be defined that do not actually exist, they can conveniently be given a width of zero, thus effectively eliminating the lanes.

The innermost (nearest to origin) band of three lanes and pivot line are defined on the left side of the input form (c.c. 5-44), and the outermost (furthest from origin) band of three lanes and pivot line are defined on the right side of the input form (c.c. 45-79). If only three lanes of superelevation are to be defined, the data to define these lanes should always be entered on the left side of the form, even though all lanes may be outside the mainline. The terms "inside" and "outside" used on the input form do not refer to the mainline but rather to the relative position of the bands to the origin. For instance both bands of superelevated lanes may be totally inside (toward origin) the mainline or outside (away from origin) the mainline.

The width and position of the lanes of superelevation are defined by giving the perpendicular or radial distances from the mainline to the edges of the lanes. The distances are negative if they are measured toward the origin from the mainline, and positive if they are measured away from the origin from the mainline. All lanes are assumed to be of constant width throughout the range of the problem, i.e., lanes with varying widths are not allowed. However, the width of any lane may be different from the width of any other lane. The pivot line may be in any one of its associated three lanes of superelevation; however, the pivot line must not be located outside the three lanes.

The position of the mainline relative to the two bands of superelevation is not restricted. That is, the mainline can be outside, inside, between, or within the two bands of superelevation. If only one band of three lanes is defined,, the relative position of the mainline is likewise unrestricted.

Each lane of superelevation may have a constant or varying (commonly called transition) rate of superelevation which is independent of any other lane. The superelevation rates and transition input data requirements are discussed on page 42. Following is the input data required to define the lanes of superelevation.

1. Crown Code (C.C. 2-4).

In order to indicate to the program that the crown is superelevated, this space should be left blank, i.e., no particular code is required to define a superelevated roadway.

2. Δ R To Begin Inside S.E. (c.c. 5-12). Form: xxxx.xxxx feet.

This dimension is the distance from the mainline to the inside edge of the innermost (nearest to origin) lane of superelevation. This distance should always be given on the input form when the roadway is superelevated. The innermost lane will be defined as lane one (1) for the purpose of explanation, and each subsequent lane, moving outward, will be assigned a number in like sequence.

3. S.R. 1 (c.c. 13-20). Form: xxxx.xxxx feet.

The"S.R.1" dimension is the distance from the mainline to the outside edge of the innermost lane (lane one) and, therefore, to the inside edge of the adjoining lane (lane two) of superelevation. This dimension is always required with a superelevated roadway crown and should never be less then the dimension " Δ R To Begin Inside S.E.", i.e., overlapping lanes would result in this case. Note that if the two dimensions,"S.R.1" and "Δ R To Begin Inside S.E. are made equal, the width of lane one will be zero and, in essence, lane one would not exist.

4. Inside Pivot (c.c. 21-28). Form: xxxx.xxxx feet.

This dimension is the distance from the mainline to the innermost pivot line. This pivot point must be in lane one, two or three. Since this pivot point must be within the innermost band of superelevated lanes, the "Inside Pivot" dimension should not be less than the “Δ R To Begin Inside S.E." dimension, nor greater than the "S.R.-3"dimension. The pivot point is that point on the superelevated surface where the Vertical Curve Data holds true. This point or line is also commonly called the "profile grade line". This dimension should always be given a value on the input form.

As mentioned before, the bridge roadway may have two pivot lines (twin bridges, for instance). The pivot line entered here is the one nearest the origin and in the case of only three lanes, the only pivot line that needs to be defined.

5. S.R. 2 (c.c. 29-36). Form: xxxx.xxxx feet.

The "S.R. 2" dimension is the distance from the mainline to the outside edge of lane two and, therefore, to the Inside edge of the outside adjoining lane (lane three). This dimension should always be defined, and the value of the dimension must never be less than the "S.R. 1" dimension. If the dimensions "S.R. 1" and "S.R. 2" are made equal, the width of lane two would then be zero and, therefore, lane two would not actually exist.

6. S-R- 3 (c.c. 37-44). Form: xxxx.xxxx feet.

The "S.R. 3" dimension is the distance from the mainline to the outside edge of lane three. This dimension defines the outer limit of the innermost (or only) band of superelevated lanes. The "S.R. 3" dimension can be made equal to the "S.R. 2" dimension to effectively eliminate lane three, but the value of "S.R. 3" should never be less than "S.R. 2". The "S.R. 3" dimension should always be defined on the input form with super-elevated roadways.

The preceding dimensions are required to define the position of the inner band (three lanes) of superelevation. If these three lanes are adequate to fully describe the roadway surface, the outer band of three lanes need not be defined, i.e., the remainder (c.c. 45-79) of the input data line should be ignored (left blank). However, sometimes more than three lanes of superelevation, or two pivot lines, are required to describe the roadway surface adequately. In this case, the outer band of three superelevated lanes can be used as follows:

7- ΔR To Begin Outside S.E. (c.c. 45-51). Form: xxx.xxxx feet.

This dimension is the distance from the mainline to the inside edge of the innermost lane of the outer band of superelevated lanes and, therefore, the inside limit of the outer band. This innermost lane of the outer band will be lane four. Note that lanes three and four are not adjoining lanes. This dimension when defined must always be equal to, or greater than, the "S.R. 3" dimension previously discussed.

8. S.R. 4 (c-c- 52-58). Form: xxx.xxxx feet.

The “S.R. 4" dimension is the distance from the mainline to the outside edge of lane four and, therefore, to the inside edge of the outside adjoining lane (lane 5). This distance should not be less than the "ΔR To Begin Outside S.E." dimension; however, the two dimensions can be made equal in order to eliminate lane four when desired.

9. Outside Pivot (c.c. 59-65). Form: xxx.xxxx feet.

This dimension is the distance from the mainline to the outermost pivot line. Since the outside pivot point must be within the outer band (lane 4, 5 or 6) of superelevated lanes, this dimension should not be less than the " ΔR To Begin Outside S.E." dimension, nor greater than the "S.R. 6" dimension.

10. S.R. 5 (c.c. 66-72). Form: xxx.xxxx feet.

The "S.R. 5" dimension is the distance from the mainline to the outside edge of lane five and, therefore, to the inside edge of the outside adjoining lane (lane six). This distance should never be less than the "S.R. 4" dimension; however, the two dimensions may be equal in order to eliminate lane five.

11. S.R. 6 (c.c. 73-79). Form: xxx.xxxx feet.

The "S.R. 6" dimension is the distance from the mainline to the outside edge of lane six and, therefore, the outside limit of the outermost band of superelevated lanes. This dimension may be equal to the "S.R. 5" dimension in order to eliminate lane six, but never less than that dimension.

For a quick check of the input data (Crown and Lane Definitions) required to define the superelevated lanes, it should be noted that all dimensions, except the two pivot dimensions, entered on the input form should be of increasing (or equal) magnitude from left to right.

NOTE:

Superelevation cannot be used in conjunction with Parabolic Crowns.

Superelevation Examples

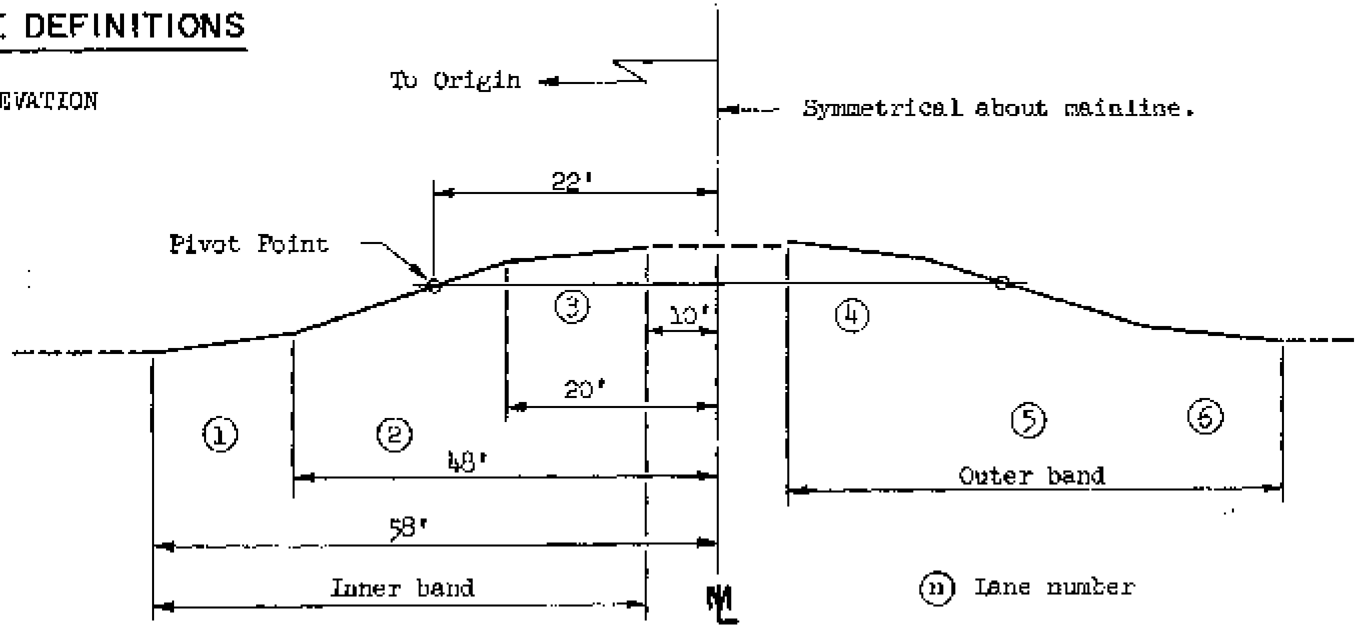
Six examples of superelevation lane orientation and the required input data are shown on the next six pages. Note that the input data are also shown on the input form for further illustration. It is suggested that these examples be studied thoroughly since this is perhaps the most difficult aspect of the program to understand.

LEVEL CROWN

If the roadway surface is level, or the crown correction for finished grade elevation is to be ignored, the only required input is the Crown Code of "LVL" in card columns 2-4. The rest of the Crown and Lane Definitions input data line should be left blank. In addition,, the Superelevation Data (6 in c.c. 1) input data lines that immediately follow the Crown and lane Definitions line should be completely ignored. Note that the number and position of the lanes of superelevation are immaterial in this instance.

CROWN AND LANE DEFINITIONS

EXAMPLE 5-1. SUPERELEVATION



This example shows a cross section of the superelevated lanes of twin bridges on a divided higway. The dimensions are assumed and symmetrical about the mainline. The actual bridge roadway surface will probably not exist as shown; however, the purpose of this illustration is to show the relative position of the lanes. The input data is shown below.

FORM OF INPUT

CROWN AND LANE DEFINITIONS

		DIST. FROM CROWN TO R/L GUTTER	ΔR FROM ℄ TO CROWN	DIST. FROM CROWN TO CONTROL PT.	DROP (INCHES) FROM CROWN TO CONTROL PT.
CROWN CODE	ΔR TO BEGIN INSIDE S.E.	ΔR'S FROM ℄ TO INSIDE LANES			
		S.R. 1	INSIDE PIVOT	S.R. 2	S.R. 3
S	-58.0000	-48.0000	-22.0000	-20.0000	-10.0000

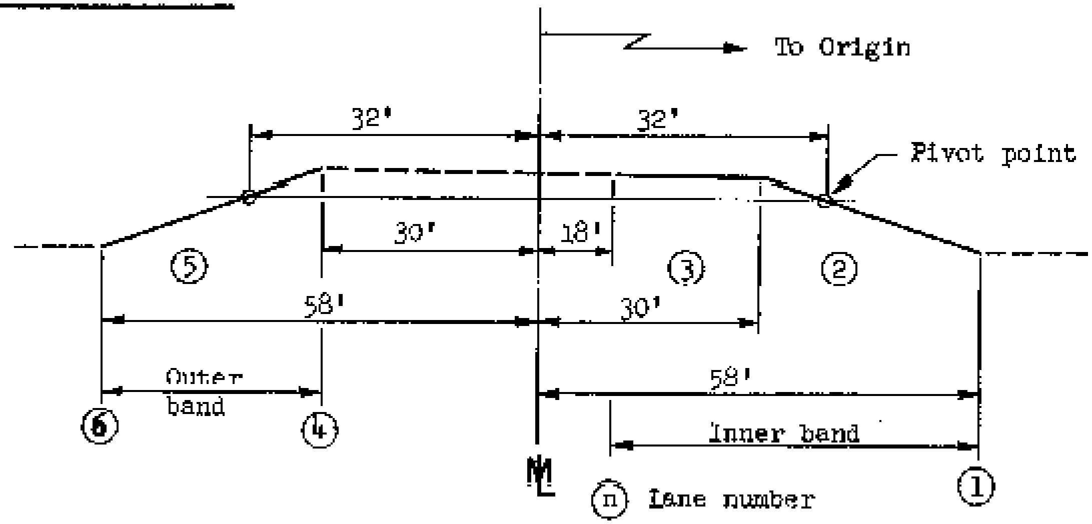
ΔR TO BEGIN OUTSIDE S.E.	ΔR'S FROM ℄ TO OUTSIDE LANES			
	S.R. 4	OUTSIDE PIVOT	S.R. 5	S.R. 6
10.0000	20.0000	22.0000	48.0000	58.0000

CROWN AND LANE DEFINITIONS (continued)

EXAMPLE 5-2. SUPERELEVATION

The example given here shows the actual roadway surface (gutter to gutter) of double bridges on a divided highway. Note that only three lanes are required to define the roadway surface; however, since two pivot lines are involved, six lanes with the two pivot lines must be given. Lanes one, four and six, however, will be given a zero width since they do not actually exist.

Lane five could have been defined as lane four or six, and lane two and three could have been defined as lanes one and two. The input data is shown below.



FORM OF INPUT

CROWN AND LANE DEFINITIONS

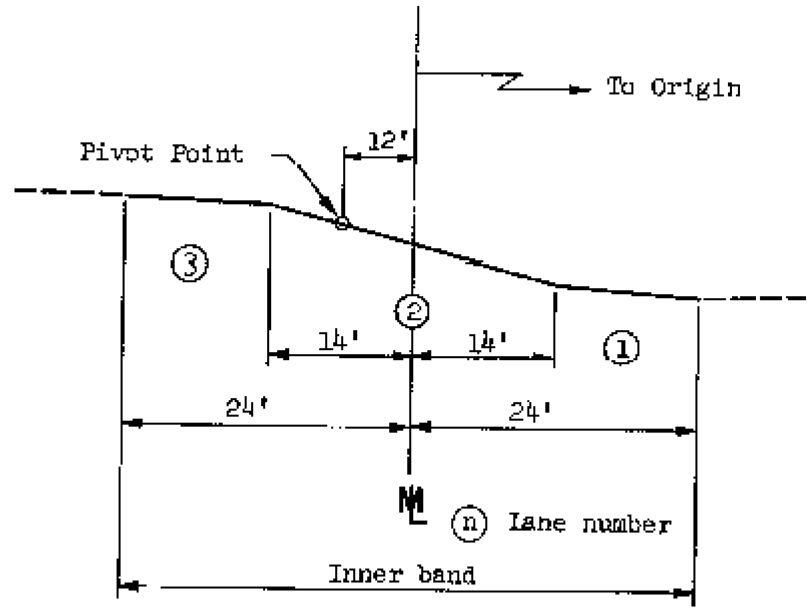
	CROWN CODE	ΔR TO BEGIN INSIDE S.E.	DIST FROM CROWN TO R/GUTTER ΔR'S FROM ℄ TO INSIDE LANES S.R. 1	ΔR FROM ℄ TO CROWN INSIDE PIVOT	DIST FROM CROWN TO CONTROL PT S.R. 2	PROF (INCHES) FROM CROWN TO CONTROL PT S.R. 3
5		-58.0000	-58.0000	-32.0000	-30.0000	-18.0000

ΔR TO BEGIN OUTSIDE S.E.	ΔR'S FROM ℄ TO OUTSIDE LANES S.R. 4	OUTSIDE PIVOT	S.R. 5	S.R. 6
30.0000	30.0000	32.0000	58.0000	58.0000

CROWN AND LANE DEFINITIONS (continued)

EXAMPLE 5-3. SUPERELEVATION

This example shows the required input data for the case of three lanes and one pivot line. Note that the three lanes are defined as the inner band of superelevation, i.e., entered on the left side of the input form. In this case, there is no outer band and the right side of the input form (c.c. 45-79) should be left blank. All dimensions in the sketch are assumed for the purpose of illustration. The data entered on the input form is shown below.



FORM OF INPUT

CROWN AND LANE DEFINITIONS

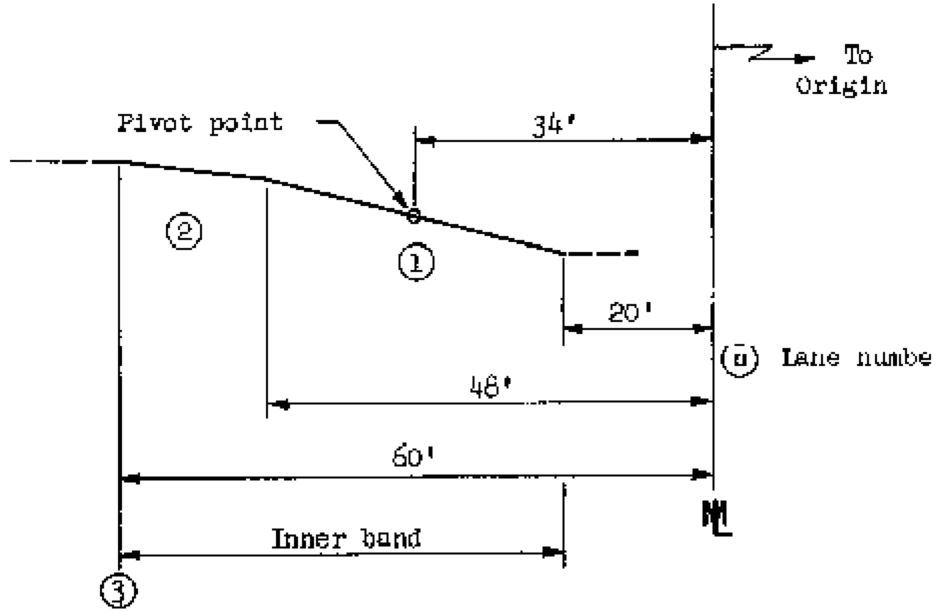
CROWN CODE	ΔR TO BEGIN INSIDE S.E.	S.R. 1 (DIST. FROM CROWN TO RT. GUTTER)	INSIDE PIVOT (ΔR FROM ℄ TO CROWN)	S.R. 2 (DIST. FROM CROWN TO CONTROL PT.)	S.R. 3 (DROP (INCHES) FROM CROWN TO CONTROL PT.)
		ΔR'S FROM ℄ TO INSIDE LANES			
1 / 2	3	13	21	29	37
5	-240000	-140000	120000	140000	240000

ΔR TO BEGIN OUTSIDE S.E.	S.R. 4	OUTSIDE PIVOT	S.R. 5	S.R. 6
	ΔR'S FROM ℄ TO OUTSIDE LANES			
45	52	59	66	73 – 79

CROWN AND LANE DEFINITIONS (continued)

EXAMPLE 5-4. SUPERELEVATION

The example shown here consists of two lanes of superelevation totally outside the mainline. Note that three lanes must be defined (lane three will be given a width of zero), and these lanes should be considered as the inner band for input purposes. Lane one and two (shown in sketch) could have been set up as lane two and three with lane one given a zero width. The data given in the sketch is shown on the input form below.



FORM OF INPUT

CROWN AND LANE DEFINITIONS

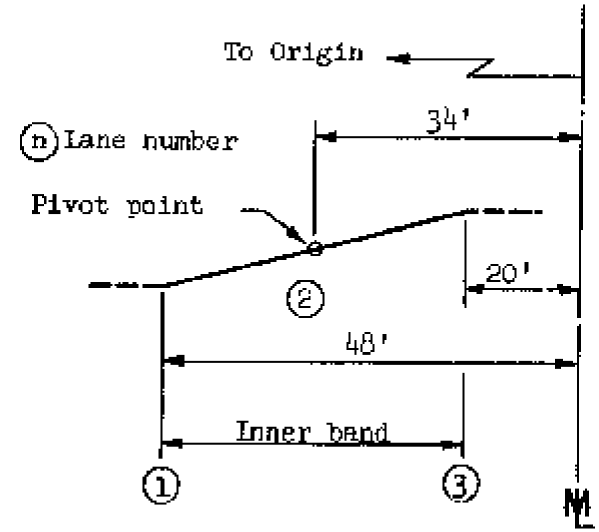
		DIST. FROM CROWN TO E/L GUTTER	ΔR FROM ℄ TO CROWN	DIST. FROM CROWN TO CONTROL PT.	DROP (INCHES) FROM CROWN TO CONTROL PT.
		ΔR'S FROM ℄ TO INSIDE LANES			
CROWN CODE	ΔR TO BEGIN INSIDE S.E.	S.R. 1	INSIDE PIVOT	S.R. 2	S.R. 3
1 2	6	13	21	29	37
5	20.0000	48.0000	34.0000	60.0000	60.0000

ΔR TO BEGIN OUTSIDE S.E.	ΔR'S FROM ℄ TO OUTSIDE LANES			
	S.R. 4	OUTSIDE PIVOT	S.R. 5	S.R. 6

CROWN AND LANE DEFINITIONS (continued)

EXAMPLE 5-5. SUPERELEVATION

The example shown here consists of only one lane of superelevation. However, the program requires that a minimum of three lanes be defined. So, lanes one and three will be given a width of zero. Note that lane two could have been defined as lane one or lane three. The outer band of superelevated lanes is not required in this example. The input data is shown on the input form below.



FORM OF INPUT

CROWN AND LANE DEFINITIONS

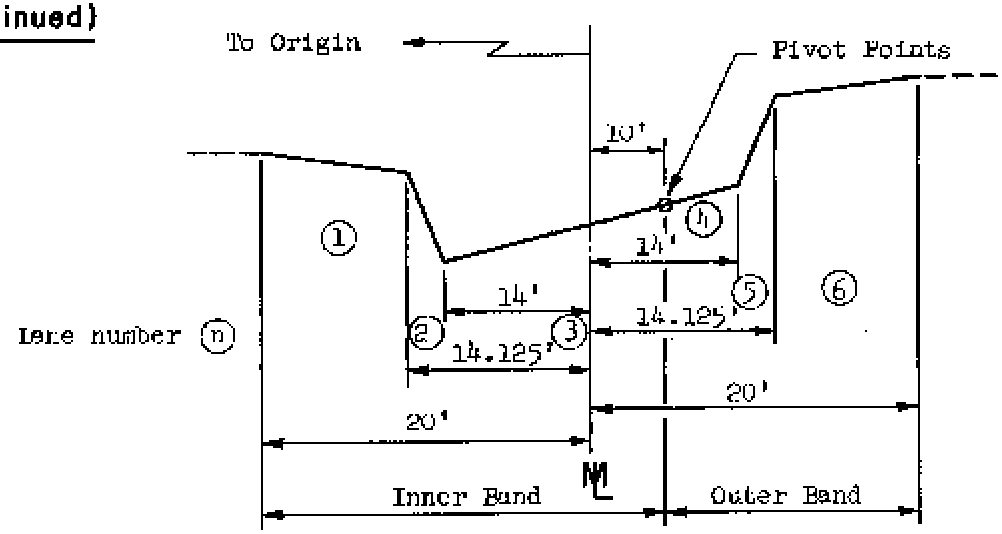
			DIST. FROM CROWN TO R/L GUTTER	ΔR FROM ℄ TO CROWN	DIST. FROM CROWN TO CONTROL PT.	ΔELEV (INCHES) FROM CROWN TO CONTROL PT.
	CROWN CODE	ΔR TO BEGIN INSIDE S.E.	ΔR'S FROM ℄ TO INSIDE LANES			
			S.R. 1	INSIDE PIVOT	S.R. 2	S.R. 3
1	2	5	13	21	29	37
5		-48.0000	-48.0000	-34.0000	-20.0000	-20.0000

ΔR TO BEGIN OUTSIDE S.E.	ΔR'S FROM ℄ TO OUTSIDE LANES			
	S.R. 4	OUTSIDE PIVOT	S.R. 5	S.R. 6
45	52	59	66	73 79

CROWN AND LANE DEFINITIONS (continued)

EXAMPLE 5-6. SUPERELEVATION

This example shows how the curb face and top of sidewalk are entered as lanes of superelevation so that finished grade elevations may be obtained on these surface planes. Therefore, it will probably be of benefit to the Engineer if he became thoroughly familiar with this example.



Six lanes of superelevation are required (Pivot point cannot be outside its associated three lanes, nor can there be overlapping lanes) and, therefore, two pivot lines are also required. However, since only one pivot line actually exists, the two pivot lines required must be defined as the same line. This, in effect, makes the two bands join at the pivot lines which are at the inside edge of lane four and at the outside edge of lane three. Lane four actually will be a continuation of lane three. The input data is shown below.

FORM OF INPUT

CROWN AND LANE DEFINITIONS

	CROWN CODE	ΔR TO BEGIN INSIDE S.E.	DIST. FROM CROWN TO R/L GUTTER ΔR'S FROM ℄ TO INSIDE LANES S.R. 1	ΔR FROM ℄ TO CROWN INSIDE PIVOT	DIST. FROM CROWN TO CONTROL PT. S.R. 2	DROP (INCHES) FROM CROWN TO CONTROL PT. S.R. 3
1	2	5	13	21	29	37
5		-200000	-141250	100000	-140000	100000

ΔR TO BEGIN OUTSIDE S.E.	ΔR'S FROM ℄ TO OUTSIDE LANES S.R. 4	OUTSIDE PIVOT	S.R. 5	S.R. 6
45	53	59	66	73
100000	140000	100000	141250	200000

F. SUPERELEVATION DATA (6 in c.c. 1).

The Superelevation Data input form line is used to enter the rates of superelevation of the various superelevated lanes. This data is not required with Level and Parabolic Crowns and, therefore, this part of the input form would be left blank. Two types of superelevation may be used to describe the roadway surface: Constant or Variable (transition) Superelevation. Constant superelevation indicates that the superelevation rate of each lane remains constant throughout the entire range of the problem. Transition superelevation indicates the superelevation rate of a lane, or lanes, varies lineally between two known stations.

It is extremely important that the correct sign be used when entering the superelevation rates on the input form. If the elevation of the roadway surface increases as the perpendicular or radial distance from the origin increases, the superelevation rate is positive. If the elevation decreases as the distance from the origin increases, the superelevation rate is negative. Note that the superelevation rates are given in inches per foot. Since the input requirements are somewhat different, the two types of superelevation will be discussed separately.

CONSTANT SUPERELEVATION

If the rate of superelevation of all lanes remains constant throughout the entire bridge, the Superelevation Data should be defined as Constant. Only one line of the Superelevation Data is required to enter the necessary data.

1. Description (c.c. 2-6).

Th define Constant superelevation., the Description Code "CONST" should be entered on the first line of the Superelevation Data under the Description heading.

2. At Station (c-c. 7-16).

This part of the Superelevation Data line should be ignored, i.e., left blank. The "At Station" data is required only when entering transition superelevation.

3. Superelevation Rates (c.c. 17-52). Form: xx.xxxx inches per foot.

The input form provides six columns for entering the rate of superelevation of the lanes. The columns are headed by "S.E. n", where n is the lane number. For example, the superelevation rate of lane one should be entered under the column heading "S.E. l” (c.c. 17-22), etc. The superelevation rate should be given for each lane defined (three or six) in the Crown and Lane Definitions input line. All rates must be entered on the first line of the Superelevation Data,, i.e., same line as the Description code "CONST". The rates of superelevation must be given in units of inches per foot.

Constant Superelevation Examples

The two examples of Constant superelevation are given on the next page for the purpose of illustration.

SUPERELEVATION DATA

EXAMPLE 6-1. CONSTANT SUPERELEVATION

This example shows the Superelevation Data for Example 5-1 (page 36). Note that the superelevation rates of the lanes in the outer band are negative.

Given:

S.E.1 = 0.125 in./ft.
S.E.2 = 0.600 in./ft.
S.E.3 = 0.125 in./ft.
S.E.4 = 0.125(-) in./ft.
S.E.5 = 0.600(-) in./ft.
S.E.6 = 0.125(-) in./ft.

FORM OF INPUT

SUPERELEVATION DATA (MAX. NO. OF 10)

	DESCRIPTION	AT STATION **	S.E. 1	S.E. 2	S.E. 3	S.E. 4	S.E. 5	S.E. 6
1	2	7	17	23	29	35	41	47 — 52
6	CONST	+	0.1250	0.6000	0.1250	-0.1250	-0.6000	-0.1250

EXAMPLE 6-2. CONSTANT SUPERELEVATION

The example given here shows the Superelevation Data of Example 5-4 (page 39). Note that the outer band of lanes (4, 5 and 6) have not been defined; therefore, the rates of lanes 4, 5 and 6 are ignored, i.e., left blank. Lane 3 has been defined but does not actually exist (zero width). So, the rate of lane 3 can be given a value of zero or left blank.

Given:

S.E.1 = 1.200 in./ft.
S.E.2 = 0.125 in./ft.

FORM OF INPUT

SUPERELEVATION DATA (MAX. NO. OF 10)

	DESCRIPTION	AT STATION **	S.E. 1	S.E. 2	S.E. 3	S.E. 4	S.E. 5	S.E. 6
1	2	7	17	23	29	35	41	47 — 52
6	CONST	+	1.2000	0.1250	.	.	.	.

TRANSITION SUPERELEVATION

In order to define Transition Superelevation, the superelevation rate of each defined lane is required at two or more stations. The rates of superelevation are assumed to hold true at the defining station only and vary lineally between the stations. It is required that the station and rate of superelevation for each lane be given at each point where the rate of transition changes in each lane. In other words, if the rate of transition changes at a point in any lane, the station and superelevation rate of all the lanes must be given at that point. The station and superelevation rates at that station are entered on one line of the Superelevation Data. The input form provides six lines for entering up to six stations. However, the program capacity is ten stations. Should more than six stations be required, extra lines may be added to the bottom of the input form. The input requirements are as follows;

1. Description (c.c. 2-6).

   In order to indicate to the program that Transition Superelevation is to be entered in the Superelevation Data, the Description code "START" must be entered on the first line of the Superelevation Data under the heading "Description". The Description code "FINIS" is required on the last line of data (station and superelevation rates) entered in the Superelevation Data. The Description code should be left blank on all lines used to enter intermediate stations, i.e., stations between the first (beginning) station and the last (ending) station. Therefore, the Description codes "START" and "FINIS" are entered only once. The Description code "CONST" should not be used with Transition superelevation. No other Description codes are valid.

2. At Station (c.c. 7-16). Form: xxxx+xx.xxxx feet.

   This column is for entering the station of each break (change) in superelevation transition. The initial station which is entered on the first line must be back of the beginning of the bridge since the superelevation rates are not known back of the initial station, i.e., the program does not assume that the superelevation rates back of the initial station are the same as the rates at the initial station. The last station entered must be ahead of the end of the bridge since the superelevation rates are not known ahead of the last station, i.e., the program does not assume that the superelevation rates ahead of the last station are the same as the rates at the last station.

   A maximum of ten stations can be used to define the transition sequence. However, only six lines are provided on the input form. The stations may be of negative magnitude.

3. Superelevation Rates (c.c. 17-52). Form: xx.xxxx inches per foot.

   The rate of superelevation of each lane defined in the Crown and Lane Definitions input data must be given at each station of transition break that is entered in the Superelevation Data., i.e., At Stations.

Six columns are provided on the input form to enter the rate of superelevation of the lanes. The number in each heading indicates which lane of superelevation is to be entered in that column. For example, the superelevation rates of lane five are entered in the column headed by "S.E. 5".

NOTE:

Superelevation defined as Constant cannot be used in conjunction with superelevation defined as Transition.

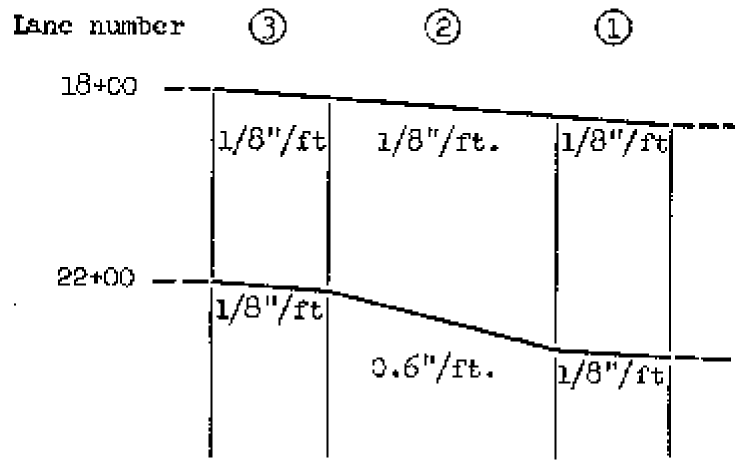
Transition Superelevation Examples

Four examples of the method of entering Transition superelevation on the input data form are given on the following four pages for the purpose of illustration only. The examples do not represent actual cases of bridge transition.

SUPERELEVATION DATA (continued)

EXAMPLE 6-3. TRANSITION SUPERELEVATION

The example shown here is the Superelevation Data for Example 5-3 (page 38). The entire bridge is assumed to be located within the transition range from station 18+00 to station 22+00. The sketch shows the given rates of superelevation of each lane at the stations where the rate of transition changes. Note that the rates of superelevation of lanes 1 and 3 are the same at both stations (no transition); however, it is required that these rates be given at both stations. The input data is shown below.



FORM OF INPUT

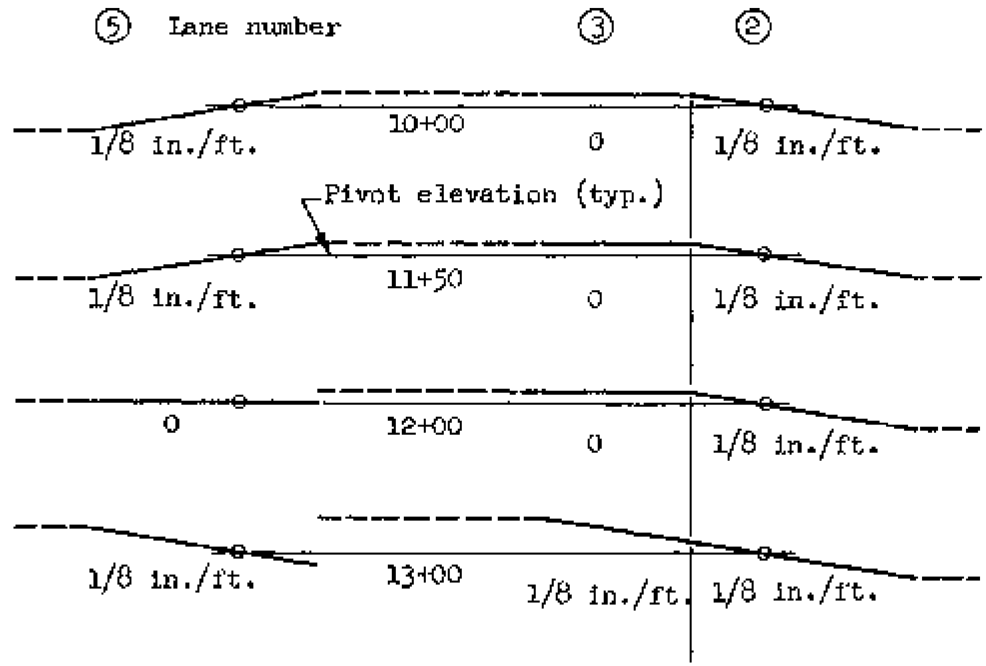
SUPERELEVATION DATA (MAX. NO. OF 10)

	DESCRIPTION	AT STATION **	S.E. 1	S.E. 2	S.E. 3	S.E. 4	S.E. 5	S.E. 6
1	2	7	17	23	29	35	41	47
6	START	18+00.0000	0.1250	0.1250	0.1250			
6	FINIS	22+00.0000	0.1250	0.6000	0.1250			

SUPERELEVATION DATA (continued)

EXAMPLE 6-4. TRANSITION SUPERELEVATION

This example is the Superelevation Data for Example 5-2 (page 37). The stations and rates of superelevation are assumed and shown in the sketch. The bridge is assumed to start at station 10+50. This is the reason that two stations (10+00 and 11+50) with the same rates of superelevation are required, i.e., the bridge began before the transition started. The initial station (10+00) is an arbitrary station in this case where the superelevation rates are constant back of station 11+50. However, the initial station was required to be back of the beginning bridge station. A station equal to 10+25 could have been used for the initial station. The input data is shown below.



FORM OF INPUT

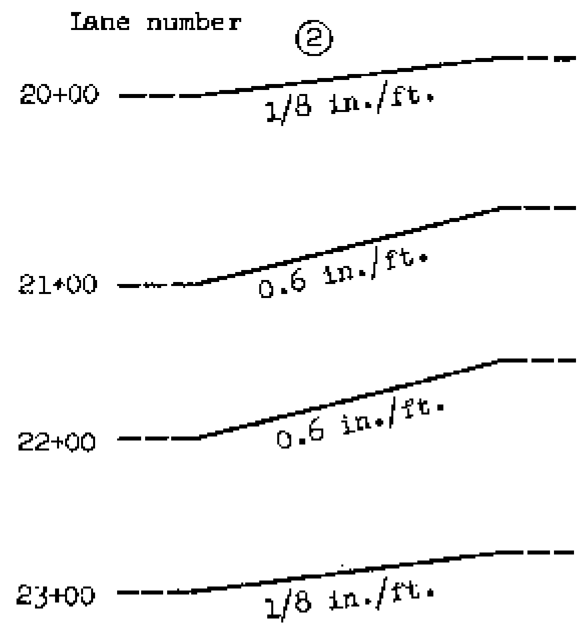
SUPERELEVATION DATA (MAX. NO. OF 10)

	DESCRIPTION	AT STATION **	S.E. 1	S.E. 2	S.E. 3	S.E. 4	S.E. 5	S.E. 6
6	START	10+00.00000	0.0000	0.1250	0.0000	0.0000	-0.1250	0.0000
6		11+50.00000	0.0000	0.1250	0.0000	0.0000	-0.1250	0.0000
6		12+00.00000	0.0000	0.1250	0.0000	0.0000	0.0000	0.0000
6	FINIS	13+00.00000	0.0000	0.1250	0.1250	0.0000	0.1250	0.0000

SUPERELEVATION DATA (continued)

EXAMPLE 6-5. TRANSITION SUPERELEVATION

This example shows the Superelevation Data for Example 5-5 (page 40). Note that the superelevation rate is constant between station 21+00 and station 22+00, i.e., full superelevation. However, these are stations of change (break) in the rate of transition and, therefore, the rates of superelevation must be given at these stations. The bridge is assumed to be located between station 20+00 and station 23+00. The input data is shown below.



FORM OF INPUT

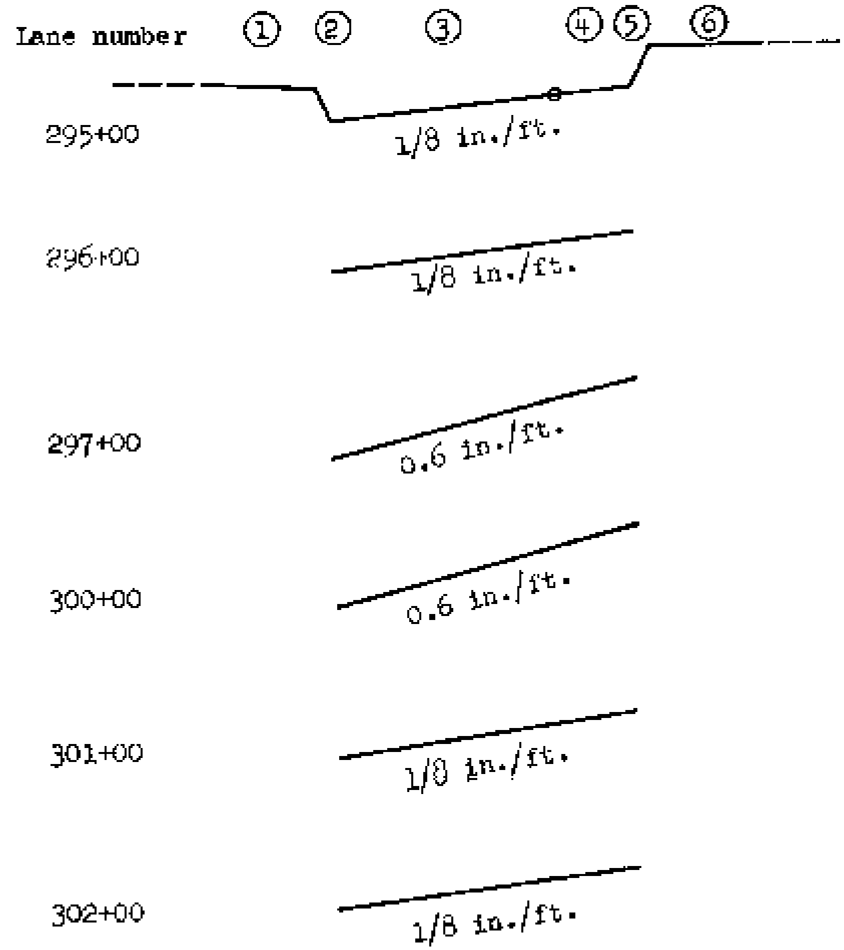
SUPERELEVATION DATA (MAX. NO. OF 10)

1	DESCRIPTION 2	AT STATION ** 7	S.E. 1 17	S.E. 2 23	S.E. 3 29	S.E. 4 35	S.E. 5 41	S.E. 6 47 52
6	START	20+00.00000	0.0000	0.1250				
6		21+00.00000	0.0000	0.6000				
6		22+00.00000	0.0000	0.6000				
6	FINIS	23+00.00000	0.0000	0.1250				

SUPERELEVATION DATA (continued)

EXAMPLE 6-6. TRANSITION SUPERELEVATION

This example shows the Superelevation Data for Example 5-6 (page 41). The top of the sidewalks slopes (lanes 1 and 6) are constant at 1/4 in./ft. The curb face slopes (lanes 2 and 5) are constant at 80 in./ft. The roadway (lanes 3 and 4) slopes are shown in the sketch. For simplicity, the curb and sidewalk lanes are shown only once. Note that when a superelevation rate of minus eighty inches per foot is entered on the input form, the position of the decimal must be overridden by inserting the decimal in a card column. This is required because the input form does not provide enough card columns to the left of the implied decimal position. The input data is shown below.



FORM OF INPUT

SUPERELEVATION DATA (MAX. NO. OF 10)

	DESCRIPTION	AT STATION **	S.E. 1	S.E. 2	S.E. 3	S.E. 4	S.E. 5	S.E. 6
6	START	295+00.0000	-0.2500	-80.•00	0.1250	0.1250	800000	0.2500
6		296+00.0000	-0.2500	-80.•00	0.1250	0.1250	800000	0.2500
6		297+00.0000	-0.2500	-80.•00	0.6000	0.6000	800000	0.2500
6		300+00.0000	-0.2500	-80.•00	0.6000	0.6000	800000	0.2500
6		301+00.0000	-0.2500	-80.•00	0.1250	0.1250	800000	0.2500
6	FINIS	302+00.0000	-0.2500	-80.•00	0.1250	0.1250	800000	0.2500

LONGITUDINAL LINES

The LONGITUDINAL LINES input form is used to define longitudinal lines that the Engineer desires to be intersected with the bents and transverse lines of each span. This input form must always be used with each problem, and at least one longitudinal line must be defined on the sheet. This input form is required as the second sheet of each problem, immediately following the LAYOUT DATA input form. Usually only one sheet of this type is required per problem. However, on occasions the need will arise for a different set of longitudinal lines within the same problem. For example, the number of beams may vary from span to span. For illustration, let's assume a bridge has five spans, and the first two spans have five beams and the remaining three spans have four beams. A set of longitudinal lines will be used with the first two spans. and a different set of longitudinal lines with the last three spans. In this example, the second set of longitudinal lines must immediately follow the SPAN DATA input sheet of span two and immediately precede the SPAN DATA input form for span three. In other words, the longitudinal lines for a span or spans must immediately precede the input data for those spans. Whenever a set of longitudinal lines are given in the input data of a problem, they completely replace the previous longitudinal lines. Any lines common to both sets of longitudinal lines must be redefined.

The program has the capacity for thirty (30) longitudinal lines. Each longitudinal line is defined by entering the required input data on one line of the input form. Note that a Sequence Number is given in card columns 2 and 3. These numbers will be assigned to the longitudinal lines. For instance, the longitudinal line entered on the fourth line (04 in c.c. 2, 3) of the input form will be longitudinal line number four (4). The longitudinal lines should be defined by entering the first longitudinal line on the first input line and continuing with one longitudinal line per input line. Lines on the form should not be skipped, i.e., no blank lines are allowed between the longitudinal lines defined on the form. This is required because the longitudinal lines must be in numerical sequence.

Immediately after entering the last longitudinal line, the code "END" must always be entered in card columns 4-6 (Type Code) of the next input line. The total number of lines of the input form that must contain data is the number of longitudinal lines (which may vary from one to thirty) plus one (the line that contains the "END" code). All remaining lines of the input form should be left blank.

The order in which the longitudinal lines are listed on the input form is immaterial. However, as a general rule, the longitudinal lines should be given in some sort of location sequence, i.e., from left to right, or right to left, across the bridge. After the user becomes familiar with the program, he will be able to give the longitudinal lines in the order that will be most beneficial to him. The Engineer should be thoroughly familiar with the "Distance To Previous Point" dimension (page 120) that is given in the output data before selecting the order of the longitudinal lines.

Ten types of longitudinal lines are available to the user. Following is a list of the different types of longitudinal lines:

1. Chord
2. Arc
3. Railing
4. Parallel
5. Parallel thru Intersect Ahead
6. Parallel thru Intersect Back
7. Curve Offset
8. Straight Taper
9. Curve Taper
10. Coordinate

Following is a discussion of the input data that is common to all longitudinal lines.

1. Skip Code (c.c. 49).

   Sometimes a longitudinal line must be defined solely for the purpose of being a reference line, i.e., a line from which some other longitudinal line is referred (dimensioned). In this case, it may not be desirable to have the intersection data of this longitudinal line in the output data. Therefore, to eliminate a longitudinal line from the output data, the digit one (1) should be entered in the Skip code column. Otherwise, this card column should be left blank to obtain this intersection data in the output.

2. Remarks (c.c. 50-6o).

   This space is for entering any identifying and pertinent Remarks which describe each longitudinal line. These Remarks will appear with the longitudinal line in the output data. It is suggested that Remarks be used freely so that the longitudinal lines may be readily recognized in the output data.

Following is a discussion of each type of longitudinal line which includes the usage, the required input data, a sketch., and example of each type.

A. CHORD

A Chord is by definition a straight line that joins two points on a circle. Therefore, a Chord longitudinal line is a straight line between two points on a curve that is concentric with the mainline. The two points that define the chord longitudinal line are the points of intersection of the concentric circle with the two defining bents (Ahead and Back) of each span. Therefore, the chord longitudinal line will vary from span to span if the mainline is a circular curve, i.e., the chord longitudinal line will not be a continuous straight line, but rather a series of straight segments (chords). If the mainline is a tangent, the chord becomes a continuous straight line parallel to the mainline. Vote that a chord longitudinal line is directly dependent on the type of mainline curve (tangent or circular).

If a bridge is on a curve, it is common practice to place the beams on chords of concentric circles with the mainline. The primary purpose of the chord longitudinal line is to define such a beam line. A chord longitudinal line may also be used solely as a reference line, i.e., so other lines may be made parallel to the chord. An example of this is when all the beams in a span are made parallel to a chord of the centerline arc. In this case, a chord longitudinal line of the centerline must be set up so that the beam lines may be referenced (made parallel) to the chord. If there is no beam on the centerline arc, then the chord is actually being used for reference only. If the mainline is a tangent, the chord longitudinal line may be used to represent other lines, i.e., gutter, curb, centerline, and structure limit lines.

Structure limit lines are such lines as the outside edges of the roadway slab or the outside edge of the sidewalks, etc.

Any number (thirty or less) of chord longitudinal lines may be defined and used in conjunction with all other types of longitudinal lines. Following are the required input data for defining chord longitudinal lines.

1. Type Code (c.c. 4-6).

   The code "CRD" is used to define a chord longitudinal line. This code is required with every chord line entered on the input form.

2. Ref. Call (c-c- 7, 8).

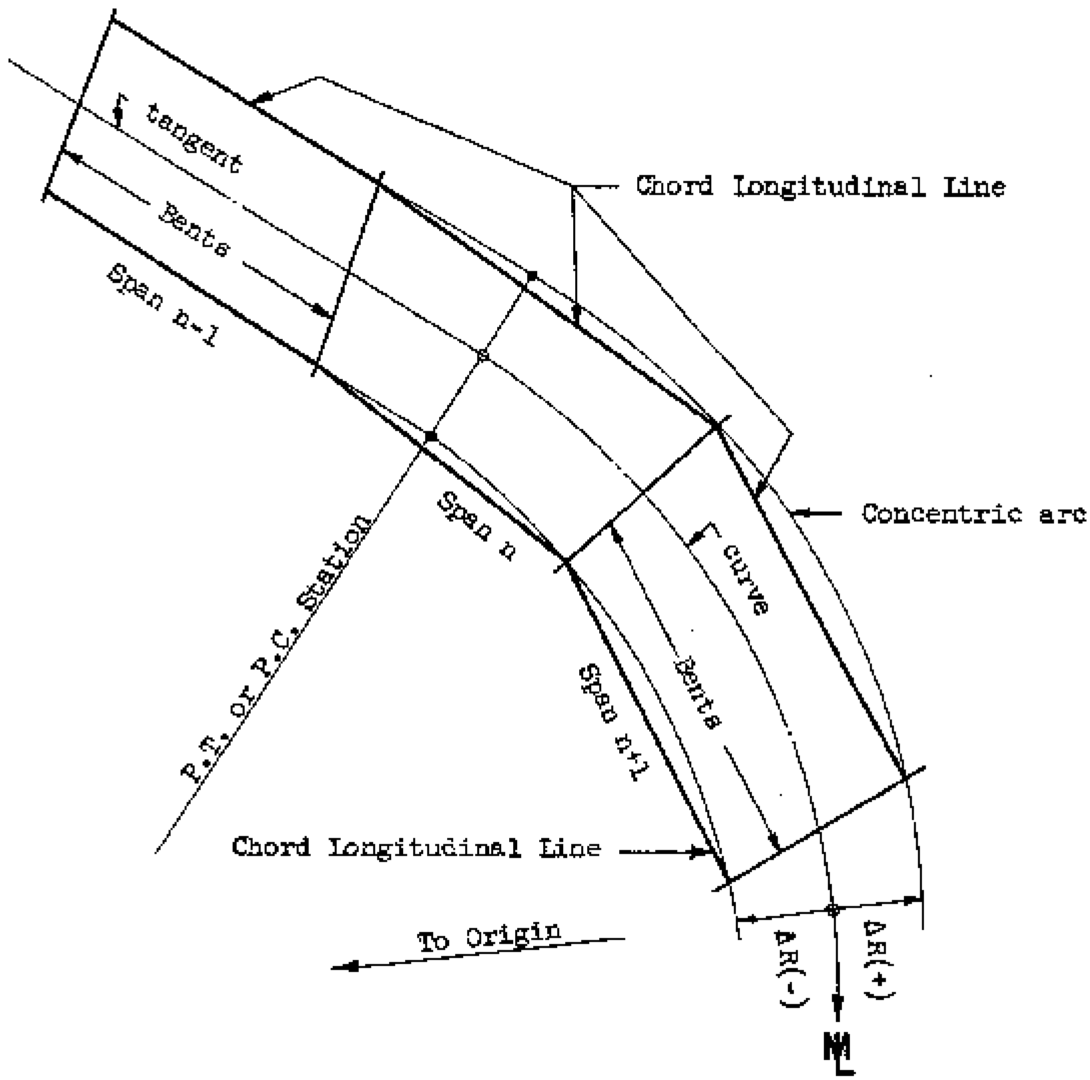
   The Reference Call is not required with longitudinal lines defined as chords. The chord longitudinal line is always assumed to be referenced from the mainline. Therefore, the Reference Call should be left blank.

3. AR From Mainline (c.c. 9-18). Form: xxxxxx.xxxx feet.

   This dimension is the radial or perpendicular distance from the mainline to the concentric circular arc of which the longitudinal line is a chord. If the concentric arc is inside (toward origin) the mainline, the dimension is negative. If the concentric arc that defines the chord is outside (away from origin) the mainline, this dimension is positive.

Card columns 19-48 of the input form should be left blank when defining a chord longitudinal line, i.e., no input data is required in these card columns. The Skip code (c.c. 49) and Remarks (c.c. 50-80) are discussed on page 51. An example showing how the chord longitudinal line data is entered on the input form is shown on pages 74 and 75.

Following is a sketch showing the characteristics of the chord longitudinal line.



"CRD" LONGITUDINAL LINE

B. ARC

An arc is by definition a portion of a circular curve. Therefore, an arc longitudinal line is a circular curve that is concentric with the mainline. The arc line will be a continuous line throughout the range of the bridge. However, if the mainline is a tangent, the arc longitudinal line will actually be a straight line parallel to the mainline. Note that the arc line is always the same type (circular or straight) line as the mainline.

If a bridge is on a curve, it is common practice to make the curb, gutter, and structure lines concentric with the mainline curve. These lines can be defined as arc longitudinal lines; in addition, the centerline or survey line (mainline) may be defined as an arc. The arc line may be used as a reference line by a Railing longitudinal line. Curved girders can also be represented by arc lines. Any number (thirty or less) of arc longitudinal lines may be defined and used in conjunction with all other types of longitudinal lines. Following is the required input data for defining arc longitudinal lines.

1. Type Code (c.c. 4-6).

   The code "ARC" is used to define an arc longitudinal line. This code is required with every arc line entered on the input form.

2. Ref. Call (c.c. 7, 8).

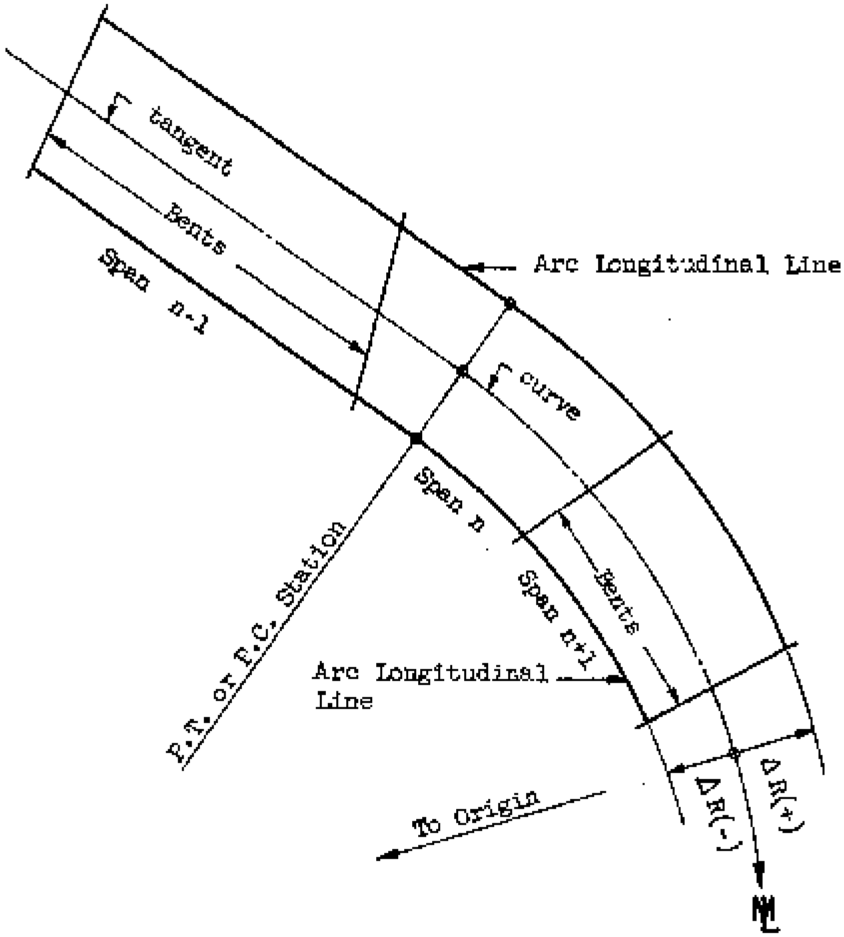
   The Reference Call is not required with longitudinal lines defined as arcs. The are longitudinal line is always assumed to be referenced from the mainline. Therefore, the Reference Call should be left blank.

3. ΔR From Mainline (c.c. 9-18). Form: xxxxxx.xxxx feet.

   This dimension is the radial or perpendicular distance from the mainline to the concentric arc. If this dimension is measured toward the origin, the distance is negative. Otherwise, the distance is positive (outside mainline).

Card columns 19-48 of the input form should always be left blank when defining an arc line. The Skip code (c.c. 49) and Remarks (c.c. 5080) are discussed on page 51. An example showing how the arc longitudinal line data is entered on the input form is shown on page 74.

On the following page is a sketch showing the characteristics of the arc longitudinal line.



"ARC" LONGITUDINAL LINE

C. RAILING

The railing line is a longitudinal line that is the same type as some other longitudinal line from which the railing line is referenced. For example, if a railing line is referenced to an arc longitudinal line, the railing line will be an arc line. If a railing line is referenced to a curve taper longitudinal line, the railing line will be a curve taper line, etc. However, there is one characteristic of the railing line that is different from the longitudinal line from which it is referenced. That is, the bent and transverse lines may be intersected with a railing line, or the bent and transverse lines may be intersected with the longitudinal line to which the railing is referenced and then turned radially to intersect the railing line. The sketch clearly shows this optional feature of the railing line. The option of which intersection the program is to consider is controlled by the bent and transverse line input data which will be discussed on subsequent pages.

The railing line is used to enter the sidewalk railing (for railing post spacings) and structure lines (elevations for construction) since the sidewalk construction joints are usually radial to the gutter line. Therefore, if a railing line is referenced to the longitudinal line that represents the gutter line, the bent and transverse lines may be intersected with the railing by turning radially from their intersection with the gutter line. If both points (see sketch) of intersection are desired in the output data, the railing or structure line must be defined twice, i.e., once as a railing longitudinal line and again as another type of longitudinal line (arc, curve taper, etc.). Note that when a bent or transverse line is coded to intersect a railing without turning radially from another longitudinal line, the bent or transverse line will intersect all railing lines in like fashion.

Any number of railing longitudinal lines may be defined and used in conjunction with all other types of longitudinal lines. However, some other type of longitudinal line must always be defined when using railing lines so that the railing lines may be referenced to the other type of longitudinal line. Railing lines should not be referenced to chord longitudinal lines when the mainline is a circular curve. Following is the required input data for defining railing longitudinal lines.

1. Type Code (c.c. 4-6).

   The code "RLG" is used to define a railing longitudinal line. This code is required with every railing line entered on the input form.

2. Ref. Call (c.c. 7, 8). Form: xx.

   The Reference Call is the Sequence Number (c.c. 2-3) of the longitudinal line to which the railing line is referenced. The Reference Call must always be given when defining a railing longitudinal line. The Reference Call must not be the Sequence Number of a longitudinal line that is referenced (has a Ref. Call) to some other longitudinal line. Therefore, the railing line cannot be referenced to the following types of longitudinal lines:

   1. Railing
   2. Parallel
   3. Parallel thru Intersect Ahead
   4. Parallel thru Intersect Back

No other type of longitudinal line may be referenced to a railing longitudinal line because the railing longitudinal line has a Reference Call. The railing line Reference Call cannot be zero or blank, nor can the Reference Call be greater than the total number of longitudinal lines. In addition, the Reference Call cannot be equal to the Sequence Number of the railing line.

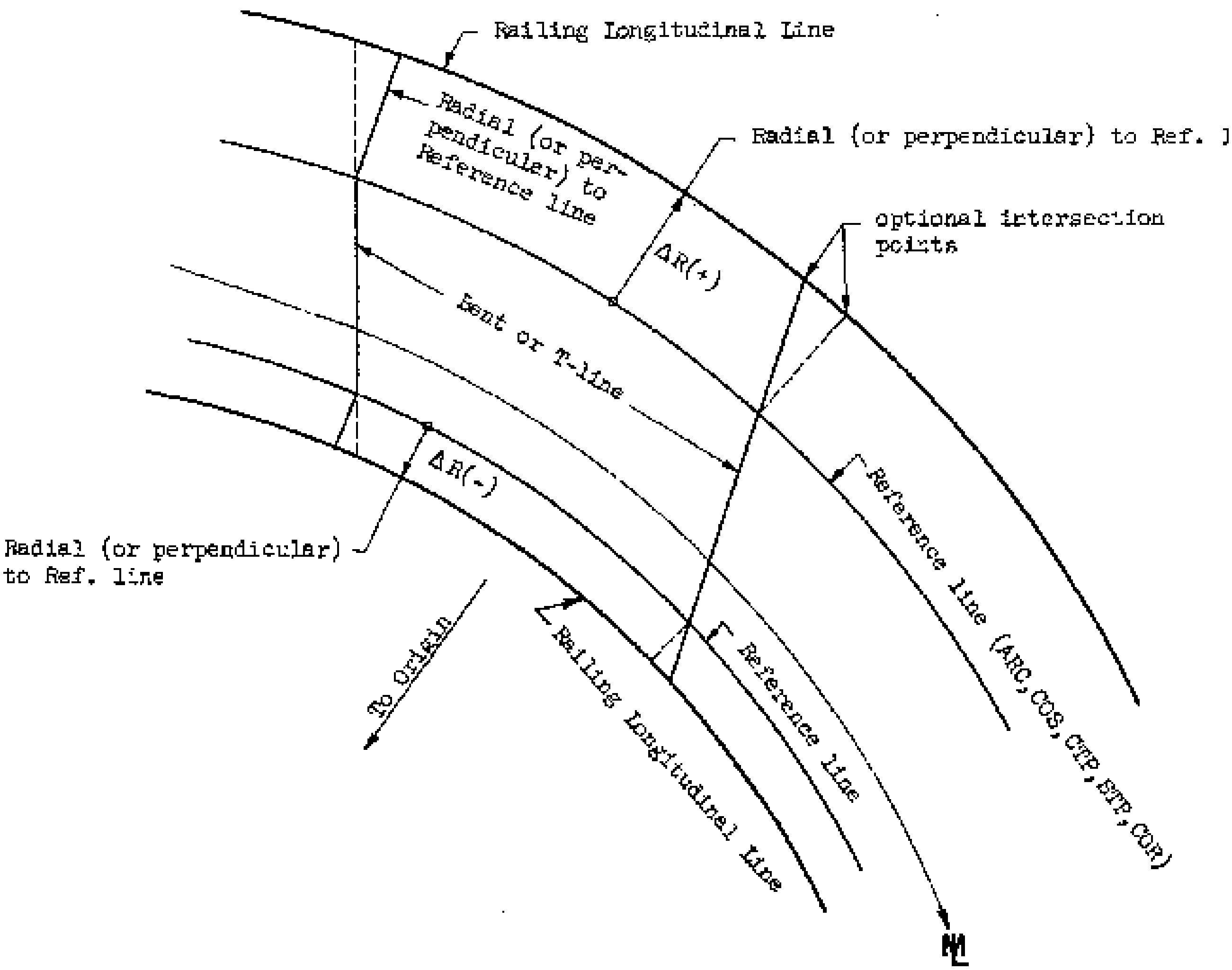
3. ΔR From Reference Line (c.c. 9-18). Form: xxxxxx.xxxx feet.

This dimension is the radial or perpendicular distance from the reference line of the railing (another longitudinal line) to the railing line. Note that the railing line is not referenced from the mainline. If the distance is measured toward the origin from the reference line, the dimension is negative; otherwise (away from the origin), the dimension is positive.

Card columns 19-48 of the input form should be ignored when defining railing longitudinal lines. The Skip code (c.c. 49) and Remarks (c.c. 50-8o) are discussed on page 51. An example showing how the railing longitudinal line data is entered on the input form is shown on page 74.

On the following page is a sketch showing the characteristics of the railing longitudinal line.

NOTE: The same railing can be defined more than one time in one set of longitudinal lines, and each time the railing is defined a different reference line can be used. This may be advantageous when the transverse lines turn radially from different railing reference lines to intersect the railing line.



"RLG" LONGITUDINAL LINE

D. PARALLEL

A parallel longitudinal line is a straight line that is parallel to some other longitudinal line (reference line). The reference line of the parallel longitudinal line must be a straight line, i.e., chord, straight taper or coordinate longitudinal line. If the parallel line is referenced to a chord longitudinal line, the parallel line will be a series of straight lines parallel to the chord line segments. If the parallel line is referenced to a straight taper or coordinate, the parallel line will be a straight line continuous throughout the range of the problem.

A parallel line cannot be referenced to a longitudinal line that is referenced to some other longitudinal line. Therefore, the following types of longitudinal lines cannot be used as a reference line for a parallel longitudinal line, since each line requires a reference line or the line is always a curve.

1. Railing

2. Parallel

3. Parallel thru Intersect Ahead

4. Parallel thru Intersect Back

5. Curve Offset

6. Curve Taper

A parallel line may be referenced to an arc longitudinal line provided the mainline is a tangent throughout the range of the problem, i.e., the arc line in this case would be a straight line.

It is common practice to make all the beams in a span on a horizontal curve parallel for simplicity in detailing and construction. The parallel longitudinal line can be used to define such beam lines. However, it is important to note that the parallel lines of adjacent spans if referenced to chords will not necessarily join at the bent that separates the spans. Parallel lines may also be used for curb, gutter and structure lines if the mainline is a tangent throughout the range of the bridge.

Any number of parallel longitudinal lines may be defined and used in conjunction with all other types of longitudinal lines. However, some other type of longitudinal line must always be defined when using parallel lines so that the parallel lines can be referenced to the other type of longitudinal line. Following is the required input data for defining parallel longitudinal lines.

I. Type Code (c.c. 4-6).

The code "PAR" is used to define a parallel longitudinal line. This code is required with every parallel line entered on the input form.

2. Ref. Call (c.c. 7, 8). Form: xx.

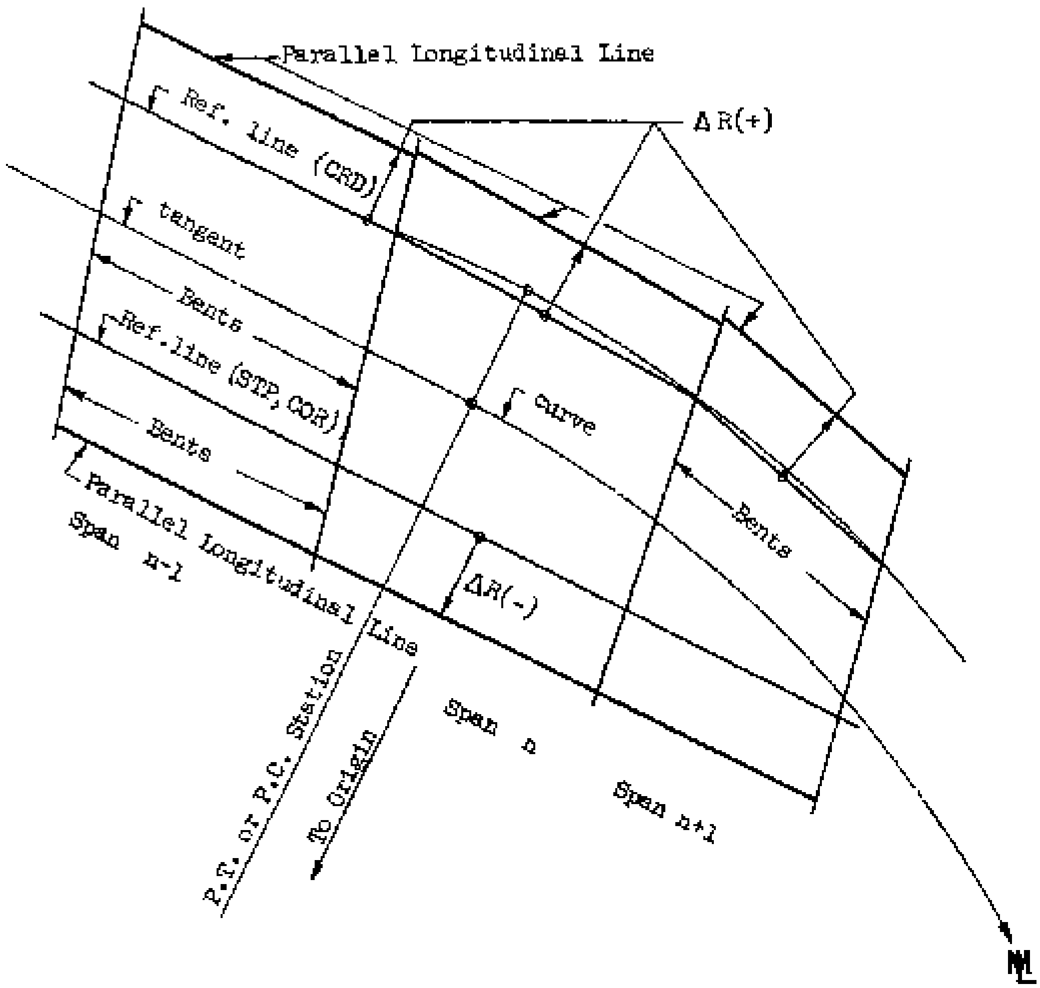
The Reference Call is the Sequence Number of the longitudinal line to which the parallel line is referenced (parallel to). The Reference Call must always be given when defining a parallel longitudinal line, i.e., cannot be zero or left blank. The Reference Call cannot be greater than the total number of longitudinal lines, nor equal to the Sequence Number of the parallel line.

3. ΔR From Reference Line (c.c. 9-18). Form: xxxxxx.xxxx feet.

This dimension is the perpendicular (normal) distance from the reference line of the parallel line (another longitudinal line) to the parallel line. Note that the parallel line is not referenced (dimensioned) from the mainline. If the distance is measured toward the origin from the reference line, the dimension is negative; otherwise (away from the origin), the dimension is positive.

Card columns 19-48 of the input form should be ignored when defining parallel longitudinal lines. See page 51 for a discussion of the Skip code (c.c. 49)and Remarks (c.c. 50-80). An example showing how the parallel longitudinal line input data is entered on the input form is shown on page 77.

On the following page is a sketch snowing the characteristics of the parallel-longitudinal line.



"PAR" LONGITUDINAL LINE

E. PARALLEL thru INTERSECT AHEAD.

This type of longitudinal line, which will be coded "PIA", is a straight line parallel to some other longitudinal line (reference line). The position of the PIA longitudinal line is determined by the intersection of a concentric circle and the Ahead bent. The radial distance from the mainline to the concentric circle that defines the PIA line is the sum of the "ΔR" dimensions of the reference line and PIA line. Note that the PIA longitudinal line is not a chord line because the intersection of the PIA line and Back bent is not the same point as the intersection of the concentric circle with the Back bent.

The reference line of the PIA longitudinal line must be a straight line, i.e., chord or straight taper longitudinal line. If the PIA line is referenced to a chord line, the PIA line will be a series of straight lines parallel to the chord segments. If a straight taper is used as a reference line, the PIA line will be a straight line continuous throughout the range of the problem. A coordinate longitudinal line should not be used as a reference line for a PIA longitudinal line. The PIA line may only be referenced to chord, straight taper and arc (when mainline is a tangent throughout range of bridge only) longitudinal lines.

It is common practice to make all beams in a span parallel to some reference line whenever the span is in a horizontal curve. The PIA line can be used to define such beam lines. The PIA lines can be used in conjunction with PIB longitudinal lines (see page 75) in order to make the parallel lines of adjacent spans meet at a common point at the bent common to both spans.

Any number of PIA longitudinal lines may be defined and used in conjunction with all other types of longitudinal lines. Note that some other type of longitudinal line must always be defined for reference. Following is the required input data for defining PIA longitudinal lines.

1. Type Code (c.c. 4-6).

   The code "PIA" is used to define a Parallel thru Intersect Ahead longitudinal line. This code is required with every PIA line entered on the input form.

2. Ref. Call (c.c. 7, 8). Form: xx.

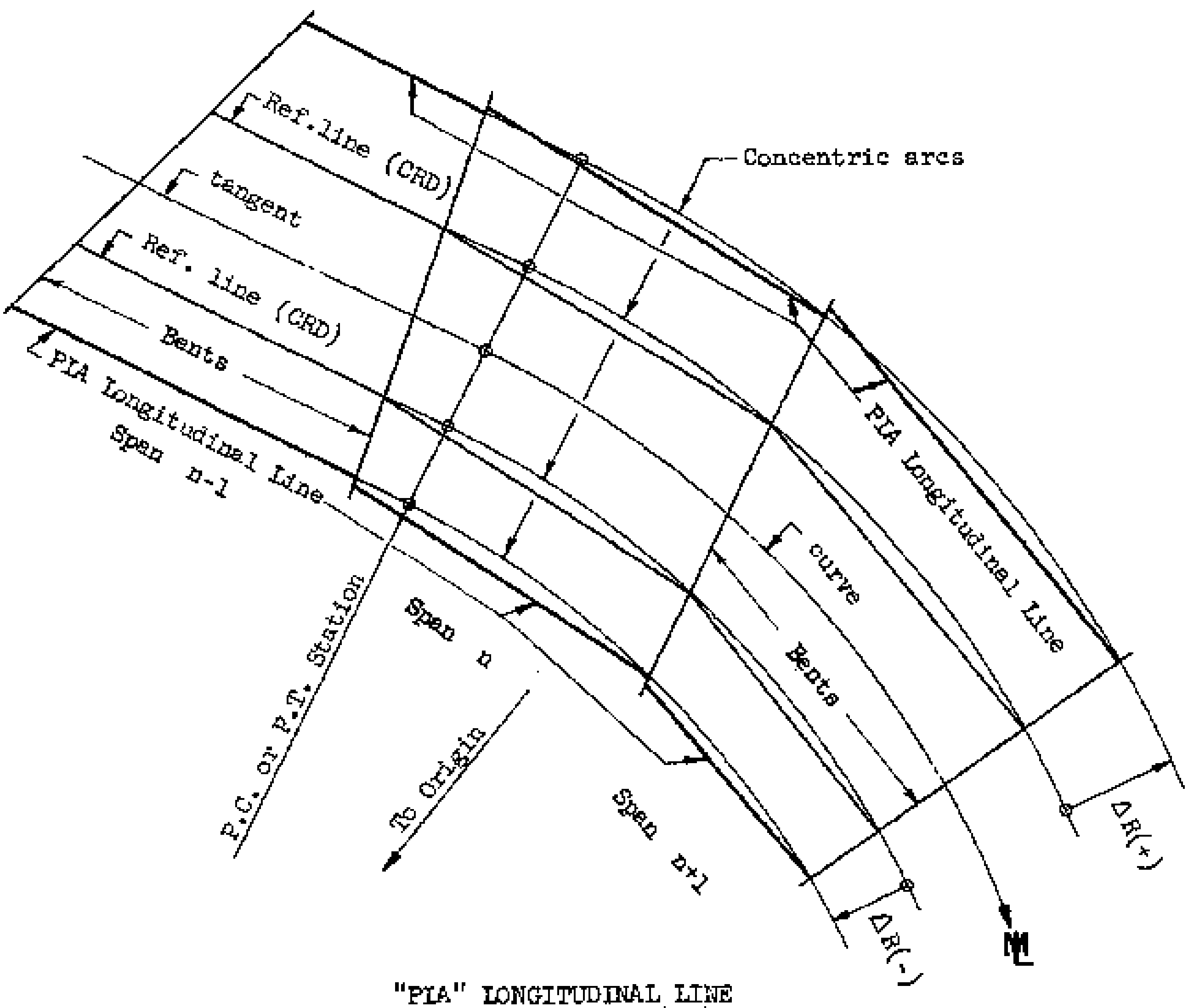
   The Reference Call is the Sequence Number of the longitudinal line to which the PIA line is referenced (parallel to). The Reference Call must always be given when defining a PIA longitudinal line, i.e., cannot be zero or left blank. The Reference Call cannot be greater than the total number of longitudinal lines, nor equal to the Sequence Number of the PIA line.

3. ΔR From Reference Line (c.c. 9-18). Form: xxxxxx.xxxx feet.

This dimension is the radial distance from the concentric circle that defines the reference line to the concentric circle that locates the intersection of the PIA line with the Ahead bent. If the distance is measured toward the origin, the dimension is negative. If the distance is measured away from the origin, the dimension is positive.

Card columns 19-48 of the input form should be left blank when defining PIA longitudinal lines. See page 51 for a discussion of the Skip code (c.c. 49) and Remarks (c.c. 50-80). An example showing how the PIA longitudinal line input data is entered on the input form is shown on page 76.

Following is a sketch showing the characteristics of the PIA longitudinal line.



"PIA" LONGITUDINAL LINE

F. PARALLEL thru INTERSECT BACK

This type of longitudinal line, which will be coded "PIB", is a straight line parallel to some other longitudinal line (reference line). The position of the PIB longitudinal line is determined by the intersection of a concentric circle and the Back bent. The radial distance from the mainline to the concentric circle that defines the FIB line is the sum of the "Δ R" dimensions of the reference line and PIB line. Note that the PIB longitudinal line is not a chord line because the intersection of the PIB line and Ahead bent is not the same point as the intersection of the concentric circle with the Ahead bent.

The reference line of the PIB longitudinal line must be a straight line, i.e., chord or straight taper longitudinal line. If the PIB line is referenced to a chord line, the PIB line will be a series of straight lines parallel to the chord segments. If a straight taper is used as a reference line, the PIB line will be a straight line continuous throughout the range of the problem. A coordinate longitudinal line should not be used as a reference line for a PIB longitudinal line. The PIB line may only be referenced to chord, straight taper and arc (when mainline is a tangent throughout range of bridge only) longitudinal lines.

It is common practice to make all beams in a span parallel to some reference line whenever the span is in a horizontal curve. The PIB line can be used to define such beam lines. The PIB lines can be used in conjunction with PIA longitudinal lines (see page 75) in order to make the parallel lines of adjacent spans meet at a common point at the bent common to both spans.

Any number of PIB longitudinal lines may be defined and used in conjunction with all other types of longitudinal lines. Note that some other type of longitudinal line must always be defined for reference. Following is the required input data for defining PIB longitudinal lines.

1. Type Code (c.c. 4-6).

   The code "PIB" is used to define a Parallel thru Intersect Back longitudinal line. This code is required with every PIB line entered on the input form.

2. Ref. Call (c.c. 7, 8). Form: xx.

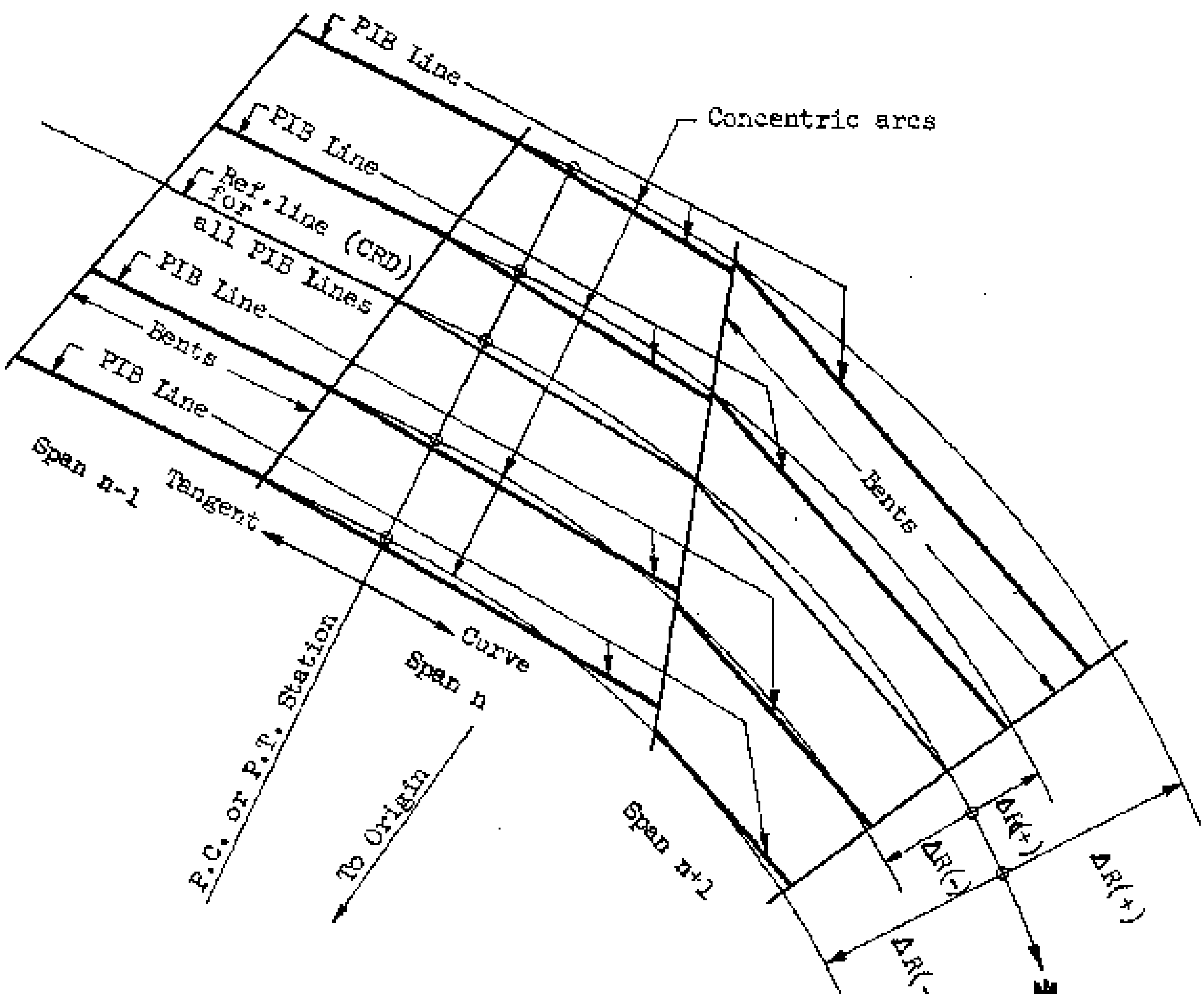
   The Reference Call is the Sequence Number of the longitudinal line to which the PIB line is referenced (parallel to). The Reference Call must always be given when defining a PIB longitudinal line, i.e., cannot be zero or left blank. The Reference Call cannot be greater than the total number of longitudinal lines nor equal to the Sequence Number of the PIB line.

3. D R From Reference Line (c.c. 9-18). Form: xxxxxx.xxxx feet.

This dimension is the radial distance from the concentric circle that defines the reference line to the concentric circle that locates the intersection of the PIB line with the Back bent. If the distance is measured toward the origin, the dimension is negative. If the distance is measured away from the origin, the dimension is positive.

Card columns 19-48 of the input form should be left blank when defining PIB longitudinal lines. See page 51 for a discussion of the Skip code (c.c. 49) and Remarks (c.c. 50-80). An example showing how the PIB longitudinal line input data is entered on the input form is shown on page 76.

Following is a sketch showing the characteristics of the PIB longitudinal line.



"PIB" LONGITUDINAL LINE

G. CURVE OFFSET

A curve offset longitudinal line is a circular curve that is independent of the mainline, i.e., not concentric with the mainline. The curve offset line is a continuous curve throughout the range of the problem. The curve offset is always referenced from the mainline. The mainline can be a circular curve or tangent; that is, a curve offset can be referenced from a tangent mainline as well as a circular mainline.

Occasionally, a portion or one side of a bridge will be on a curve that is not concentric with the mainline; for instance, when a ramp or lane separates from the mainline roadway. The curve offset longitudinal line can be used to define curb, gutter and structure lines in such a portion or side of the bridge. The program does not have the capacity to compute a chord of the curve offset longitudinal line. However, the coordinates of the intersections of the curve offset line with the bents of each span can be used to define longitudinal lines (coordinate lines) in another run of the problem. Therefore, beams can be set up as chords of curve offsets by running the program twice.

Any number (thirty or less) of curve offset longitudinal lines may be defined and used in conjunction with all other types of longitudinal lines. Following is the required input data for defining curve offset longitudinal lines.

1. Type Code (c.c. 4-6).

   The code "COS" is used to define a curve offset longitudinal line. This code is required with every curve offset line entered on the input data form.

2. Ref. Call (c.c. 7, 8).

   The Reference Call is not required with longitudinal lines defined as curve offsets. The curve offset longitudinal line is always assumed to be referenced from the mainline. Therefore, the Reference Call should be left blank.

3. ΔR From Mainline (c.c. 9-18). Form: xxxxxx.xxxx feet.

   This dimension is the common radial distance from the mainline to the curve offset line when the mainline is a curve. When the mainline is a tangent, this distance is the perpendicular distance from the mainline to a tangent of the curve offset that is parallel to the mainline. Actually, both definitions given for this dimension are synonymous. If the distance is measured toward the origin, the dimension is negative. Otherwise (away from origin), the dimension is positive.

4. Mainline Control Station (c.c. 19-28). Form: xxxx+xx.xxxx feet.

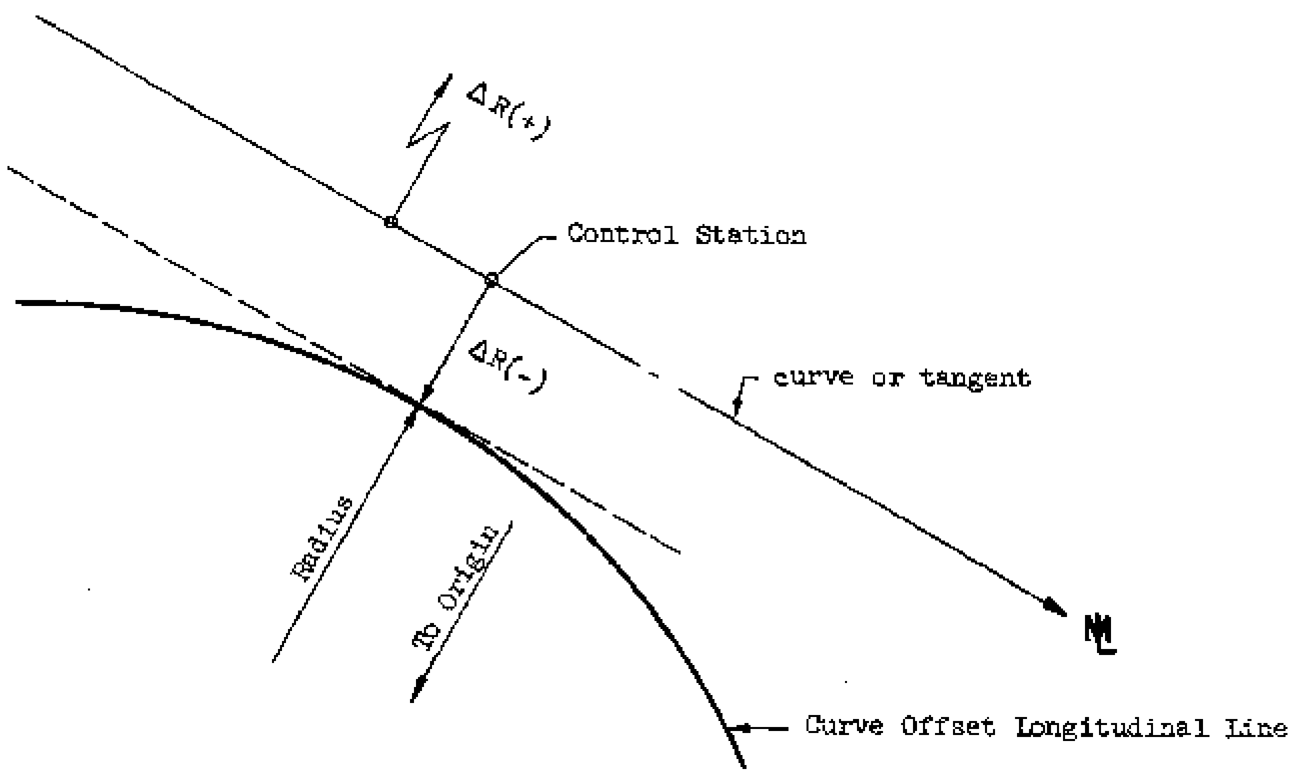
The Control Station is the mainline station of the point where the "D R From Mainline" dimension is given. This station is always required when defining curve offset longitudinal lines. The Control Station may be of negative magnitude, and this station is completely independent of any other station given in the input data. Note that this station must be a mainline station and not a station along the curve offset line. A tangent to the curve offset line at the Control Station will be parallel to a tangent of the mainline curve at the Control Station.

5. Radius (c.c. 29-38). Form: xxxxxx.xxxx feet.

Enter in this column the radius of the curve offset longitudinal line. This dimension should always be given, and it is required that this dimension be greater than zero.

Card columns 39-48 of the input form should be left blank when defining a curve offset longitudinal line. The Skip code (c.c. 49) and Remarks (c.c. 50-80) are discussed on page 51. An example showing how the curve offset longitudinal line data is entered on the input form is shown on page 78.

Following is a sketch showing the characteristics of the curve offset longitudinal line.



"COS" LONGITUDINAL LINE

H. STRAIGHT TAPER

A straight taper is defined as a line whose distance from the mainline varies lineally. If the main line is a circular curve, the straight taper varies lineally from a tangent to the mainline curve. Therefore, the straight taper longitudinal line will always be a straight line that is continuous throughout the range of the bridge and which is completely independent of a change in the mainline from tangent to curve or vice versa.

Occasionally, one side of a bridge will be on a straight taper from the mainline, i.e., the beginning of a new lane or ramp, etc. The straight taper longitudinal line can be used to represent the curb, gutter and structure lines in this case. In addition, straight taper lines may be used to enter splayed beams, i.e., non-parallel beams.

A special case of straight taper line usage is when the rate of taper is set equal to zero. In this case, the straight taper is parallel to the main line. For an example, lets assume a four-span bridge where a short portion of one end span is in a circular curve - the rest of the bridge is on a tangent. It is desired to make this a continuous unit and extend the beams straight into the curve portion. The beams can be set up as straight taper longitudinal lines with a zero taper rate. No other type of longitudinal line can be set up for this type of usage except the coordinate longitudinal line. However, the coordinates would have to be computed to define a coordinate line making this alternate somewhat cumbersome.

Any number (thirty or less) of straight taper longitudinal lines may be defined and used in conjunction with all other types of longitudinal lines. Following is the required input data for defining straight taper longitudinal lines.

1. Type Code (c.c. 4-6).

   The code "STP" is used to define a straight taper longitudinal line. This code is required with every straight taper line entered on the input data form.

2. Ref. Call (c.c. 7, 8).

   The Reference Call is not required with longitudinal lines defined as straight tapers. Since the straight taper line is always referenced from the main line, the Reference Call should be left blank.

3. &R From Mainline (c.c. 9-18). Form: xxxxxx.xxxx feet.

   This dimension is the distance from the mainline to a point on the straight taper line and is measured normal (perpendicular) to the mainline (or mainline tangent). If the distance is measured toward the origin, the dimension is negative; otherwise, the dimension is positive.

4. Mainline control Station (c.c. 19-28). Form: xxxxxx.xxxx feet.

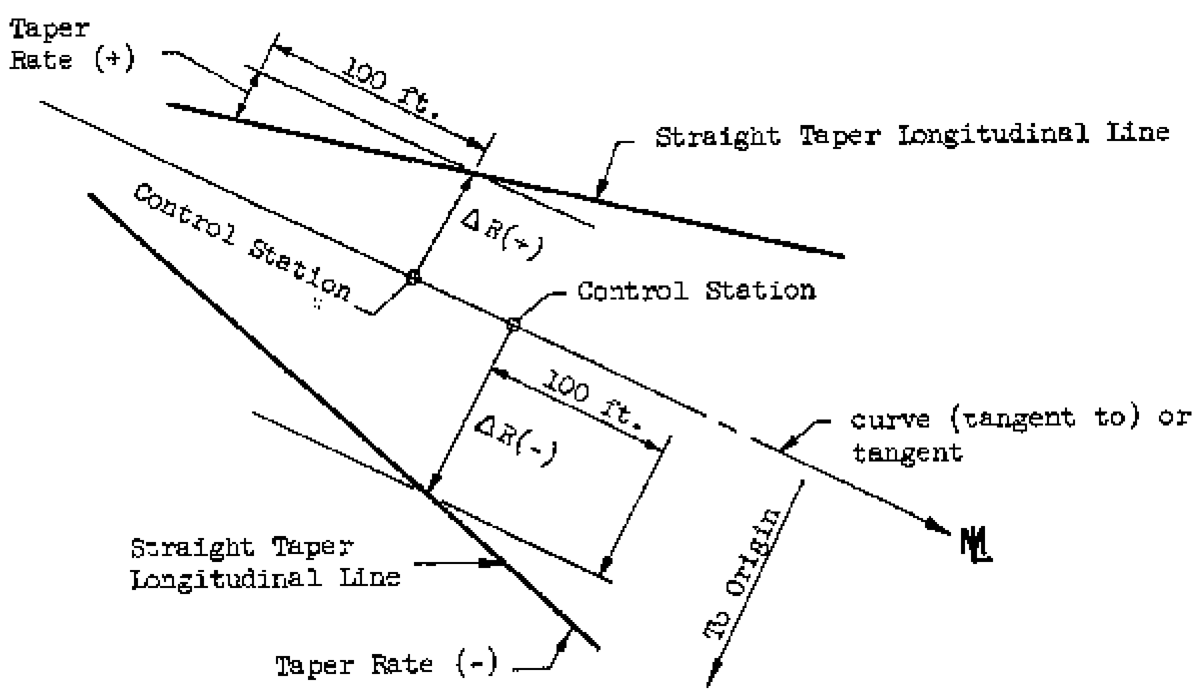
The Control Station is the mainline station of the point where the "ΔR From Mainline" dimension is given. This station is always required when defining straight taper longitudinal lines. The Control Station may be of negative magnitude; and this station is completely independent of any other station given in the input data. Note that this station must be on the mainline and not a station along the straight taper line.

5. Taper Rate (c.c. 29-38). Form: xxxxxx.xxxx ft./100 ft.

The Taper Rate is the variation of the distance from the main line to the straight taper line per one hundred feet along the main line. The Taper Rate is actually the tangent of the angle between the mainline and straight taper line multiplied by one hundred. The Taper Rate sign convention is shown in the sketch below.

Card columns 39-48 of the input form should be left blank when defining a straight taper longitudinal line. The Skip code (c.c. 49) and Remarks (c.c. 50-80) are discussed on page 51. An example showing how the straight taper longitudinal line data is entered on the input form is shown on page 77.

Following is a sketch showing the characteristics of the straight taper longitudinal line.



"STP" LONGITUDINAL LINE

I. CURVE TAPER

A curve taper longitudinal line is a curved line that varies lineally from a circular curve. This actually makes the curve taper line an Archimedes spiral, i.e., the radius varies lineally with the distance along a circular arc. This takes the form:

$r = k*\Theta$, in polar coordinates.

The curve taper will be continuous throughout the range of the bridge and, therefore, is completely independent of any change in the mainline from curve to tangent or vice versa.

The curve taper longitudinal line can be used to represent curb, gutter, and structure lines if a portion of the bridge is in this type of taper. Occasionally, this type of taper is used when the roadway is being widened in a circular curve. A railing line can be referenced to a curve taper line. The program does not have the capacity to compute a chord of the curve taper longitudinal line. However, the coordinates of the intersection of the curve taper line with the bents of each span can be used to define longitudinal lines (coordinate lines) in another run of the problem. Therefore, beams can be set up as chords of curve taper longitudinal lines by running the program twice.

Any number (thirty or less) of curve taper longitudinal lines can be used in conjunction with all other types of longitudinal lines. Following is the required input data for defining curve taper longitudinal lines.

1. Type Code (c.c. 4-6).

The code "CTP" is used to define a curve taper longitudinal line. This code is required with every curve taper line entered on the input data form.

2'. Ref. Call (c.c. 7, 8).

The Reference Call is not required with longitudinal lines defined as curve tapers. The curve taper longitudinal line is always assumed to be referenced from the mainline. Therefore, the Reference Call should be left blank.

3. AR From Mainline (c.c. 9-18). Form: xxxxxx.xxxx feet.

This dimension is the radial distance from the mainline to a point on the curve taper longitudinal line. This distance must be given at a known station. If the distance is measured toward the origin, the dimension is negative. Otherwise, the dimension is positive.

4. Mainline Control Station (c.c. 19-28). Form: xxxx+xx.xxxx feet.

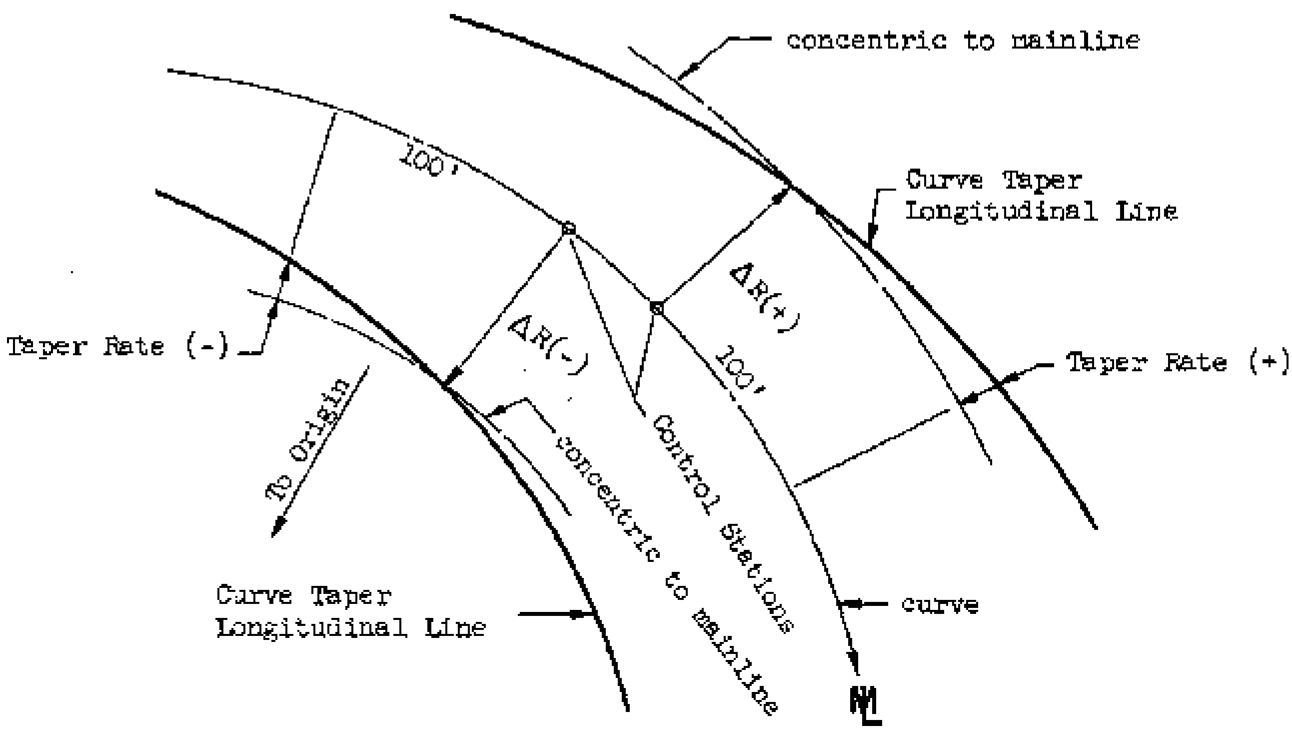
The Control Station is the mainline station of the point where the "ΔR From Mainline" dimension is given. This station is always required when defining curve taper longitudinal lines. The Control Station is completely independent of any other station given in the input data and may be of negative magnitude. Note that this station must be a mainline station and not a station along the curve taper line. This station must be in a circular curve mainline, i.e., the mainline cannot be tangent at this station. Note that a tangent to the mainline curve of any station will be parallel to a tangent to the curve taper at the same station.

5. Taper Rate (c.c. 29-38). Form: xxxxxx.xxxx ft./100 ft.

The Taper Rate is the change in radius of the curve taper longitudinal line per one hundred feet along the mainline. The Taper Rate must always be defined when entering curve taper longitudinal lines, i.e., cannot be left blank or given a value of zero. If the radius of the curve taper line increases as the stations increase, the taper rate is positive. If the radius of the curve taper line decreases as the stations increase, the taper rate is negative.

Card columns 39-48 of the input form should be left blank when defining a curve taper longitudinal line. The Skip code (c.c. 49) and Remarks (c.c. 50-80) are discussed on page 51. An example showing how the curve taper longitudinal line data is entered on the input form is shown on page 78.

Following is a sketch showing the characteristics of the curve taper longitudinal line.



"CTF" LONGITUDINAL LINE

J. COORDINATE

A coordinate longitudinal line is a straight line throughout the range of the bridge and, therefore, is completely independent of the mainline. The coordinate line is defined by entering the X and Y coordinates of two points on the coordinate line. The coordinates are assumed or computed by hand or another program. Note that this program can be used to compute coordinates that can be used to define coordinate longitudinal lines in subsequent runs of the problem.

This type of longitudinal line can be used to represent most any kind of straight line on the bridge provided, of course, the coordinates are known, i.e., curbs, gutter, beam and structure lines.

Any number (thirty or less) of coordinate longitudinal lines may be defined and used in conjunction with all other types of longitudinal lines. Following is the required input data for defining coordinate longitudinal lines.

I. Type Code (c.c. 4-6).

The code "COR" is used to define a coordinate longitudinal line. This code is required with every coordinate line entered on the input data form.

2. Ref. Call (c.c. 7, 8).

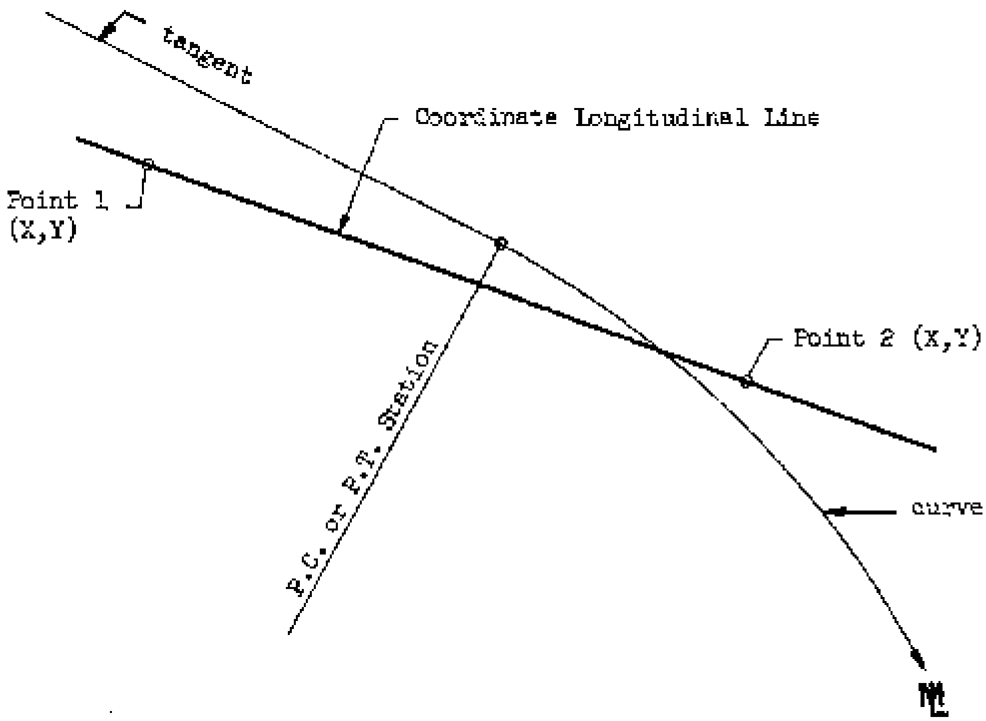
The Reference Call is not required with longitudinal lines defined as coordinate lines. Therefore, the Ref. Call should be left blank.

3. Coordinates (c.c. 9-48). Form: xxxxxx.xxxx feet.

Note that the input form has a separate heading (format) for use when entering a coordinate defined longitudinal line. The X-coordinate of point one is entered in c.c. 9-18, and the Y-coordinate of point one is entered in c.c. 19-28. The X-coordinate of point two is entered in c.c. 29-38, and the Y-coordinate of point two is entered in c.c. 39-48.

The Skip code (c.c. 49) and Remarks are discussed on page 51. An example showing how the coordinate longitudinal line data is entered on the input form is shown on page 77.

On the following page is a sketch showing the characteristics of the coordinate longitudinal line.

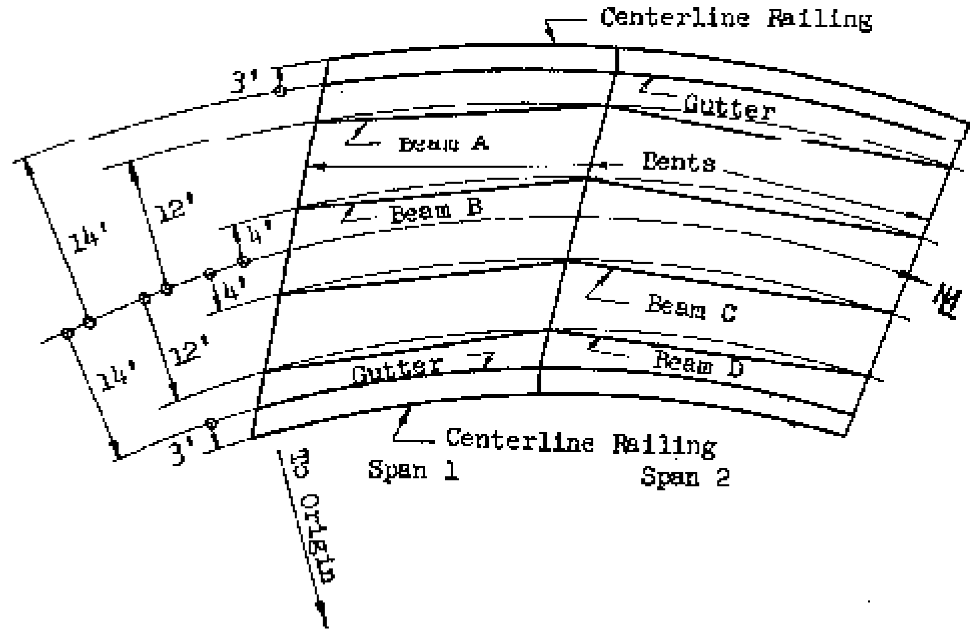


"COR" LONGITUDINAL LINE

LONGITUDINAL LINES

EXAMPLE 7-1. CRD,ARC,RLG

This example shows the longitudinal line input data for a two-span bridge with four beams. The beams are placed on chords of circles concentric to the mainline. The railing and gutter lines will also be defined in this example for illustration. Note that the mainline (survey line) is also entered as a longitudinal line. The dimensions required to define the longitudinal lines are shown in the sketch. Shown below is the longitudinal line input data entered on the input form.

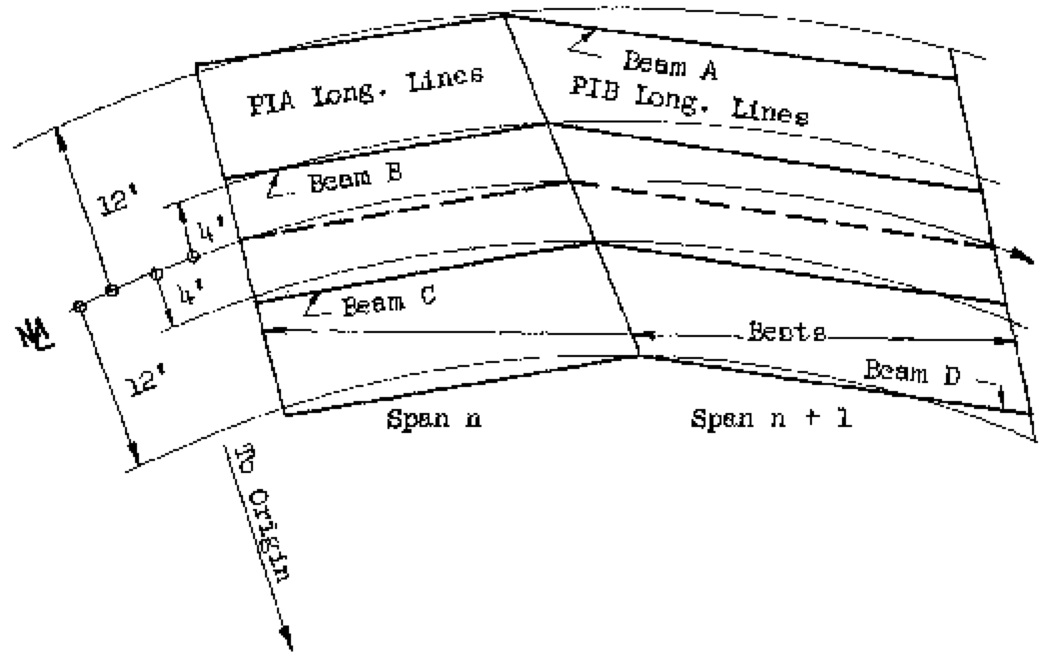


FORM OF INPUT

	SEQ. NO.	TYPE CODE	REF. CALL	Δ R FROM ℄ IF COS,CTP,ARC,CRD,STP,REF LINE IF RLG,PAR,PIB,PIA — POINT I X-COORDINATE	Y	SKIP	REMARKS
1	2	4	7	9	19	49	50 … 80
7	01	RLG	2	30000			LT. RAILING
7	02	ARC		140000			LT. GUTTER
7	03	CRD		120000			BEAM A
7	04	CRD		40000			BEAM B
7	05	ARC		00000			SURVEY LINE
7	06	CRD		-40000			BEAM C
7	07	CRD		-120000			BEAM D
7	08	ARC		-140000			RT. GUTTER
7	09	RLG	8	-30000			RT. RAILING
7	10	END					

LONGITUDINAL LINES (continued)

EXAMPLE 7-2. PIA, PIB, CRD



In this example, the beams of each span are placed parallel to a chord of the centerline arc. In order for the beams lines to meet at the intermediate bent, the beams of span "n" must be coded as PIA longitudinal lines and the beams of span "n + 1" must be coded as PIB longitudinal lines. For the purpose of illustration, two sets of longitudinal lines will be given. The first set will be used with span "n", and the other set used with span "n + 1". The input data is shown on the following page.

However, it should be noted that all the longitudinal lines could be given in one set. For example, beam A could be defined twice in the same group of longitudinal lines, as a PIA and PIB longitudinal line. In this case, the PIA longitudinal lines should be skipped when defining the bents and T-lines of span "n + 1", and the PIB longitudinal lines would be skipped in span "n". This would keep the output data from containing extraneous information.

EXAMPLE 7-2. Continued

FORM OF INPUT

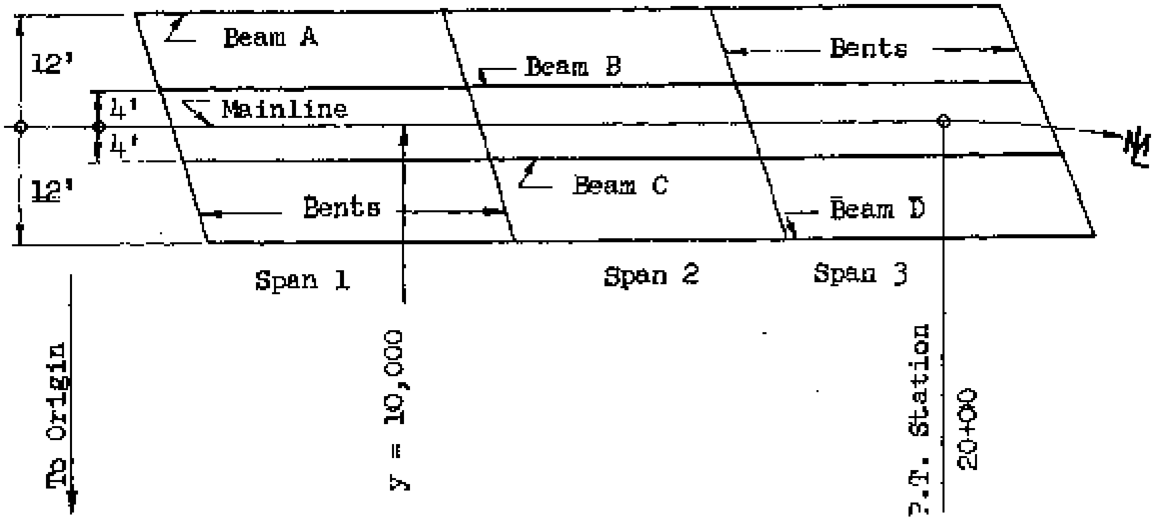
These longitudinal lines are used with span "n" only. This input should immediately precede span "n" (assuming the lines are not common to some previous span).

SEQ. NO.	TYPE CODE	REF. CALL	POINT X-COORDINATE (Δ R FROM ℄ IF COS, CTP, ARC, CRD, STP, REF LINE IF RLG, PAR, PIB, PIA)	REMARKS
701	PIA	3	120000	BEAM A
702	PIA	3	40000	BEAM B
703	CRD		00000	CL CHORD
704	PIA	3	-40000	BEAM C
705	PIA	3	-120000	BEAM D
706	END			

These longitudinal lines are used with span "n+1" only. This input would follow immediately behind the span "n" input data and immediately precede the input data of span "n+1".

SEQ. NO.	TYPE CODE	REF. CALL	POINT X-COORDINATE (Δ R FROM ℄ IF COS, CTP, ARC, CRD, STP, REF LINE IF RLG, PAR, PIB, PIA)	REMARKS
701	PIB	3	120000	BEAM A
702	PIB	3	40000	BEAM B
703	CRD		00000	CL CHORD
704	PIB	3	-40000	BEAM C
705	PIB	3	-120000	BEAM D
706	END			

LONGITUDINAL LINES (continued)



EXAMPLE 7-3. STP, PAR, COR

This example shows a three-span continuous unit that has a portion of the last span in a curve. The tangent portion has been set up parallel to the X-axis, and the beams are to extend straight into the curve portion. The beams will be set up as PAR longitudinal lines that are parallel to the mainline tangent. The mainline will be defined as a STP longitudinal line for reference. For the purpose of illustration, the mainline tangent will also be defined as a COR longitudinal line. The input data is shown below.

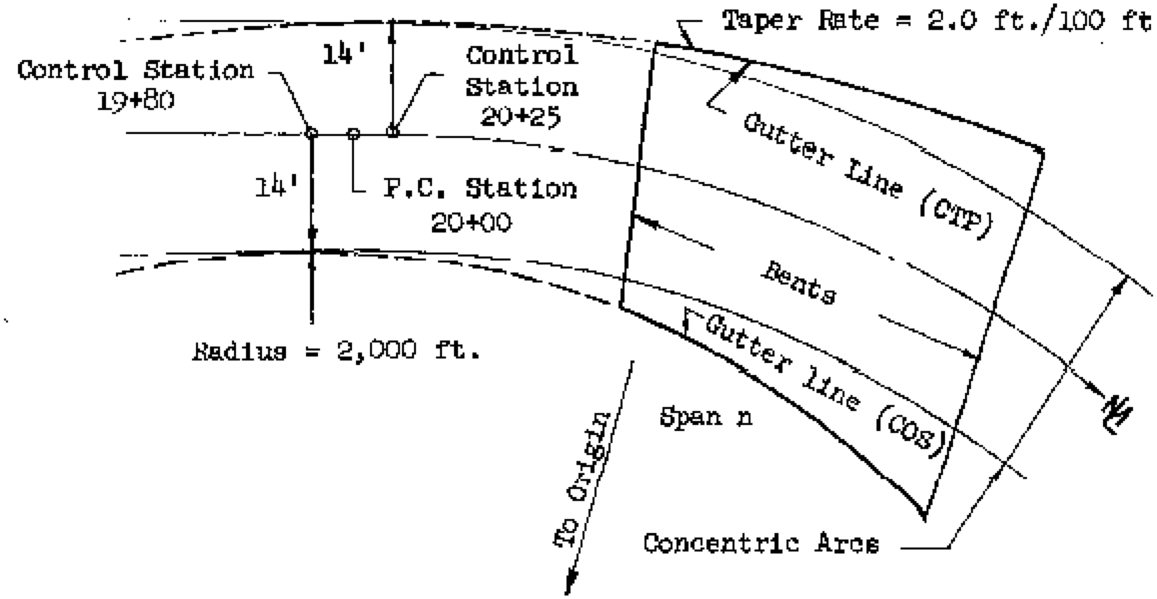
FORM OF INPUT

SEQ NO.	TYPE CODE	REF. CALL	POINT 1 X-COORDINATE (Δ R FROM ℄ IF COS, CTP, ARC, CRD, STP REF LINE IF BL, G, PAR, PIB, PIA)	POINT 1 Y-COORDINATE (IGNORE EXCEPT FOR STP-CTP & COS: ℄ CONTROL STA)	POINT 2 X-COORDINATE (IGNORE EXCEPT FOR STP-CTP & COS: TAPER RATE IF CTP, STP RADIUS IF COS)	POINT 2 Y-COORDINATE	SKIP	50
701	PAR	3	120000					BEAM A
702	PAR	3	40000					BEAM B
703	STP		00000	19000000	00000			REF.
704	COR		00000	1000000000	1000000000	1000000000		REF.
705	PAR	4	-40000					BEAM C
706	PAR	4	-120000					BEAM D
707	END							

LONGITUDINAL LINES (continued)

EXAMPLE 7-4. CTP, COS, ARC

This example shows a span in a bridge of varying width. The left side is controlled by a curve taper, and the right side is controlled by a curve offset. The CTP and COS longitudinal lines will be used to define the gutter lines. Note that the curve taper and curve offset are tangent to the concentric arc at their Control Station. The distances, etc. required to define the longitudinal lines are shown in the sketch. Below is shown the input form with the required input data.



FORM OF INPUT

			Δ R FROM ℄ IF COS, CTP, ARC, CRD, STP, REF LINE IF RL, G, PAR, PB, PIA	IGNORE EXCEPT FOR STP, CTP & COS: ℄ CONTROL STA +	TAPER RATE IF CTP, STP RADIUS IF COS			
			POINT 1		POINT 2			
SEQ. NO.	TYPE CODE	REF. CALL	X-COORDINATE	Y-COORDINATE	X-COORDINATE	Y-COORDINATE	S K I P	REMA
701	CTP		1.40000	2025.0000	2.0000			LT. GUTTER
702	ARC		0.0000					MAINLINE
703	COS		-14.0000	1980.0000	2000.0000			RT. GUTTER
704	END							

SUMMARY OF LONGITUDINAL LINE INPUT REQUIREMENTS

TYPE (c.c.4-6)	CARD COLUMNS 7 - 8	9 - 18	19 - 28	29 - 38	39 - 48	49	50 - 80
ARC		ΔR From Mainline.				Skip Code (1 or blank).	Remarks
CRD		ΔR From Mainline.				Skip Code (1 or blank).	Remarks
RLG	Number of Ref.line.	ΔR From Ref. line.					Remarks
PIA	Number of Ref.line.	ΔR From Ref. line.					Remarks
PIB	Number of Ref.line.	ΔR From Ref. line.					Remarks
PAR	Number of Ref.line.	Normal distance from Ref. line.					Remarks
STP		ΔR From Mainline.	Station of ΔR dimension.	Taper Rate		Skip Code (1 or blank).	Remarks
CTP		ΔR From Mainline.	Station of ΔR dimension.	Taper Rate		Skip Code (1 or blank).	Remarks
COS		ΔR From Mainline.	Station of ΔR dimension.	Radius		Skip Code (1 or blank).	Remarks
COR		X-Coordinate of point 1.	Y-Coordinate of point 1.	X-Coordinate of point 2.	Y-Coordinate of point 2.	Skip Code (1 or blank).	Remarks

SPAN DATA

The SPAN DATA input form is used to define each span of the bridge. One input sheet is required for each span. However, exceptions can occur if more than eleven transverse lines are used in a span, or if several spans are combined and entered as one span. The program computes the output data in units of spans; that is, the first span is computed and the answers printed before the second span is considered, etc. Therefore, there is no limitation on the maximum number of spans that can be processed with each problem. Normally, the SPAN DATA input form(s) should always be used. However, when the coordinates of all the points on the bridge are known, i.e., computed some other method, the COORDINATE input form can be used in lieu of the SPAN DATA form. Note that the SPAN DATA input can also be used in conjunction with the COORDINATE input data.

The solution for each span is completely independent of the solution for any other span. The spans can be given in any sequence, but it is common practice to enter the spans in the same order that they are positioned in the bridge.

Each span consists of two bents and from zero to twenty transverse lines. Actually, the bents are transverse lines but, since the bent lines define the span, the bent and transverse lines must be defined separately. The bents and transverse lines of each span are intersected with each longitudinal line unless a line is coded to skip the intersection.

The Span Input Data consists of the following data:

1. Span Identification (one input line).

2. Bent Data (two input lines).

3. T-Line Data (zero to twenty* input lines).

The data listed above will be discussed in detail on the following pages Examples and sketches will also be given.

An exception will be noted in the discussion of the T-Lines.

A. Span Identification (8 SPAN in c.c. 1-5).

The Span Identification consists of data pertinent to the processing of the span and Remarks that identify the span. The Span Identification data is entered on one line of the input form, and this line is the first input line of the SPAN DATA input form. The Span Identification should always contain data except as noted on page 95. An example of the Span Identification input is not given since it is felt that the instructions are adequate. Following are the input data requirements.

1. Span Number (c.c. 7, 8). Form: xx

Enter in this space the span number. Either numbers or characters may be used, i.e., 1, 2, 3L, 4R, etc. This number will be given in the output data of the span. There is no sequence check on the order of the Span Numbers.

2. Number of Transverse Lines (c.c. 10, 11). Form: xx

The Number of Transverse Lines that are going to be defined in the span should be given in this space. If no T-lines are going to be defined, this number may be left blank or given a value of zero. Since the maximum number of T-lines is twenty per span, this number cannot exceed twenty. Therefore, the Number of Transverse Lines will vary from zero (0) to twenty (20). Note that this number is the total number of T-lines in the span and not, necessarily, the number of T-lines defined on one SPAN DATA input form, i.e., two sheets can be used when more than eleven T-lines are defined.

3. Last Span Code (c.c. 13-16).

The code "LAST" should be entered in this space when filling in the input data of the last span of the problem. This space should be left blank in all preceding spans. This code indicates to the program that no further input data is going to be given after the present (last) span. Whenever coordinates are used as input data (on COORDINATE input data form) after the last span,, the Last Span Code should be left blank since additional input data must be processed.

4. Remarks (c.c. 16-73).

This space is provided so that the Engineer can enter any pertinent Remarks describing the span. These Remarks will appear in the output data of the span.

5. Code for Additional Longitudinal Lines (c-c. 74-76).

Whenever another set of longitudinal lines are going to be defined immediately after a SPAN DATA input sheet, the code "YES" should be given in card columns 74-76 of the Span Identification. Otherwise, these card columns can be used for Remarks. Therefore, if "YES" is given in these card columns, the program will expect the next sheet of input data after the span input data to be LONGITUDINAL LINES.

B. Bent Data (B or A in c.c. 1).

Two lines on the SPAN DATA input form are provided so that the two bents that define each span can be defined. The bent that begins the span will be referred to as the Back bent and should always be defined first, i.e., on the input line with the letter "B" in card column one. The bent that terminates the span will be referred to as the Ahead bent and should always be defined next on the input line with the letter "A" in card column one. The Back and Ahead bent must always be given when defining a span. Note that a bent common to two spans must be defined twice, once with each span.

Except as noted otherwise, the procedure for defining the Back and Ahead bent is identical. Following is the input data required to define the bents.

1. RLG Intersect Code (c.c. 2).

This code is used to indicate to the program which point of intersection the program is to consider when intersecting the bent line with the railing longitudinal lines of the span. If the bent line is to extend straight and intersect the railing lines, the digit one (1) should be entered as the RLG Intersect Code. However, if the bent line is to turn at the intersection of the bent line with the reference line of the railing line and extend radially from the reference line to intersect the railing longitudinal line, the RLG Intersect Code should be left blank or given a value of zero. Note that the bent line will intersect all railing longitudinal lines in the same fashion. A sketch showing this optional point of intersection is shown on page 58. This code has no effect on the intersection of the bent line with other types of longitudinal lines, nor on any longitudinal lines located between the railing line and its reference line.

2. Bent Number (c.c. 3, 4). Form: xx.

This space is for entering the number of the bent. This number can be numeric or alphabetic characters and will appear in the output data.

3. Remarks (c.c. 37-50).

This space is provided so that the user can enter any pertinent Remarks that describe the bent. These Remarks will appear in the output data to assist in the interpretation of the output.

4. Longitudinal Line Skips (c.c. 51-80).

The longitudinal Line Skip is used to instruct the program to by-pass the intersection of the bent line with some particular longitudinal line. The digit one (1) is used to indicate that the intersection is to be skipped. Otherwise., the Longitudinal Line Skip is left blank. For example, if the intersection of the bent with longitudinal line four (4) is not desired in the output data, the digit "I" should be entered in card column 54. Note that immediately below the Longitudinal Line Skip heading there are numbers that correspond to the longitudinal line number (1-30), and immediately below the longitudinal line numbers are the card column numbers (51-8o).

It is important to note that if the Longitudinal Line Skip is coded to skip a longitudinal line when defining the Ahead bent, the length of that longitudinal line from the Back bent to the Ahead bent will not be given in the output data. Also, when a bent is coded to skip a longitudinal line, the "Distance to Previous Point" dimension given in the output data will be zero in the output data of the intersection of the bent with the next longitudinal line. For example, the distance from the point of intersection of the bent with longitudinal line "n-l" to the point of intersection of the bent with longitudinal line "n+l" is not given in the output data when longitudinal line "n" is skipped. If a longitudinal line has been coded to skip all intersections (the digit one entered in card column 49 of the longitudinal Line input data) the bent Longitudinal Line Skip for that longitudinal line is meaningless, since the bent will not be intersected with the longitudinal in any event.

5. Type Code (c.c. 5-8).

The Type Code is used to indicate to the program how the bent is going to be defined. There are five codes available to the Engineer with which the bent can be defined. They are:

1) SKEW (Skewed at a station)

2) PARL (Parallel to reference line at a normal distance)

3) PSTA (Parallel to reference line at a station)

4) PREV (Parallel to bent B at a normal distance or a station)

5) SAME (Same as bent A of preceding span)

It is left up to the user to select the code and data that can most conveniently be used to define the bent. Following is a discussion and sketch of each Type Code, the required input data of each type, and examples (pages 90-92) showing how the data is entered on the input data form.

1. "SKEW" Bent

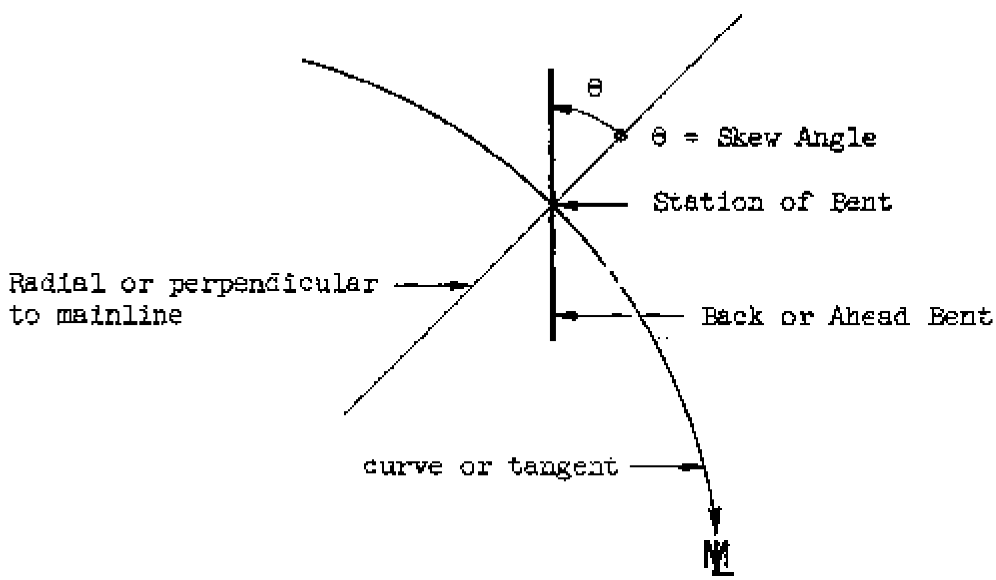
A SKEW type bent is defined by giving the Skew Angle and Station of the bent and mainline intersection. Therefore, the Skew Angle and Station of Bent must be known before this Type Code can be used to define a bent. This Type Code can be used to define both the Back and Ahead bent. The SKEW code is not used exclusively to define bents that are skewed with the bridge, i.e., the other Type Codes can be used to define bents that are not perpendicular or radial to the mainline.. Card columns 27-36 of the input line should be left blank when using the SKEW code. Following is the additional input data required to define a SKEW bent.

a. Station of Bent (c.c. 9-18). Form: xxxx+xx.xxxx feet.

The station of the point of intersection of the bent with the mainline should be entered in this space of the input form. This station may be of negative magnitude.

b. Skew Angle of Bent (c.c. 19-26). Form: xxx deg.,xx min.,xx.x sec.

The angle between the bent line and a line that is radial to the mainline at the Station of Bent should be entered on the input form as the Skew Angle of Bent. The angle is entered in degrees, minutes, and seconds (to tenths). The sign convention of the Skew Angle is given on page 93. A negative angle is indicated by entering a minus sign (-) before the first significant digit of the degrees.



"SKEW" BENT

2. "PARL" Bent

A PARL type bent is defined by first defining a reference line. The bent is defined to be parallel to this reference line at a given normal distance from the reference line. The reference line can be another bent or any arbitrary line; however, the skew angle and mainline station of the reference line must be known. The reference line will not be intersected with any of the longitudinal lines. The Back and Ahead bent may be defined by this Type Code. Following is the additional input data required to define a PARL bent.

a. Station of Reference Line (c.c. 9-18). Form: xxxx+xx.xxxx feet.

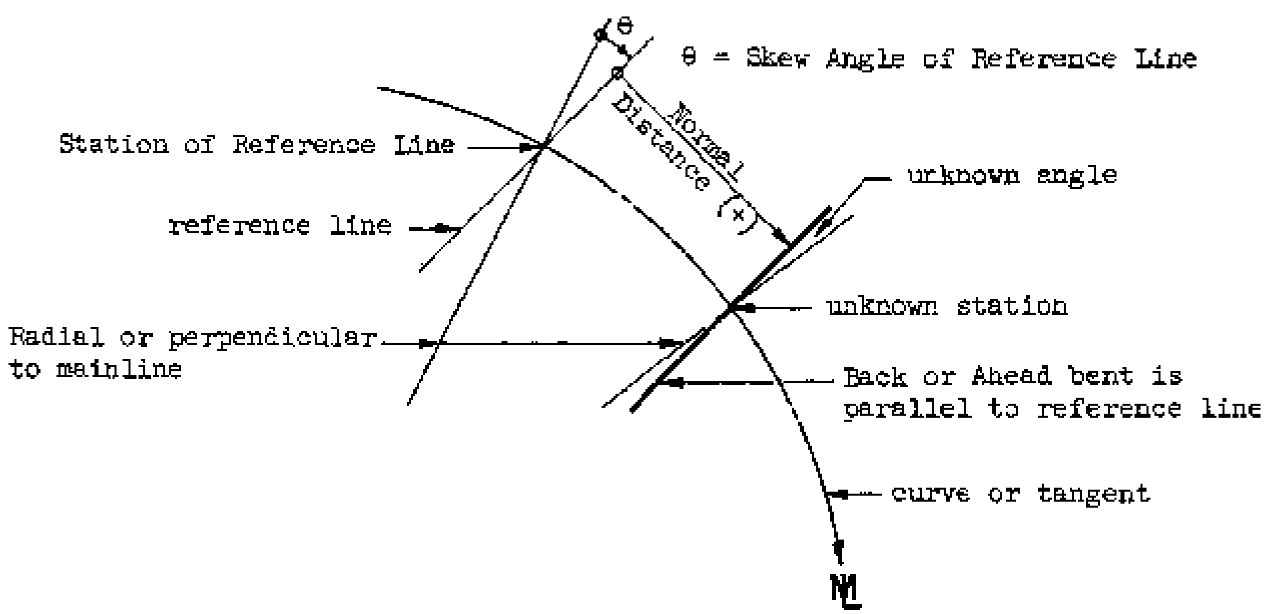
Enter in this space the station of the intersection of the reference line with the mainline. This station may be of negative magnitude.

b. Skew Angle of Reference Line (c.c. 19-26).
Form: xxx deg.,xx min.,xx.x sec.

The angle between the reference line and a line radial to the mainline at the Station of Reference Line should be entered on the input form as the Skew Angle of Reference Line. The angle is entered in degrees, minutes, and seconds (to tenths). See page 93 for the Skew Angle sign convention. A negative angle is indicated by placing a minus sign (-) before the first significant digit of the degrees.

C. Normal Distance (c.c. 27-36). Form: xxxxxx.xxxx feet.

Enter in this space the Normal Distance from the reference line to the bent line. If the bent is ahead of the reference line ' the distance is positive. Otherwise (bent back of the reference line), the distance is negative.



"PARL" Bent

3. "PSTA" Bent

A PSTA type bent is defined by first defining a reference line. The bent is defined to be parallel to this reference line at a given station. The reference line can be another bent or any arbitrary line; however, the skew angle and mainline station of the reference line must be known. The reference line will not be intersected with any of the longitudinal lines. The Back and Ahead bent may be defined by this Type Code. Following is the additional input data required to define a PSTA bent.

a. Station of Reference Line (c.c. 9-18). Form: xxxx+xx.xxxx feet.

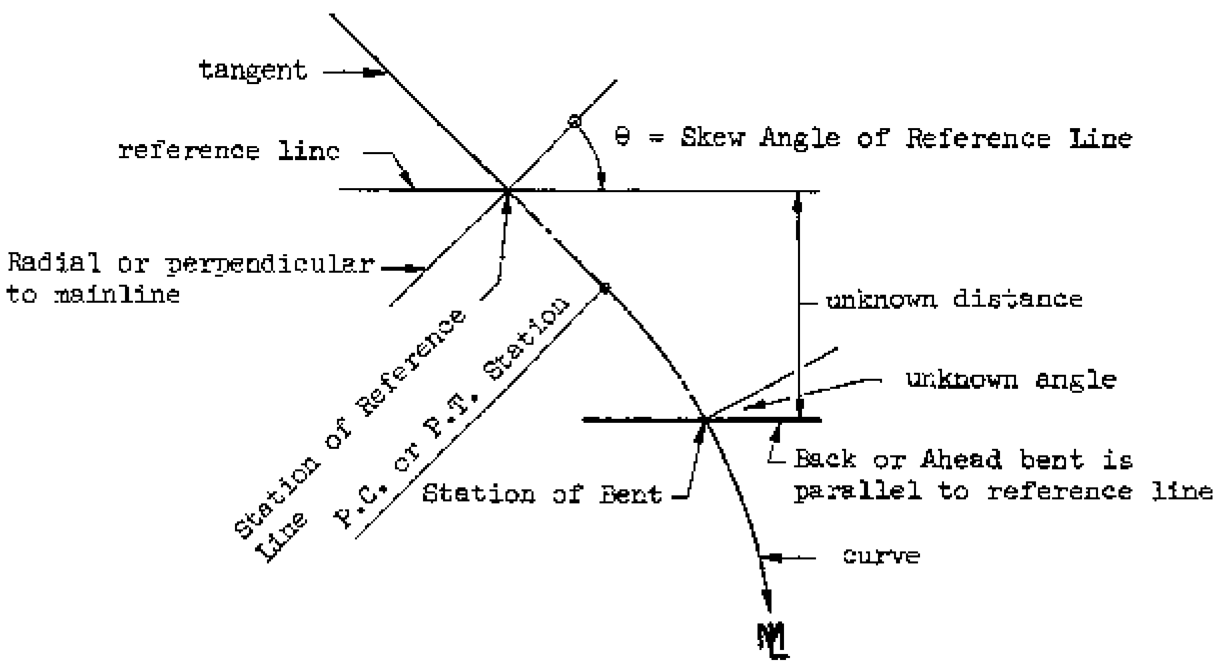
Enter in this space the station of the intersection of the reference line with the mainline. This station may be of negative magnitude.

b. Skew Angle of Reference Line (c.c. 19-26).
Form: xxx deg.,xx min.,xx.x sec.

The angle between the reference line and a line radial to the mainline at the Station of Reference Line should be entered on the input form as the Skew Angle of Reference Line. The angle is entered in degrees, minutes, and seconds (to tenths). See page 93 for the Skew Angle sign convention. A negative angle is indicated by placing a minus sign (-) before the first significant digit of the degrees.

C. Station of Bent (c.c. 27-36). Form: xxxx+xx.xxxx feet.

Enter in this space the station of the intersection of the bent with the mainline. This station may be of negative magnitude.



"PSTA" Bent

4. "PREV" Bent

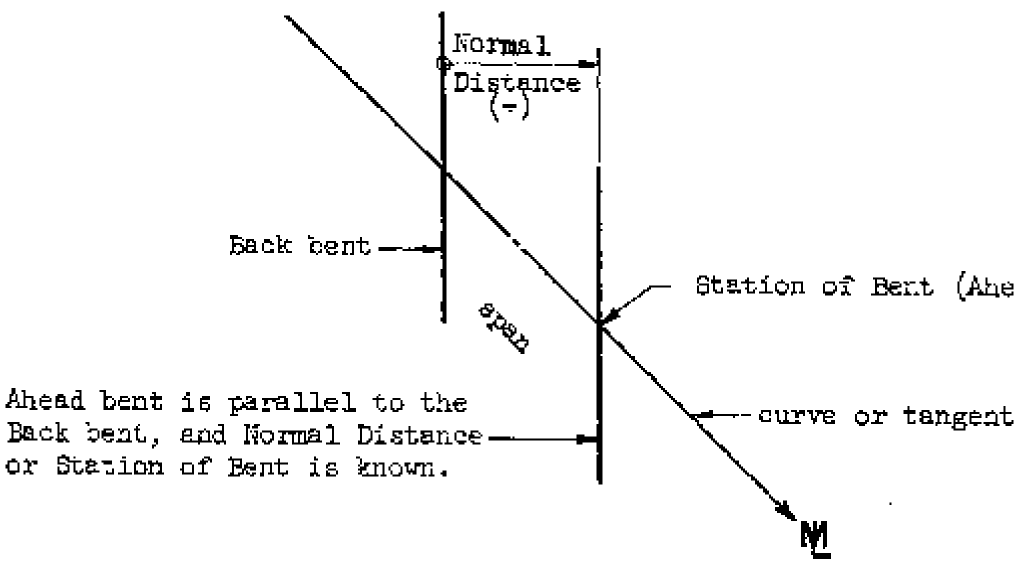
A PREV type bent can only be used to define the Ahead bent (A in c.c. 1). The PREV code indicates that the Ahead bent (being defined) is parallel to the Back bent (already defined). The Ahead bent is defined further by giving the normal distance from the Back bent to the Ahead bent OR (not both) the mainline station of the Ahead bent. Card columns 19-26 of the input data line should left blank. Following is the additional input data required to define a PREV bent.

a. Station of Bent (c.c. 9-18). Form: xxxx+xx.xxxx feet.

If the station of the Ahead bent is known (Normal Distance is unknown), that station should be entered in this space. The station may be of negative magnitude. If the station is not known, the Normal Distance must be given, and this space is left blank. If both the Station and Normal Distance are known, either one may be given in its proper place.

b. Normal Distance (c.c. 27-36). Form: xxxxxx.xxxx feet.

If the Normal Distance from the Back bent to the Ahead bent is known (Station of Bent is unknown), that distance should be entered in this space. The distance should always be positive since the Ahead bent is ahead of the Back bent by definition. If the Normal Distance is not known, the Station of Bent is given, and this space is left blank.

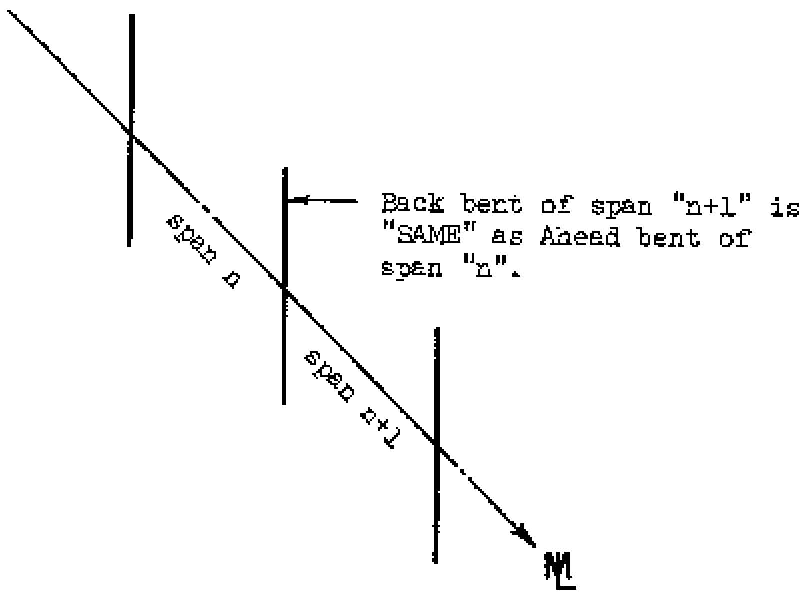


"PREV" Bent (Use to define Ahead bent only)

5. "SAME" Bent

The SAME type bent can only be used to define the Back bent (B in c.c. 1). This code indicates that the Back bent is identical to the Ahead bent of the previous span. Therefore, this code cannot be used to define the Back bent of the first span of the problem, i.e., there is no previous span of that problem. The only input data required are the Longitudinal Line Skips and Type Code (SAME). The other input data (RLG Intersect Code, Bent Number, Remarks, etc.) are not required.

The SAME Type Code can be used even though a new set of longitudinal lines may have been defined immediately before the Span Data, i.e., the previous Ahead bent is not affected. The Longitudinal Line Skips are required since the previous Ahead bent skips may not be valid.



"SAME" Bent (Use to define Back bent only)

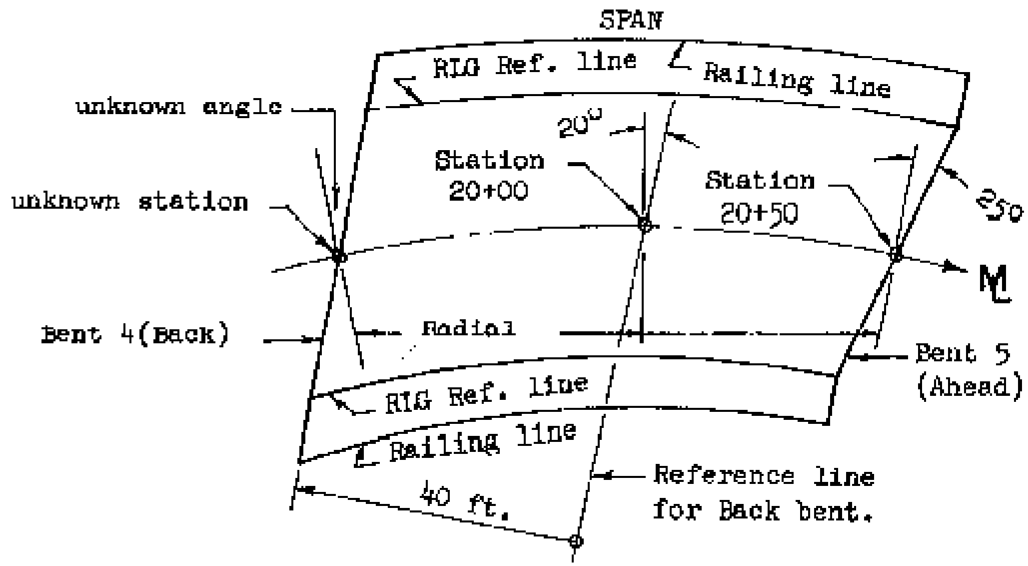
SUMMARY OF BENT INPUT DATA

Card Columns	TYPE Code (c.c.5-8) and Input Data SKEW	PARL	PSTA	PREV	SAME
2	RLG INT. Code	RLG INT. Code	RLG INT. Code	RLG INT. Code	
3,4	Bent Number	Bent Number	Bent Number	Bent Number	
9-18	Station of Bent	Station of Reference Line	Station of Reference Line	Station of Bent if Normal Distance is unknown	
19-26	Skew Angle of Bent	Skew Angle of Reference Line	Skew Angle of Reference Line		
27-36		Normal Distance from Reference Line	Station of Bent	Normal Distance if Station of Bent is unknown	
37-50	Remarks	Remarks	Remarks	Remarks	
51-80	Longitudinal Line Skips	Longitudinal Line Skips	Longitudinal Line Skips	Longitudinal Line Skips	Longitudinal Line Skips

BENT DATA

EXAMPLE 8-1. SKEW, PARL

This example shows the input data that is required to define a "SKEW" and "PARL" type bent. The Skew Angle and Station of the Back bent are unknown; however, this bent is parallel to a line that has a known (given) Skew Angle and Station. Therefore, the Back bent will be defined as "PARL" since the Normal Distance is known. Note that the Normal Distance is negative, i.e., Station of Bent is less than Station of Reference Line. The Skew Angle and Station of the Ahead bent are known (given); therefore, the Ahead bent can conveniently be defined as a "SKEW" bent. The Railing longitudinal lines and their reference line are shown for the purpose of illustrating the RLG Intersect Code. Note that the Back bent is coded (RLG Intersect Code = 1) to extend straight and intersect the Railing line. Bent 5 (Ahead) has been coded (RLG Intersect Code left blank) to turn radially at the reference line of the Railing and extend to intersect the Railing. Any other type (not Railing) of longitudinal line, whether located between the Railing line and its reference line or not, is intersected with the bent extended straight (no turn). Note that both bents have been coded to skip the intersection with longitudinal line four (4). This is done by entering the digit one (1) in card column 54 of the Longitudinal Line Skips. The input data is shown below on the input form.



FORM OF INPUT

USE DIGIT 1 FOR RLG INT. CODE

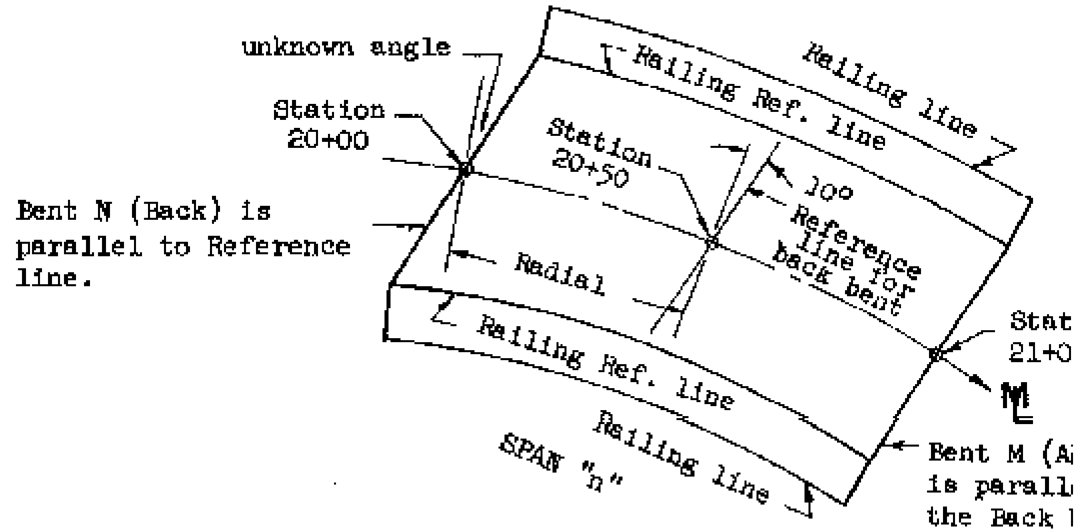
← USE THIS FORMAT FOR "SKEW" CODE.
USE THIS FORMAT FOR "PSTA" OR "PARL" CODES.

1	2	BENT NO. (3)	TYPE CODE (5)	STATION OF BENT / STATION OF REFERENCE LINE (9)	SKEW ANGLE OF BENT / SKEW ANGLE OF REFERENCE LINE (18, 22, 24)	STA. OF BENT "PSTA" / NORMAL DIST. IF "PARL" (27)	REMARKS (37–50)	LONGITUDINAL LINE SKIPS 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
B	1	4	PARL	20+00.0000	-20 00 00.0	-40.00000	BENT 4 BACK				1														
				STA. OF BENT IF "PREV"	← OR →	NORMAL DIST. IF "PREV"																			
A		5	SKEW	20+50.0000	-25 00 00.0		BENT 5 AHEAD				1														

BENT DATA (continued)

EXAMPLE 8-2. PSTA, PREV.

This example shows the input data that is required to define a "PSTA" and "PREV" type bent. The Skew Angle of the Back bent is unknown; however, this bent is parallel to a line that has a known Station and Skew Angle (given). Therefore, the Back bent can be defined as "PSTA" since the Station of the bent is known (given). The Ahead bent is at a known Station (given) and parallel to the Back bent. Therefore, the Ahead bent can be defined as a "PREV" bent. The input data is shown on the input form below.



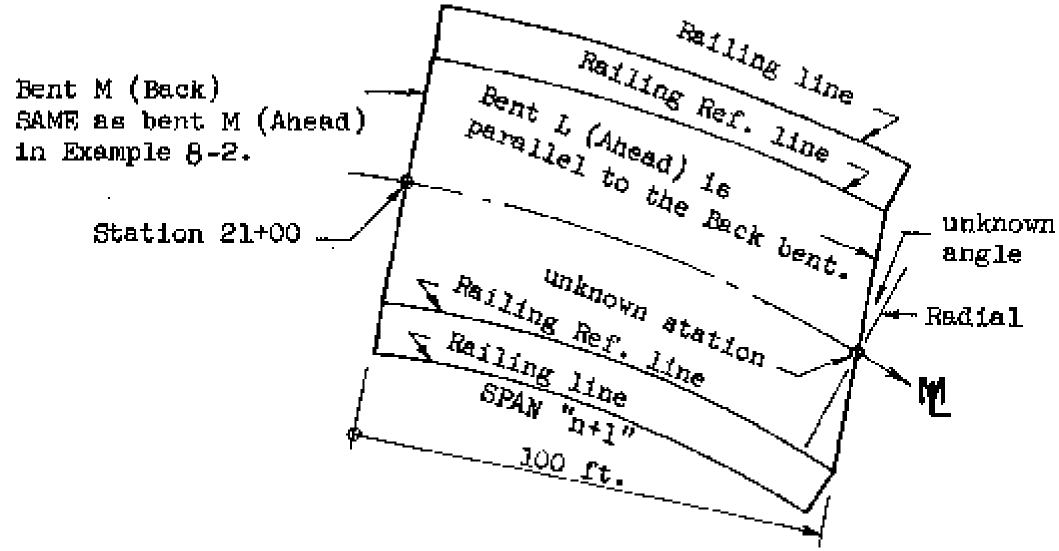
FORM OF INPUT

←USE THIS FORMAT FOR "SKEW" CODE.
USE THIS FORMAT FOR "PSTA" OR "PARL" CODES.

USE DIGIT 1 FOR RLG INT. CODE	BENT NO.	TYPE CODE	STATION OF BENT / STATION OF REFERENCE LINE	SKEW ANGLE OF BENT / SKEW ANGLE OF REFERENCE LINE	STA OF BENT "PSTA" NORMAL DIST. IF "PARL"	REMARKS	LONGITUDINAL LINE SKIPS 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
1 2	3	6	9	10 22 24	27	37 50	51 56 60
B	N	PSTA	20+50.0000	-10 00 00.0	2000.0000	BENT N C.L.	
			STA.OF BENT IF "PREV"	← OR →	NORMAL DIST. IF "PREV"		
A	M	PREV	21+00.0000			BENT M C.L.	

EXAMPLE 8-3. SAME, PREV

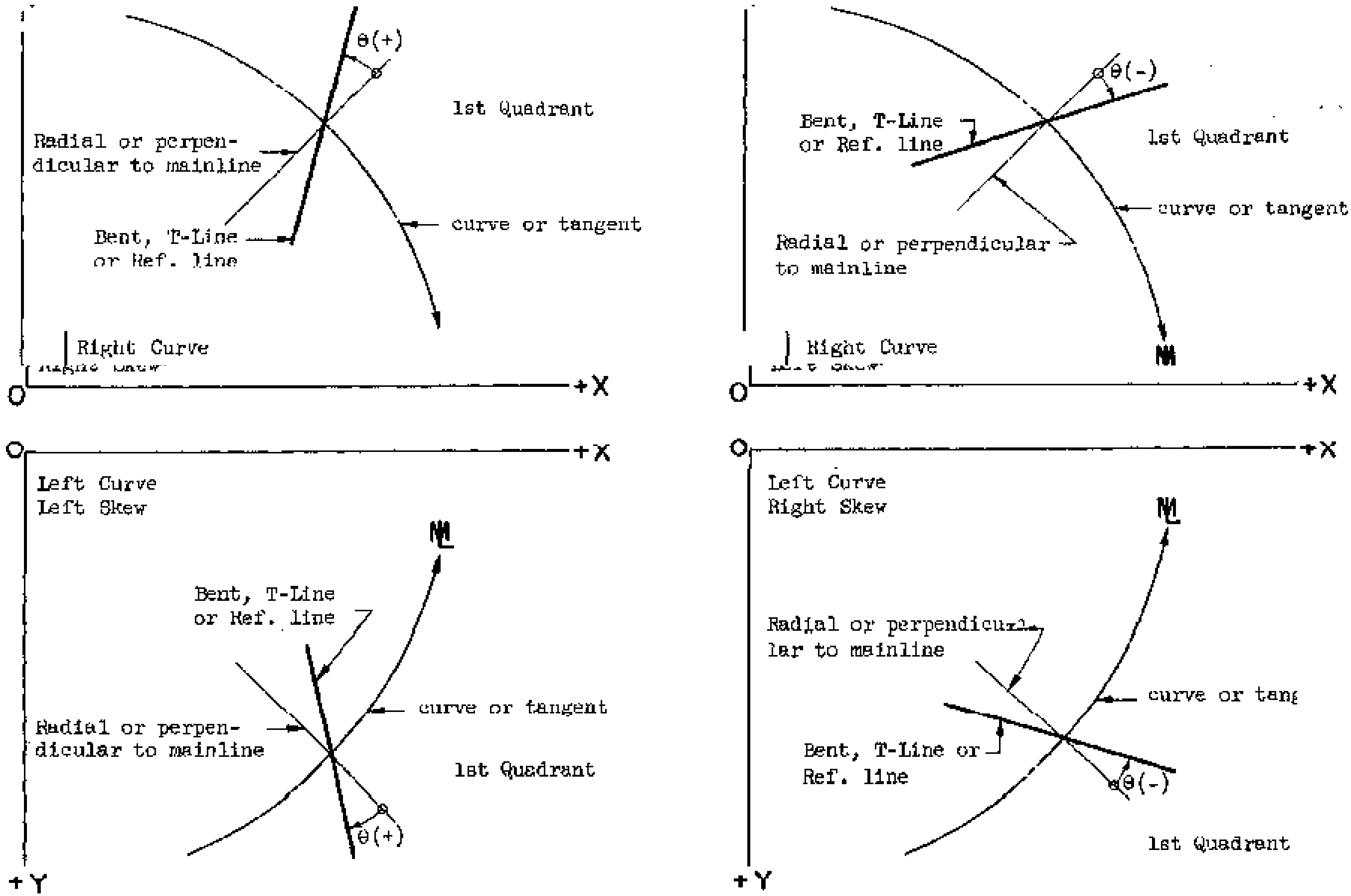
This example shows the span (n+1) immediately after the span (n) of Example 8-2. Since the Back bent of this span (n+1) has already been defined as the Ahead bent of span "n", this bent can be assigned as the Back bent of this span (n+1) by using the "SAME" code. The only other data that is required with the "SAME" code is the Longitudinal Line Skips. The Ahead bent is parallel to the Back bent, but the Station and Skew Angle are unknown. However, the Normal Distance from the Back bent is known (given) and, therefore, the Ahead bent can be defined as a "PREV" type bent. Note that the Normal Distance is positive, i.e., the Ahead bent station is greater than the Back bent station. The input data is shown on the input form below.



FORM OF INPUT

USE DIGIT 1 FOR RLG INT. CODE — USE THIS FORMAT FOR "SKEW" CODE. — USE THIS FORMAT FOR "PSTA" OR "PARL" CODES.

(1)	BENT NO. (3)	TYPE CODE (5)	STATION OF BENT / STATION OF REFERENCE LINE (9)	SKEW ANGLE OF BENT / SKEW ANGLE OF REFERENCE LINE (19, 22, 24)	STA. OF BENT "PSTA" / NORMAL DIST. IF "PARL" (27)	REMARKS (37–50)	LONGITUDINAL LINE SKIPS (51–68)
B		SAME	+ .	.	.		
			STA.OF BENT IF "PREV"	OR	NORMAL DIST. IF "PREV"		
A	L	PREV	+ .	.	100.0000	BENT L	



SKEW ANGLE (θ) SIGN CONVENTION

C. Transverse Lines (T-Lines).

Transverse lines are lines that normally run across the bridge and are not classified as bent lines. The program has the capacity for twenty such lines per span. T-Lines usually lie between the Ahead and Back bent. However, this is not a program requirement since the T-Lines are allowed to be outside the range of the span. Each T-Line along with the Ahead and Back bent will be intersected with each longitudinal line and the various data of each intersection point given in the output. T-Lines can be used to represent most any type of transverse line. Following is a list that shows several examples of T-Line usage, and the purpose for each usage.

1. Centerline of bearings

The finished grade elevations (output) at the centerline of bearings can be used for substructure elevations when adjusted for slab, beam depth, etc. During construction, these elevations can be used to check the top of beam elevation for any adjustment in the coping depth.

2. Diaphragms

The length, distance from bent, and angle between the diaphragm and various longitudinal lines, which are given in the output, can be used for detailing purposes.

3. Substructure lines

Other substructure lines can be used to compute elevations in order to obtain the substructure elevations, i.e., face of substructure cap. The face of the substructure cap in the case of the end bent can be used in many instances to assist in computing railing post spacings.

4. Construction joints

The finished grade elevations at the construction joints can be used by the field Engineer during construction to set screed elevations.

5. Splice points of beams

The finished grade elevations at the splice points can be used to determine beam slopes. This is particularly true if a continuous unit is used in a vertical curve or transition superelevation.

6. Span division lines

The span can be arbitrarily divided by lines in order to compute elevations for construction purposes, i.e., quarter points, third points, tenth points, etc.

7. Road underneath lines

The edge of paving, shoulder, etc. of the road underneath can be entered as a T-Line of the bridge above in order to assist in computing clearances.

The list of T-Line usage given on the preceding page is by no means a complete list. However, the lines listed are probably used most often, and they are listed for the purpose of illustrating how and why T-Lines are used.

The input data necessary to define each T-Line is entered on one line of the input form (an exception will be noted later). The SPAN DATA input form provides eleven input data lines for entering the T-Lines. If more than eleven T-Lines are going to be entered in any one span, additional lines can be attached to the bottom of the input form, or an additional SPAN DATA input form can be used to enter the additional T-Lines. However, when an additional input form is used, the Span Identification and Bent Data should be left blank on the second SPAN DATA input form of the span since a new span is not being defined, i.e., used solely to enter T-Lines. Note that when using an additional sheet for T-Lines, or attaching T-Lines to the bottom of the SPAN DATA input form, the Line Number (c.c. 2, 3) which is given on the input form will have to be changed so that two T-Lines will not have the same number, i.e., T-Lines must be defined in numerical sequence.

The letter "T" is required in card column one of each T-Line input data line. This is used by the program for identification purposes. A Line Number is required in card columns 2 and 3 of the input data lines. This number is assigned to the T-Line and will be associated with the output data of the T-Line. When more than eleven T-Lines are used per span, make sure that the letter "T" and the appropriate Line Number are entered on the additional T-Line input data lines. Note that the letter "T" and Line Number have already been entered on eleven lines of the input form. Following is the input data common to all types of T-Lines.

1. RLG Intersect Code (c.c. 36).

   The RLG Intersect Code for the T-Line functions in the same manner as the RLG Intersect Code for the bent lines. See the discussion on page 82 and the sketch on page 58. Note that the intersecting of a T-Line and any type of longitudinal other than a railing longitudinal line is found by extending the T-Line straight regardless of the position of that longitudinal line. When defining a "CONS" First Code T-Line, the RLG Intersect Code has no meaning and should be left blank.

2. Remarks (c.c. 37-50).

   This space is provided so that the user can enter any pertinent Remarks that describe the T-Line. The Remarks given here will appear in the output data to assist in the interpretation of the output.

3. Longitudinal Line Skips (c.c. 51-80).

   The Longitudinal Line Skips for the T-Lines function in the same manner as the Longitudinal Line Skips for the bent lines. See the discussion on page 82. Note that when an intersection is skipped, the output will contain no data relating to that point of intersection.

Two codes are used to indicate how the T-Line is going to be defined: First Code and Second Code. The First Code denotes how the direction or slope of the T-Line is defined, and the Second Code denotes how the position of the T-Line is going to be defined. There are five available First Codes. From one to three different Second Codes are available in conjunction with each First Code. Following is a list of the five First Codes and the Second Codes that are available with each.

First Code	Second Code
1. PARL	NORM
	DIST
	PROP
2. ANGL	DIST
	PROP
3. PTPT	DIST
	PROP
	COOR
4. SKEW	STAT
5. CONS	DIST
	PROP

From the above list, it can be seen that there are eleven possible combinations of First and Second Codes. For every T-Line that is defined, the user must decide how that line can be most conveniently defined. That is, what data is available to define the line and what Codes can best be used with the available data to define the T-Line. The five available First Codes are discussed in detail on the following pages. The required input data for each available Second Code is given in the discussion of each T-Line First Code. Examples of T-Lines defined on the input form are given on pages 110 to 113.

1. "PARL" T-Line

The "PARL" First Code defines a straight T-Line that is parallel to either the Ahead or Back bent. A T-Line cannot be defined as being parallel to any other type of line, i.e., another T-Line or reference line. A T-Line is designated as parallel to a bent when the Code "PARL" is entered in card columns 4-7 of the T-Line input data line. The position of the "PARL" T-Line can be defined by any one of three available options. The option or method that is used must be indicated by the Second Code. The three Second Codes and the required input data for each are as follows.

First and Second Code	Required Input Data
PARL/NORM	Reference Bent, Normal distance
PARL/DIST	Reference Bent, Distance, Reference Line
PARI/PROP	Reference Bent, Proportion, Reference Line

a. Reference Bent (c.c. 12). A or B

The Reference Bent indicates the bent to which the "PARL" T-Line is parallel. Therefore, this Reference Bent designation is always required with a "PARL" First Code, regardless of the Second Code that is used. Enter the letter "A" to indicate that the "PARL" T-Line is parallel to the Ahead bent, and the letter "B" is used to orient the "PARL" T-Line parallel to the Back bent. Any other character or number entered in this card column will cause an Error Message and terminate the processing of the problem. The program will not assign a bent by default when an invalid character is found.

b. Normal, Distance, or Proportion (c.c. 13-22).
Form: xxxxxx.xxxx feet or ratio.

The data entered in this space on the input form depends on the Second Code used with the "PARL" T-Line.

If the Normal distance from the bent to the T-Line is known, the Second Code can be given as "NORM" and the Normal distance entered in this space on the input form. The Normal distance can be given in either direction from either bent.

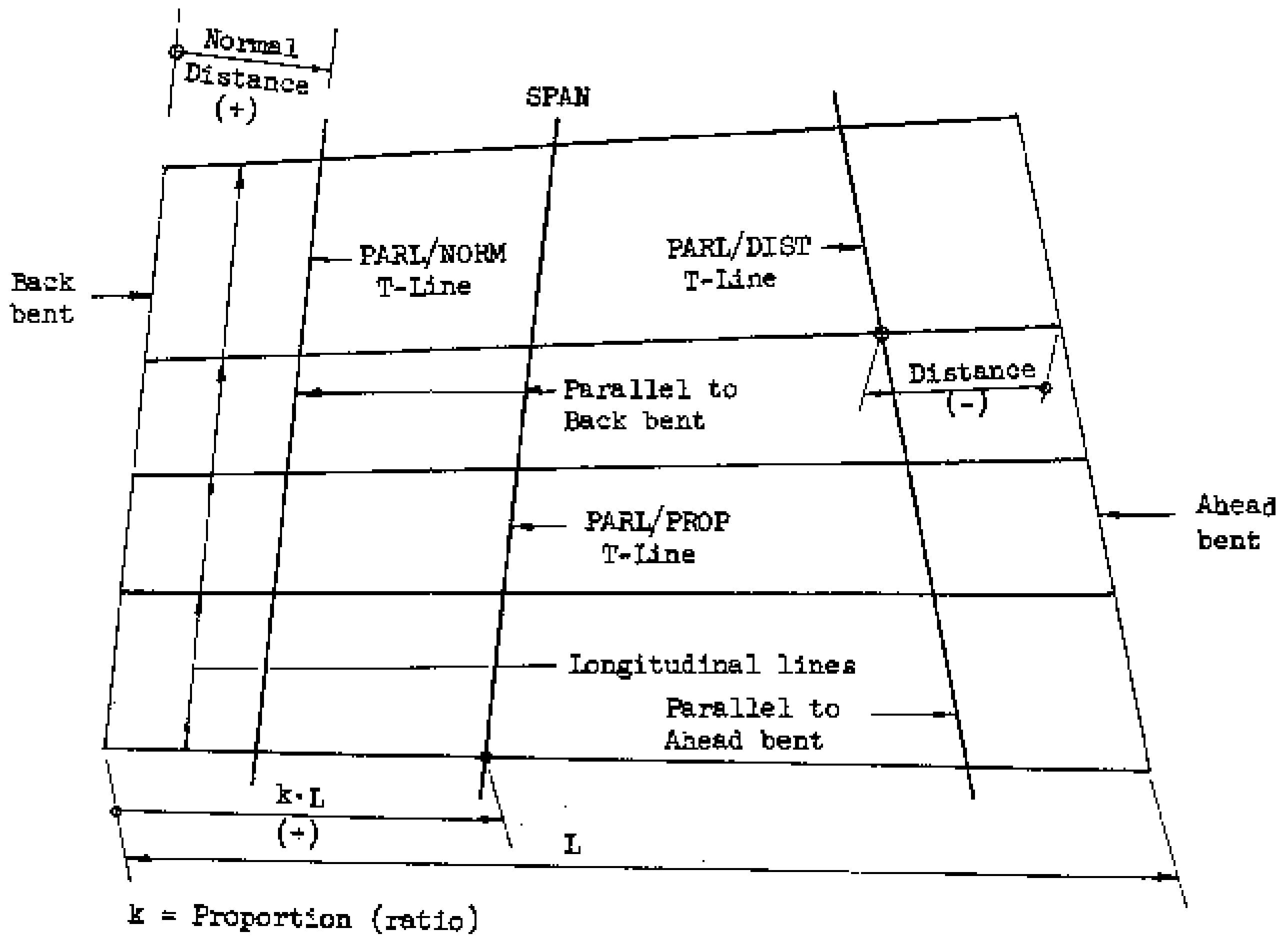
If the Distance, measured along a longitudinal line, from the bent to the T-Line is known, the Second Code can be given as "DIST" and the Distance entered in this space on the input form. This Distance can be measured in either direction from either bent and along any type of longitudinal line (curve or straight).

If the distance from the bent to the T-Line is to be a Proportion of the length (from the Back bent to the Ahead bent) of the longitudinal line that the distance is measured along, the Second Code can be given as "PROP" and the Proportion (ratio) entered in this space on the input form. The Proportion distance can be measured in either direction from either bent and along any type of longitudinal line.

C. Reference Line (c.c. 23, 24). Form: xx

If the Second Code is "DIST" or "PROP", the number of the longitudinal line that the Distance or Proportion distance is measured along must be entered in this space. If the Second Code is "NORM", this space should be left blank.

Card columns 25-35 should be left blank when defining "PARL" T-Lines. Following is a sketch showing "PARL" T-Lines and the sign convention for the various data.



"PARL" T-LINES

2. “ANGL” T-Line

The "ANGL" First Code defines a straight T-Line that is at a known angle with a longitudinal line. A T-Line cannot be defined as being at an angle with a curve longitudinal line, i.e., the longitudinal line must be straight. A T-Line is defined at an angle with a longitudinal line by entering the Code "ANGL" in card columns 4-7 of the T-Line input data line. The position of the "ANGL" T-Line can be defined by either one of two available options. The option or method that is used is indicated by the Second Code. The two Second Codes and the required input data for each are listed as follows.

First and Second Code	Required Input Data
ANGL/DIST	Reference Bent,Distance,Reference Line,Angle
ANGL/PROP	Reference Bent,Proportion,Reference Line,Angle

a. Reference Bent (c.c. 12). A or B

The Reference Bent is the bent from which the Distance or Proportion distance is measured to locate the "ANGL" T-Line. This Reference Bent is always required with a "ANGL" First Code, regardless of the Second Code. Enter the letter "A" to indicate that the "ANGL" T-Line is going to be located by measuring from the Ahead bent, and the letter "B" is used to designate that the distance (absolute or proportion) is measured from the Back bent. All other characters are invalid and will cause an Error Message and terminate the processing of the problem.

b. Distance or Proportion (c.c. 13-22). Form: xxxxxx.xxxx feet or ratio.

The data entered in this space of the input form depends on the Second Code used with the "ANGL" T-Line.

If the Distance (must be measured along a longitudinal line and from the Ahead or Back bent) from a bent to the T-Line is known, the Second Code can be given as "DIST" and the Distance entered in this column of the input form. However, the Distance must be along the same longitudinal line from which the Angle is going to be measured. Therefore, the Distance must be measured along a straight longitudinal line. However, the Distance can be measured in either direction for either bent.

If the distance from the Reference Bent to the T-Line is to be a Proportion of the length of the longitudinal line that the distance is measured along, the Second Code can be given as "PROP" and the Proportion (ratio) entered in this column of the input form. All other criteria is the same as for the "DIST" Second Code.

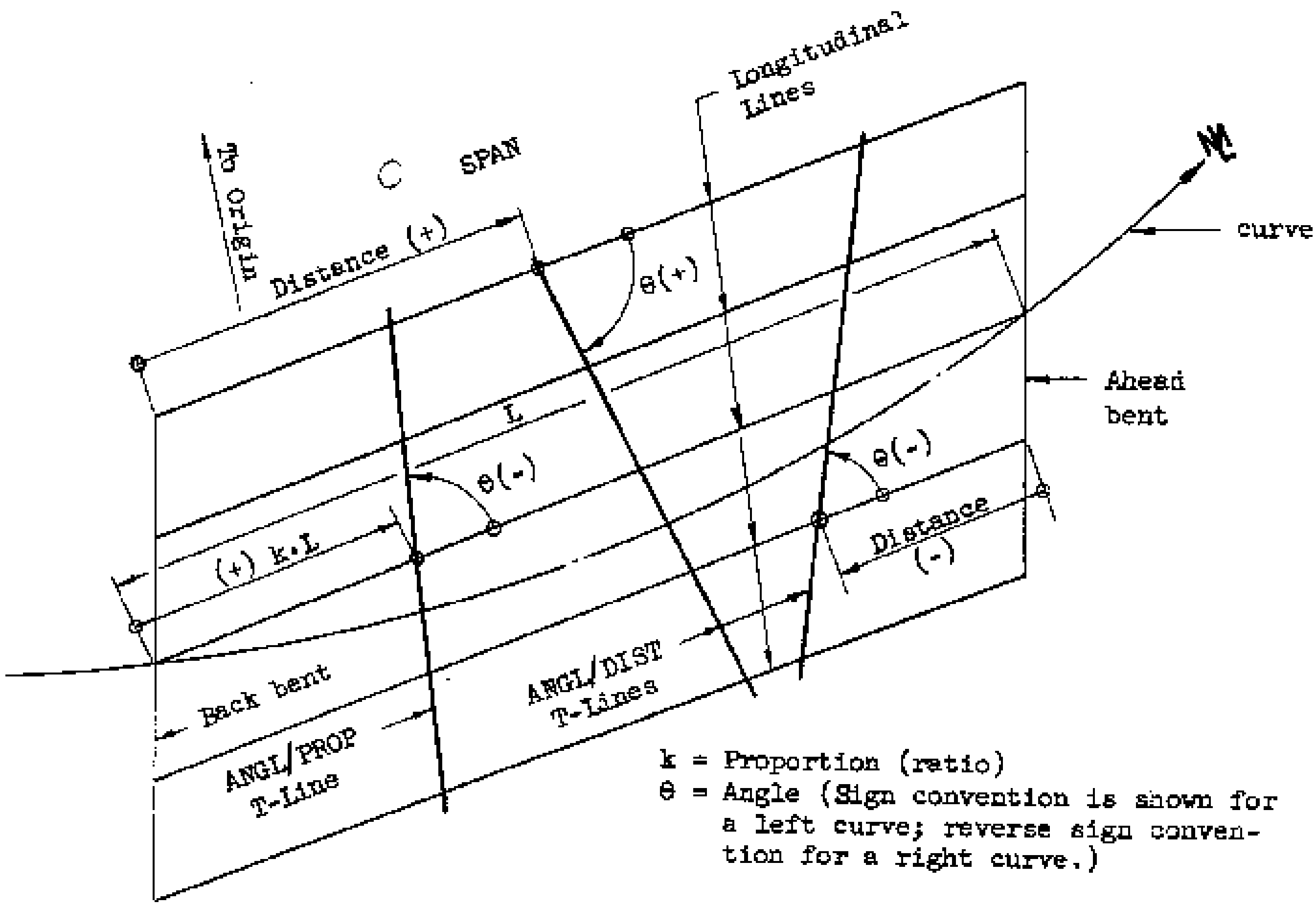
c. Reference Line (c.c. 23, 24). Form: xx.

The number of the longitudinal line along which the Distance or Proportion distance is measured, and from which the Angle is measured, should be entered as the Reference Line. Only the number of a straight longitudinal line is valid.

d. Angle (c.c. 25-32). Form: xxx deg.,xx min.,xx.x sec.

Enter in this space the Angle between the T-Line and the longitudinal line (Reference Line). This Angle should always be given in degrees, minutes and seconds (to tenths) and should always be measured from the same longitudinal line that the Distance or Proportion distance is measured along. The Angle should always be an acute (< 90 degrees) angle. However, the Angle may be of negative magnitude. Note that an Angle equal to zero makes the T-Line collinear with the longitudinal line and, therefore, a value of zero is invalid. Note that a dotted line on the input form separates the columns for degrees, minutes, and seconds.

Card columns (33-35) should be left blank when defining "ANGL" T-Lines. Following is a sketch showing "ANGL" T-Lines and the sign convention of the required input data.



"ANGL" T-LINES

3. "PTPT" T-Line

The "PTPT" (Point Point) First Code is used to indicate that the T-Line is going to be defined by identifying two points on the T-Line, i.e., a straight line between two points. Such a T-Line is indicated by entering "PTPT" in card columns 4-7 of the T-Line input data line. The two points, if not defined by coordinates, must be located on the longitudinal lines. The points that determine the T-Line can be defined by any one of three available options. The option or method that is used is indicated by the Second Code. The three Second Codes and the required input data for each type are as follows.

First and Second Code		Required Input Data
PTPT/DIST	(Point 1)	Reference Bent,Distance,Reference Line
	(Point 2)	Reference Bent,Distance,Reference Line
PTPT/PROP	(point 1)	Reference Bent,Proportion,Reference Line
	(Point 2)	Reference Bent,Proportion,Reference Line
PTPT/COOR	(Point 1)	X-Coordinate, Y-Coordinate
	(Point 2)	X-Coordinate, Y-Coordinate

a. Reference Bent (c.c. 12 and c.c. 33). A or B

The Reference Bents are the bents from which the Distances or Proportion distances are measured in order to locate the points that define the T-Line. The Reference Bents are not required when defining a "COOR" Second Code T-Line since the input will actually be coordinates, i.e., independent of the Ahead or Back bent.

Each point (except coordinate point) is identified by measuring a Distance or Proportion distance from the Reference Bent (Back or Ahead bent) along a Reference Line (longitudinal line). Either point of the T-Line can be located from either bent. That is, each of the two points that define the "PTPT" T-Line is independent of the other. "A" is used to indicate that the point is located from the Ahead bent, and "B" is used to indicate that the point is located from the Back bent. Any character other than "A" or "B" will cause an Error Message and terminate the problem. Note that two Reference Bents (one-for each point) must be given. The Reference Bent (A or B) for point one is given in card column 12, and the Reference Bent (A or B) for point two is given in card column 33. Which point is designated as point one, or point two, is arbitrary.

b. Distance, Proportion, or X-Coordinate (c.c. 13-22).
Form: xxxxxx.xxxx feet or ratio.

The data entered in this space of the input form depends on the Second Code that is used with the "PTPT" T-Line.

If the points that define the T-Line are located by Distances from the Reference Bents (Ahead or Back) along the Reference Lines (longitudinal lines), the Second Code should be given as "DIST" and the Distance from the Reference Bent (c.c. 12) to point one given in this column of the input form. The Distance can be measured from either bent, in either direction, and along any type of longitudinal line.

If the distances from the Reference Bent to the points that define the T-Line are given as Proportions of the length (from the Back bent to the Ahead bent) of the Reference Lines (longitudinal lines), the Second Code should be given as "PROP" and the Proportion (ratio) for point one entered in this column of the input form. The Proportion distance can be measured from either bent, in either direction, and along any type of longitudinal line.

If the T-Line is defined by the coordinates of two points, the Second Code should be given as "COOR" and the X-coordinate of point one entered in this column of the input form.

C. Reference Line (c.c. 23, 24 and 34, 35). Form: xx

If the Second Code is "DIST" or "PROP", the number of the longitudinal line (Reference Line) on which each point is located must be given in these input data columns. The number of the longitudinal line on which point one is located is given in card columns 23 and 24, and the number of the longitudinal line on which point two is located is given in card column 34 and 35. Note that both points of a "PTPT" T-Line cannot be located on the same longitudinal line.

If the Second Code is "COOR", these columns should be left blank, i.e., the coordinate input data is independent of the longitudinal lines.

d. Distance, Proportion, or Y-Coordinate (c.c. 25-32).
Form: xxxx.xxxx feet or ratio.

The data required in this column depends on the Second Code and the data that is entered in card column 13-22, i.e., the same type of data should be entered in this column that was entered in card columns 13-22.

If the Second Code is "DIST", the Distance (along the longitudinal line given in card columns 34, 35) from the Reference Bent (c.c. 33) to point two should be entered in this column of the input form. This Distance can be measured from either bent, in either direction, and along any type of longitudinal line.

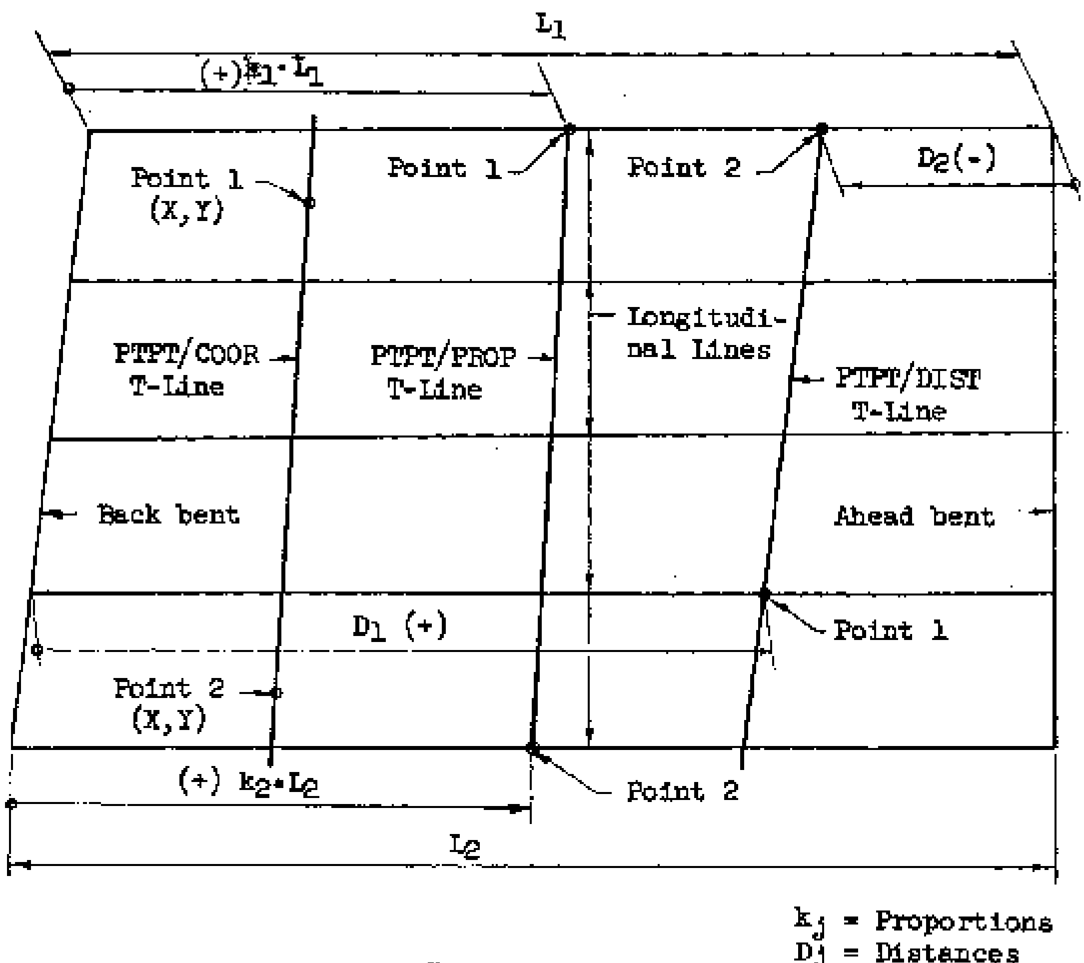
If the Second Code is "PROP", the Proportion used to locate point two should be entered in this column. This Proportion distance can be measured from either bent, in either direction, and along any type of longitudinal line.

If the T-Line is defined by coordinates, the Y-Coordinate of point one should be entered in this column of the input form.

If the T-Line is defined by coordinates, an additional input line is required to enter the coordinates of point two. The X and Y Coordinates of point 2 are entered in the same card columns of the second line that was used to enter the coordinates of point one, i.e., the X-Coordinate is entered in card columns 13-22, and the Y-Coordinate is entered in card columns 25-32. It is suggested that the blank space between the input lines be used to enter these coordinates. The only other data required in the second coordinate input line is the letter "T" which should be put in card column one. However, the next T-Line input data line can be used to enter the coordinates of the second point. But, if additional T-Lines are used, the Une Number (c.c. 2, 3) must be adjusted on the subsequent T-Lines, i.e., the two lines required to enter the coordinates of the two points define only one T-Line.

Following is a sketch showing the "PTPT" T-Lines.

SPAN



"PTPT" T-LINES

4. "SKEW" T-Line

The "SKEW" First Code defines a straight T-Line that is at a known Station and Skew Angle with the mainline. Therefore, the "SKEW" T-Line is completely independent of the bent and longitudinal lines. There is only one type of "SKEW" T-Line available, and the Second Code for this T-Line is "STAT". Actually, since there are no alternate Second Codes, the "STAT" Second Code is not required. The required input data is as follows.

First and Second Code	Required Input Data
SKEW/STAT	Mainline Station of T-Line,Skew Angle of T-Line

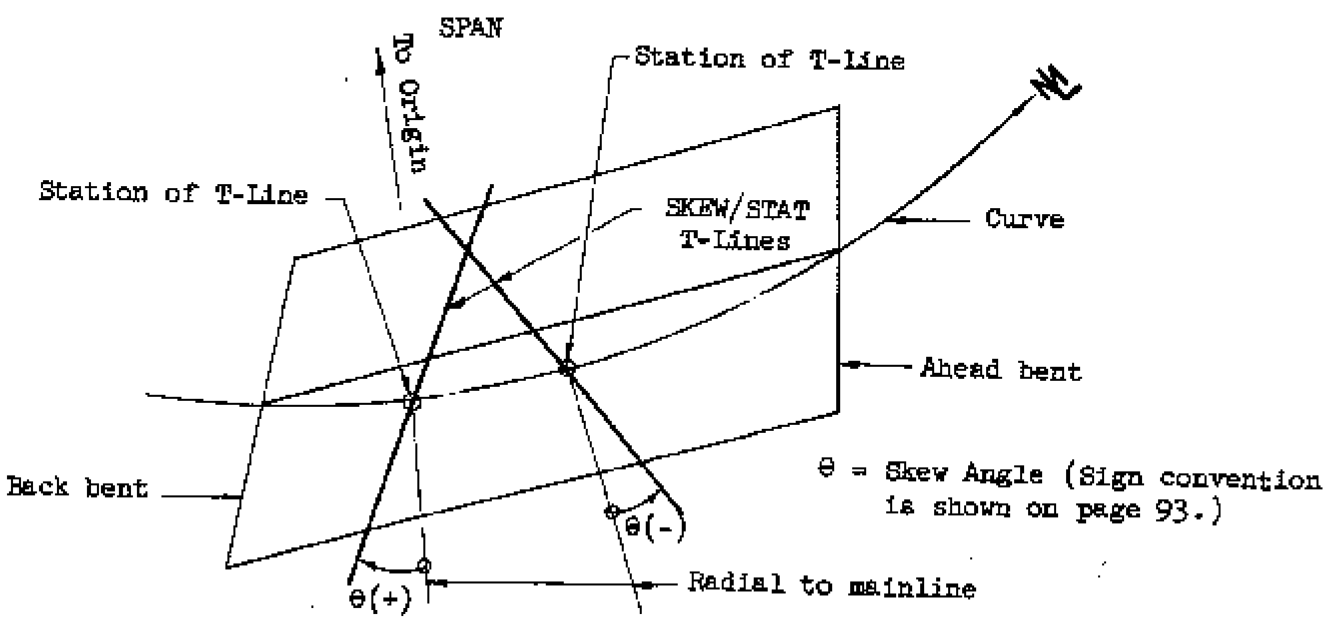
a. Station (c.c. 13-22). Form: xxxx+xx.xxxx feet.

The mainline Station of the intersection of the T-Line and mainline should be given in this column. The Station may be of negative magnitude.

b. Skew Angle (c.c. 25-32). Form: xxx deg.,xx min.,xx.x sec.

The Scew Angle that should be entered in this column of the input form is the angle between a line radial (or perpendicular) to the mainline, at the Station of the T-Line, and the T-Line. The Skew Angle is given in degrees, minutes and seconds (to tenths). Note that a dotted line on the input form separates the degree, minute, and second columns. The sign convention for the Skew Angle is the same as for the bents.

Card columns 12, 23, 24, 33-35 should be left blank when defining it SKEW" T-Lines. Following is a sketch showing the "SKEW" T-Line.



"SKEW" T-LINE

5. "CONS" T-Line

The "CONS" T-Iiines are not straight lines but rather a series of points that may or may not lie in a straight line. These points are located on the longitudinal lines. Each It “CONS” T-Line locates one point on each longitudinal line that has been defined. The locations of the points are determined by a given Distance, or Proportion ratio for distance, from either the Ahead or Back bent. The Distance or Proportion is constant to all points. Note that although the Proportion remains constant for all longitudinal lines, the actual distances (Proportion multiplied by the lengths of the longitudinal lines) from the bents to the points can vary since the length of the longitudinal lines (from bent to bent) may vary. If the actual Distance is given, the variation in the lengths of the longitudinal lines has no effect on the location of the points. Since the "CONS" T-Line is a series of points, the RLG Intersect Code is meaningless and should be left blank. Following is the input data requirements.

First and Second Code	Required Input Data
CONS/DIST	Reference Bent, Distance
CONS/PROP	Reference Bent, Proportion

a. Reference Bent (c.c. 12). A or B.

Enter the letter "A" if the Distance or Proportion distance is measured from the Ahead bent. The letter "B" will indicate that the Distance or Proportion distance is to be measured from the Back bent. All other characters are invalid, i.e., cause an Error Message.

b. Distance or Proportion (c.c. 13-22). Form: xxxxxx.xxxx feet or ratio.

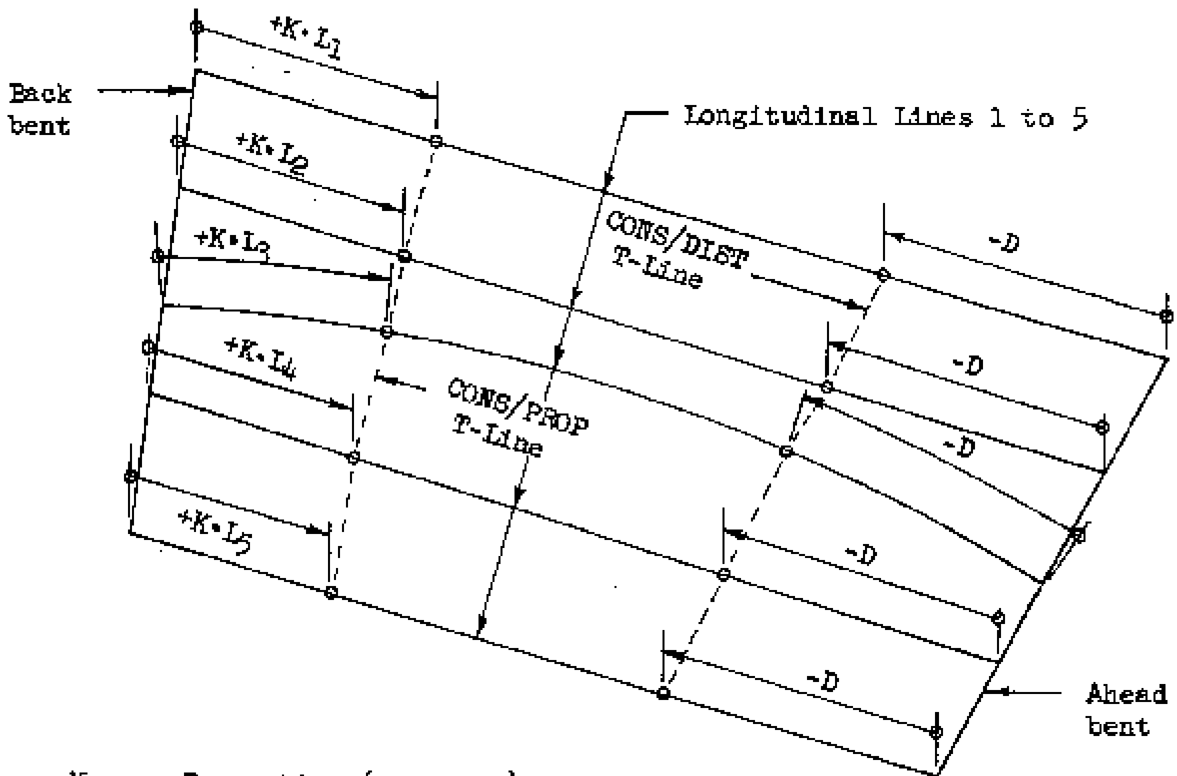
The data that is entered in this column of the input form depends on the Second Code used with the "CONS" T-Line.

If the Distance (constant for all longitudinal lines) measured along the longitudinal lines from the bent to the points is known, the Second Code can be given as "DIST" and the Distance entered in this column of the input form. This Distance can be measured in either direction from either bent and along any type of longitudinal line.

If the distance from the bent to each point is to be a Proportion of the length of the longitudinal line that the distance is measured along, the Second Code can be defined as "PROP" and the Proportion (ratio) entered in this column of the input form. This Proportion distance can be measured in either direction from either bent along any type of longitudinal line.

Card columns 23-36 should be left blank when defining "CONS" T-Lines. On the following page is a sketch showing the "CONS" T-Line and the sign convention of the input data.

SPAN



K = Proportion (constant)
D = Distance (constant)
L_j = Length of Longitudinal Line j from bent to bent.

<u>"CONS" T-LINES</u>

T-LINE INPUT DATA SUMMARY

Summary of "PARL" T-Line Input Data Requirements

First and Second Codes, and Input Data

Card Columns 4-11	PARL/NORM	PARL/DIST	PARL/PROP
12	Bent (A or B) to which the T-Line is parallel.	Bent (A or B) to which the T-Line is parallel.	Bent (A or B) to which the T-Line is parallel.
13-22	Normal distance from bent to T-Line.	Distance from bent to T-Line along a longitudinal line.	Proportion ratio for distance from bent to T-Line.
23,24		Number of longitudinal line that Distance is measured along.	Number of longitudinal line that Proportion distance is measured along.

Summary of "ANGL" T-Line Input Data Requirements

First and Second Codes, and Input Data

Card Columns 4-11	ANGL/DIST	ANGL/PROP
12	Bent (A or B) from which the Distance is measured.	Bent (A or B) from which the Proportion ratio for distance is measured.
13-22	Distance from bent to T-Line along a longitudinal line.	Proportion ratio for distance from bent to T-Line along a longitudinal line.
23,24	Number of longitudinal line that Distance is measured along, and from which the Angle is measured.	Number of longitudinal line that Proportion ratio for distance is measured along, and from which the Angle is measured.
25-32	Angle between longitudinal line and T-Line.	Angle between longitudinal line and T-Line.

Summary of "PTPT" T-Line Input Data Requirements

First and Second Codes, and Input Data

Card Columns 4-11	PTPT/DIST	PTPT/PROP	PTPT/COOR
12	Bent (A or B) from which the Distance to point 1 is measured.	Bent (A or B) from which the Proportion ratio for distance to point 1 is measured.	
13-22	Distance to point 1 along a longitudinal line.	Proportion ratio for distance to point 1 along a longitudinal line.	X-Coordinate of point 1 (first line) X-Coordinate of point 2 (second line)
23, 24	Number of the longitudinal line that the Distance to point 1 is measured along.	Number of the longitudinal line that the Proportion ratio for distance to point 1 is measured along.	
25-32	Distance to point 2 along a longitudinal line.	Proportion ratio for distance to point 2 along a longitudinal line.	Y-Coordinate of point 1 (first line) Y-Coordinate of point 2 (second line)
33	Bent (A or B) from which the Distance to point 2 is measured.	Bent (A or B) from which the Proportion ratio for distance to point 2 is measured.	
34, 35	Number of the longitudinal line that the Distance to point 2 is measured along.	Number of the longitudinal line that the Proportion ratio for distance to point 2 is measured along.	

Summary of "SKEW" T-Line Input Data Requirements

Card Column 4-11	First and Second Codes, and Input Data SKEW/STAT
13-22	Mainline Station of T-Line
25-32	Skew Angle of T-Line

Summary of "CONS" T-Line Input Data Requirements

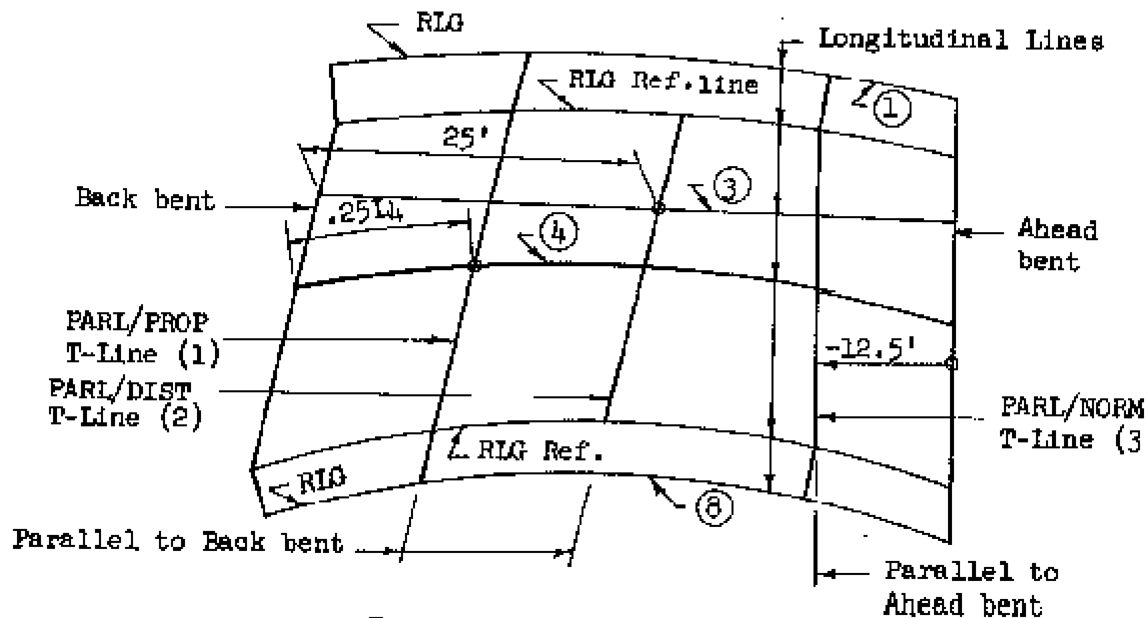
First and Second Codes, and Input Data

Card Column 4-11	CONS/DIST	CONS/PROP
12	Bent (A or B) from which the Distance is measured.	Bent (A or B) from which the Proportion ratio for distance is measured.
13-22	Distance from the bent to the various points on the longitudinal lines.	Proportion ratio for distance from the bent to the various points on the longitudinal lines.

T-LINES

EXAMPLE 9-1. PARL/DIST, PARL/PROP PARL/NORM

This example shows how the "PARL" T-Lines are defined. By definition these T-Lines are parallel to the Back or Ahead bent. T-Line 1 has been defined as a "PARL/PROP" T-Line that is parallel to the Back bent and located at one-fourth the distance from the Back bent to the Ahead bent along Longitudinal Line 4. Note that the length of Longitudinal Line 4 does not have to be known. In the Remarks, this line is identified as a construction joint. For the purpose of illustration, T-Line 1 has been coded to extend straight to intersect the Railing lines 1 and 8. T-Line 2 is a "PARL/DIST" T-Line that is parallel to the Back bent and located at a Distance of twenty-five feet from the Back bent along Longitudinal Line 3. This line is identified as a diaphragm in the Remarks column. Note that this T-Line has been coded to skip Longitudinal Line 1 and 8. T-Line 3 is a "PARL/NORM" T-Line that is parallel to the Ahead bent and located at a Normal Distance of 12'-6" from the Ahead bent. Note that this type of T-Line is independent of the Longitudinal Lines. T-Line 3 has been labeled a construction joint in the Remarks column. Following is the input data shown on the input form.



(n) = Longitudinal Line Number

L_4 = Length of Longitudinal Line 4 from the Back bent to the Ahead bent (unknown).

FORM OF INPUT

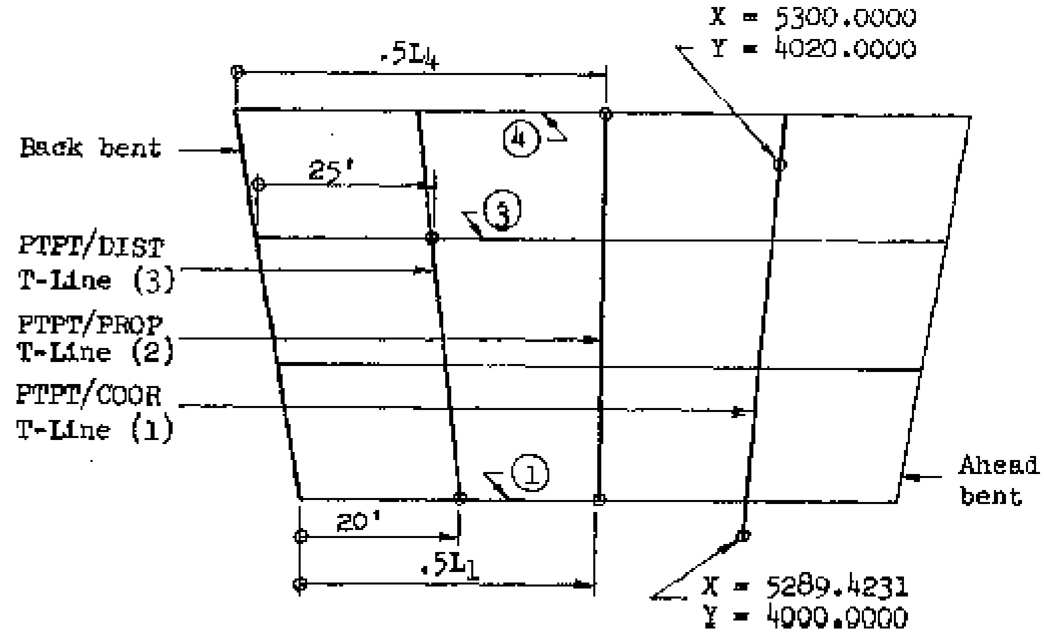
	REFERENCE BENT: LINE NO.	FIRST CODE	SECOND CODE		STATION or NORMAL or DISTANCE or PROPORTION or X COORDINATE	REFER. LINE	ANGLE or SKEW ANGLE or DIST. or PROPORTION or Y COORDINATE	REFERENCE BENT	REFER. LINE	USE DIGIT 1 FOR RLG INT. CODE	REMARKS	LONGITUDINAL 1	2	3	4	5	6	7	8	9	10	11	12
T	01	PARL	PROP	B	.2500	4				1	CONST. JT.												
T	02	PARL	DIST	B	25.0000	3					CENTER DIAPH.	1							1				
T	03	PARL	NORM	A	-12.5000						CONST. JT. 2												

STA. → NORM. or DIST. or PROP. or COOR. ← DIST. or PROP. or COOR. C.C. 61 55 60

T—LINES (continued)

EXAMPLE 9-2. PTPT/COOR, PTPT/DIST, PTPT/PROP

This example illustrates the "PTPT" T-Lines. This type of T-Line is defined by identifying two points on the T-Line. T-Line 1 (PTPT/COOR) is defined by giving the X and Y Coordinates of two points which were computed by some other means. These coordinates must be from the same axis system on which the bridge is oriented. Note that two T-Line input lines are used to enter the coordinates. This necessitates that the Line Number be changed on the following T-Line input lines. T-Line 2 is a "PTPT/PROP" T-Line that joins the midpoints of Longitudinal Line 1 and 4. T-Line 3 is a "PTPT/DIST" T-Line that is defined by a point located twenty feet from the Back bent along Longitudinal Line 1, and a point located twenty-five feet from the Back bent along Longitudinal Line 3. The input data for all three T-Lines is shown on the input form below.



(n) = Longitudinal Line Number

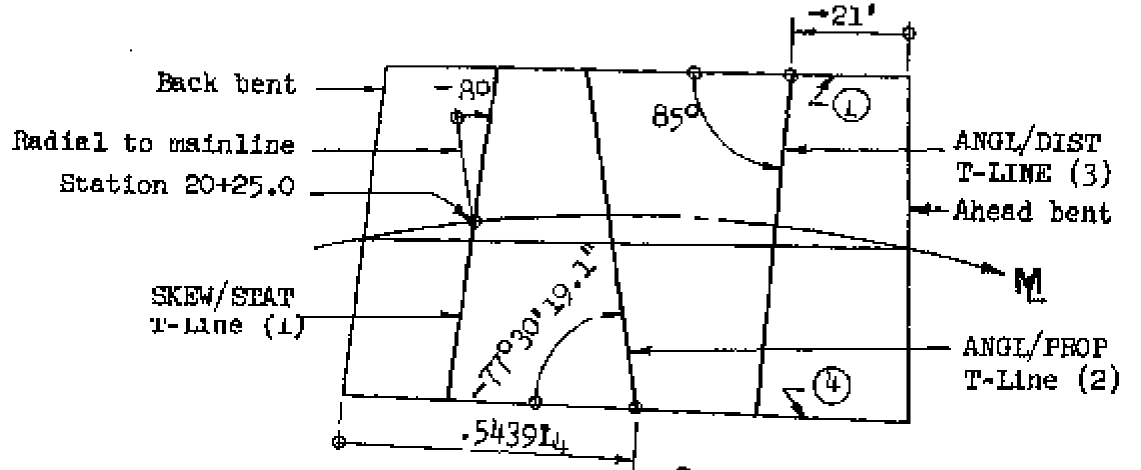
L_n = Length of Longitudinal Line n from the Back to the Ahead bent.

FORM OF INPUT

	Line No.	First Code	Second Code	Reference Bent	*Station or Normal or Distance or Proportion or X Coordinate	Refer Line	Angle or Skew Angle or Dist. or Proportion or Y Coordinate	Reference Bent	Refer Line	Use digit 1 for RLG Int. Code	Remarks	Longitudinal 1 2 3 4 5 6 7 8 9 10 11 12
T	01	PTPT	COOR		5300.0000		4020.0000				DIAPHRAGM 1	
					STA. / NORM. or DIST. or PROP. or COOR.		DIST. or PROP. or COOR.				C.C. 61 55 60	
T	02				5289.4231		4000.0000					
T	02	PTPT	PROP	B	.5000	4	.5000	B	1		DIAPHRAGM 2	
T	03	PTPT	DIST	B	20.0000	1	25.0000	B	3		DIAPHRAGM 3	

T-LINES (continued)

EXAMPLE 9-3. SKEW/STAT, ANGL/PROP, ANGL/DIST



(n) = Longitudinal Line Number

L_4 = Length of Longitudinal Line 4 from the Back to Ahead Bent.

The example shown here illustrates the "ANGL" and "SKEW" T-Lines. Transverse line 1 is defined as a "SKEW/STAT" T-Line. This line intersects the mainline at Station 20+25.0 and at an angle of 8° with a radial line. Transverse line 2 is an "ANGL/PROP" T-Line defined as being at an angle of 77°-30'-19.1" with Longitudinal Line 4, and at a Proportion (0.5439) of the length (from bent to bent) of Longitudinal Line 4 from the Back bent. Transverse line 3 is a "ANGL/DIST" T-Line defined by a Distance of twenty-one feet from the Ahead bent along Longitudinal Line 1, and at an angle of 85° with that same Longitudinal Line. The input data given in the sketch is shown on the input form below.

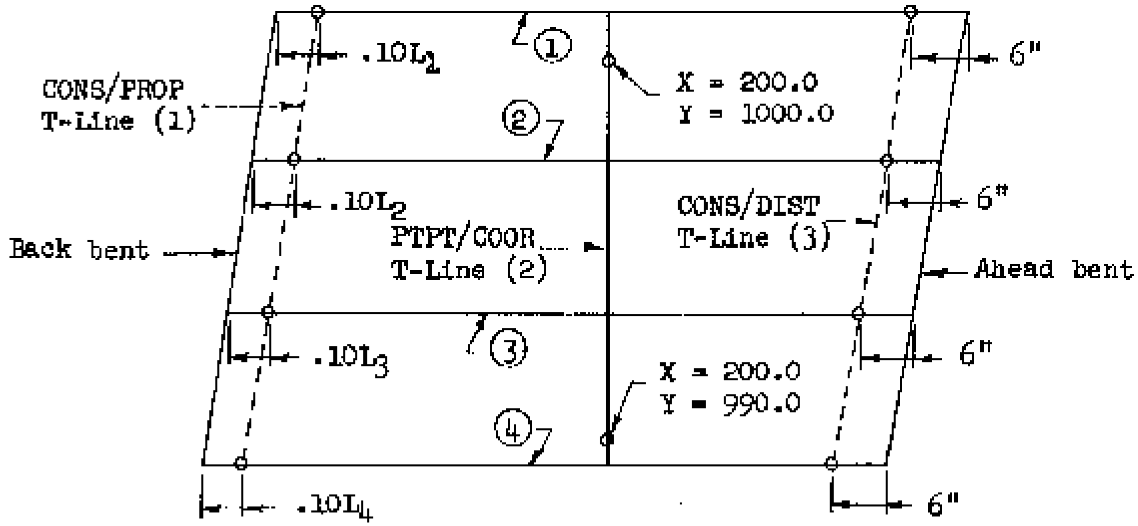
FORM OF INPUT

1	LINE NO (2)	FIRST CODE (4)	SECOND CODE (8)	REFERENCE BENT (12)	*STATION or NORMAL or DISTANCE or PROPORTION or X COORDINATE (13)	REFER. LINE (23)	ANGLE or SKEW ANGLE or DIST. or PROPORTION or Y COORDINATE (26, 28, 30)	REFER. LINE (34)	USE DIGIT 1 FOR RLG INT. CODE (36)	REMARKS (37–50)	LONGITUDINAL 1 2 3 4 5 6 7 8 9 10 11 12
T	01	SKEW	STAT		2025.0000		-8 00 00.0			SPLICE PTS. 1	
T	02	ANGL	PROP	B	.5439	4	-77 30 19.1				
T	03	ANGL	DIST	A	-21.0000	1	85 00 00.0			SPLICE PTS. 2	

STA. → + ; NORM. or DIST. or PROP. or COOR. ; DIST. or PROP. or COOR. ; C.C. 51 ; 55 ; 60

EXAMPLE 9 4. CONS/PROP, CONS/DIST, PTPT/COOR

This example shows how the "CONS" T-Lines are defined. The "PTPT/COOR" type T-Line is also shown. Transverse line 1 is defined as a "CONS/PROP" T-Line which will locate a series of points on the Longitudinal Lines at a Proportion of the length of each Longitudinal Line from the Back bent. If the lengths of the Longitudinal Lines vary, the distance from the Back bent to the points will vary since the Proportion remains constant. The T-Line shown here locates the first tenth point of each Longitudinal Line. Transverse line 2 is defined as a "CONS/DIST" T-Line which locates a series of points a Distance of six inches from the Ahead bent along each Longitudinal Line. Here the centerline of bearing of each beam at the Ahead bent is being located. T-Line 3 (PTPT/COOR) is shown here for the purpose of illustrating how the Coordinates of the second point can be entered on the input form between the T-Line input lines. The input data is shown below on the input form.



(n) = Longitudinal Line Number

L_n = Length of Longitudinal Line n from the Back to Ahead bent (unknown).

FORM OF INPUT

REFERENCE BENT LINE NO. (1–3)	FIRST CODE (4)	SECOND CODE (8)	(12)	*STATION or NORMAL or DISTANCE or PROPORTION or X COORDINATE (13)	REFER. LINE (23)	ANGLE or SKEW ANGLE or DIST. or PROPORTION or Y COORDINATE (25, 28, 30, 33)	REFERENCE BENT REFER. LINE (34)	(36)	USE DIGIT 1 FOR RLG INT. CODE — REMARKS (37–60)	LONGITUDINAL 1 2 3 4 5 6 7 8 9 10 11 12
T 01	CONS	PROP	B	1000					L. L. DIV. PTS.	
				STA. —+ NORM. or DIST. or PROP. or COOR.		DIST. or PROP. or COOR.			C.C. 61 65 60	
T 02	PTPT	COOR		2000000		10000000			CONSTRUCTION J	
T				2000000		9900000				
T 03	CONS	DIST	A	-5000					CL. BEARING 4	

COORDINATE TYPE INPUT

Tile COORDINATE input form is used to enter the coordinates of known points on the bridge. Therefore, the coordinate input must be computed by hand or by some other program. The program requires that the bridge and the coordinate input data be oriented on the same X and Y coordinate axis system. The Coordinate input data can be used in lieu of, or in conjunction with, the Span input data. That is, the program can compute the intersections of T-Lines and longitudinal lines of a span and then compute the various output data from Coordinate input data, or vice versa, all in the same problem. If the point defining input data consists solely of coordinates (no Span Data), the first Coordinate input sheet should follow the Longitudinal Line input data sheet. Although the longitudinal lines are not used when computing the output data for the coordinate input data, at least one longitudinal line must always be defined when using point defining input data that consists entirely of coordinates. When Coordinate and Span input data are used in the same problem, the sequence of the Coordinate and Span input data is immaterial.

The program has the capacity for related coordinate points to be grouped into units, analogous to the Span input data, by using two or more sheets of Coordinate input data. The program will skip to the beginning of a new page when a new unit (another input sheet) is given.

The COORDINATE input data form consists of two types of input data lines. They are: Coordinate Identification and Coordinate Point.

A. Coordinate Identification (8COOR in c.c. 1-5).

The Coordinate Identification is used to identify each unit of related points. This input line should always be filled in except in the following case. If more than thirty points are in a unit, a second Coordinate input sheet can be used to enter the remaining points after thirty points have been entered on the first Coordinate sheet. The Coordinate Identification of the second sheet of Coordinate input would be left blank.

The total Number of Points in the unit should be entered in card columns 10, 11. This number should not be zero nor greater than ninety-nine. Whenever the last unit of coordinates are entered, and no Span Data is to follow, the code "LAST" should be entered in card columns 13-16. This signifies that after processing the unit of coordinate points the problem is to be terminated. Any pertinent Remarks that describe the unit of coordinate points are entered in card columns 18-48. These Remarks will head the output listing of each unit.

B. Coordinate Point (CP in c.c. 1,2).

Each COORDINATE input form contains thirty (30) Coordinate Point input lines. The X and Y coordinates of each point are entered on one Coordinate Point input line. There is no limitation on the number of points that can be entered except that only ninety-nine are allowed per unit. However, any number of units may be used. A Sequence Number is given it card columns 3, 4. However, the sequence of the points is not checked by the program. This number will appear in the output data of each point.

1. Point Identification (c.c. 5-8).

This space is provided so that each point can be labeled with a short alphabetic or numeric code. This information will be given in the output data of each point. If the Sequence Number is sufficient to identify the point, this space can be left blank.

2. X-Coordinate (c.c. 9-18). Form: xxxxxx.xxxx feet.

Enter in this column the X-Coordinate of the point. This coordinate can be zero only when the Y-Coordinate is not zero.

3. Y-Coordinate (c.c. 19-28). Form: xxxxxx.xxxx feet.

Enter in this column the Y-Coordinate of the point. This coordinate can be zero only when the X-Coordinate is not zero.

4. Remarks (c.c. 29-48).

Enter in these card columns any pertinent Remarks that describe the point. These Remarks will be given in the output data of each point.

The output data of each point consists of the following information.

1. Sequence Number of point.
2. Station of point.
3. Finished grade elevation of point.
4. Distance (radial or perpendicular to mainline) from point to mainline.
5. X-Coordinate of point.
6. Y-Coordinate of point.
7- Point Identification.
8. Remarks.

IV. THE OUTPUT DATA

In the following discussion of The Output Data,, refer to the output data of one of the example problems. All dimensions (Distances), Stations, Elevations)and Coordinates are given in feet. Angles are given in degrees, minutes, and seconds (to tenths).

The output data will contain in addition to the data computed by the program, the input data given on the input data forms. This input data listing can be used to check against the data entered on the input forms and, in addition, used as a permanent part of the record of the problem. The first page of the output data is a listing of the layout Data which is given on the first page of the input data forms. Suitable headings are given so that this output is easily recognized. All blank numeric input data fields are listed as zero.

The second page of the output data is a listing of the Longitudinal Lines, also with headings. The heading "DR / Xl" indicates that the data in that column is a "∆R" dimension or X-Coordinate. The heading "STA./ Yl" identifies the data in that column as a Station or Y-Coordinate. The heading "TR / R / X2" indicates a Taper Rate, Radius, or X-Coordinate is listed in that column. The data listed in the columns of the headings mentioned above depends on the type of longitudinal line. Whenever more than one set of Longitudinal lines is used, the additional Longitudinal Lines are listed in the output data when they appear in the input data, i.e., immediately following the output data of the preceding span.

The input data of each span with headings is listed in the output data immediately preceding the computed output data for that span. The heading "STA./NORM." given in the Bent Data identifies the data in that column as a Station or Normal distance. The heading "S/N/D/P/X" given in the listing of the T-Line input data indicates that the data in that column is a Station, Normal distance, Distance, Proportion or X-Coordinate, depending on the type of T-Line being listed. The heading "A/S/D/P/Y" identifies the data in that column as an Angle, Skew angle, Distance, Proportion, or Y-Coordinate, again depending on the type of T-Line being listed.

THE SPAN OUTPUT DATA

The Span Output Data will contain the various computed data for each point of intersection of the longitudinal lines with the T-Lines. The first line of the Span Output will contain the Span Number and Problem Number for identification.

Bent Data

The Bent Data of the Span Output Data contains the Bent designation (A or B), Bent Number, Station, Skew Angle, Remarks, and Type for each of the two bents that defines the span. The Station of the bent is the station of the point of intersection of the bent with the mainline. The Skew Angle is the angle between a line radial to the mainline at the Bent Station and the bent line. The same sign convention applies to the output Skew Angle that applies to the input Skew Angles. If the Station and Skew Angle of the bent are not given in the input data, the program will compute this data. Therefore, the program can be used to compute bent Skew Angles and Stations when they are not otherwise known. The Bent Number, Remarks and Type are a repeat of the input data. The Bent designation "A" identifies the Ahead bent, and "B" identifies the Back bent. The Bent Data of the Back bent is listed first, and the data for the Ahead bent is listed immediately following.

Longitudinal Line Output

The data computed for the points of intersection of the bents and T-Lines with a longitudinal line is given in the output of that longitudinal line. The heading for the output of each longitudinal line will contain the Sequence Number, Type and Remarks that were given in the input data when defining the longitudinal line. Following is an example.

"LONG. LINE 4 CRD BEAM C"

The next line of the output data contains the headings for the data computed at the points of intersection of the bent and T-Lines with the longitudinal line.

All intersections with longitudinal line one (1) are listed first. The data for one intersection point is given on each line, and this data is listed immediately below the longitudinal line and data headings. The number of intersection points (lines) given in each longitudinal line output will depend on the number of T-Lines, and the number of T-Lines coded to skip that longitudinal line. For example, if T-Line two (2) has been coded to skip longitudinal line one (1), this T-Line will not appear in the output of longitudinal line one. The data for the Back bent intersection with the longitudinal line is listed first. Next, the data for the intersections of the T-Lines with the longitudinal line is given, and in the same order that the T-Lines were defined in the Span Data input. After the T-Line intersection data is listed, the data for the Ahead bent intersection with the longitudinal line is given. This process of listing the intersection point data for the Back bent, T-Lines, and Ahead bent with a longitudinal line is repeated for each longitudinal line beginning with longitudinal line one (1). Note that when a longitudinal line has been coded to be skipped (used as reference line only), the longitudinal line will not appear in the output data and, therefore, the intersection point data of the bents and T-Lines with that longitudinal line will be omitted in the output data. In contrast, when a T-Line is coded to skip a longitudinal line, only one intersection point is skipped in the output for each code used. For example, if T-Line two (2) is coded to skip only longitudinal line four (4), the intersection data of this T-Line with the other longitudinal lines will be given in the output data of those longitudinal lines.

The Distances, Stations, Elevations, and Coordinates listed in the output data are given to four decimal positions and have been rounded off to the nearest ten-thousandth. If the fractional part is exactly equal to zero, only one decimal position (a zero) is given. Beginning on the next page is a discussion of the data given in the output of each point of intersection of a T-Line or bent with a longitudinal line. The output data headings are shown in parentheses.

1. Transverse Line Notation (T-LINE).

The data for the intersection point of a T-Line or bent with the longitudinal line is given on one output data line. The T-Line Notation is used to identify the transverse line for which the data is given. The longitudinal line will have been noted in the longitudinal line heading. The letter "B" indicates the transverse line is a bent, and the letter "T" identifies a T-Line. In addition to the letter Code (B or T), the T-Line Notation will include the Bent Number or Line Number of the T-Line, whichever the case may be. Following is an example of the T-Line Notations. Assume that the intersection data being given is for longitudinal line two (2). Explanations are given in parentheses.

T-LINE	(Output data headings listed on this line.)
B 1	(Bent 1 (Back) intersection with longitudinal line 2 data.)
T 1	(T-Line 1 intersection with longitudinal line 2 data.)
T 2	(T-Line 2 intersection with longitudinal line 2 data.)
T 4	(T-Line 4 intersection with longitudinal line 2 data.)
B 2L	(Bent 2L (Ahead) intersection with longitudinal line 2 data.)

Note that T-Line 3 is not shown in the above example. This indicates that T-Line 3 was coded to skip the intersection with longitudinal line 2.

In order to locate the output data for the intersection of T-Line I with longitudinal line J, first locate the output data of longitudinal line J. Then find the Transverse Line Notation for T-Line I in the column headed by "T-LINE". The line on which the Transverse Line Notation (T I) is found contains the desired data.

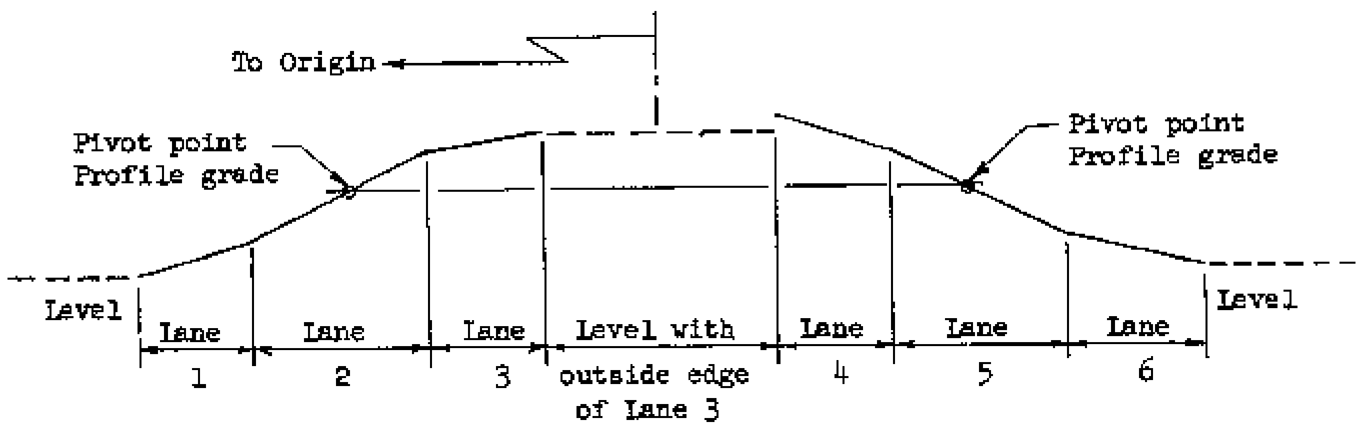
2. Station of Intersection Point (STATION).

The output data in this column is the station (measured along the mainline) of the point of intersection of the T-Line (or bent) with the longitudinal line. Since the point usually will not be located on the mainline, the mainline station is found by projecting the point radially (or perpendicular) to the mainline. Note that a plus sign (+) has been included in the station for clarity and consistence with normal practice.

3. Elevation of Intersection Point (ELEVATION).

The elevation listed in this column of output data is the finished grade (bridge surface) elevation of the point of intersection of the T-Line (or bent) with the longitudinal line. This elevation is computed by first determining the profile grade elevation of the station of the intersection point. Then the elevation is corrected for the bridge crown whether the crown is a parabola or superelevated (constant or transition).

If an asterisk appears with the elevation (immediately to the right), this denotes that the intersection point is not located within superelevated lanes or parabolic crown. If the point falls outside a parabolic crown, the elevation is the same as the elevation at the edge of the parabola, i.e., the crown is level from the edge of the parabola to the point. When a point is not located within the superelevated lanes, the elevation of the point is level with the edge of an exterior lane. Since lanes one, two, and three are adjoining, and lanes four, five, and six are adjoining, the point (if not located within a lane) must be located either between the origin and lane one, between lane three and four, or outside of lane six. If the point is located between the origin and lane one, the elevation is level with the inside edge of lane one. If the point is located between lanes three and four, the elevation is always level with the outside edge of lane three. If the point is located outside of lane six, the elevation is level with the outside edge of lane six. In the following sketch, the dotted lines show how the elevations are determined when points are not located within the superelevated lanes or parabolic crown.



SUPERELEVATION

If a point is located exactly on the inside edge of lane four, it is possible for the elevation of that point to be computed as if the point was between lane 3 and 4, i.e., level with the outside edge of lane 3. For example, the distance from the mainline to the inside edge of lane 4 is given as 15.0000 feet. An intersection point on this line may be computed by the program to be 14.99999999999999 feet (the program uses sixteen significant digits for all computations) from the mainline. In this case., the elevation of the point is level with the outside edge of lane three, i.e., the point is not located within the range of lane 4. However, this type of error presents no problem if the Engineer is aware of this possibility and adjusts the lane dimension in the input data.

The program assumes that the width of each lane of superelevation remains constant throughout the range of the problem and that the rate of superelevation is given radial (or perpendicular) to the lane. If the width of a lane actually varies, or for some reason the superelevation rate is not radial (or perpendicular) to the mainline, some elevations given in the output may have to be corrected. These corrections would depend upon their location.

4. Distance from Point to Mainline (DT TO ML).

The distance listed in this column is from the point of intersection of the T-Line (or bent) with the longitudinal line to the mainline. This distance is always measured on a radial or perpendicular line to the mainline depending on the type (curve or tangent) of mainline. If the distance is negative, the point is located on the origin side of the mainline; otherwise (positive), the point is located on the side of the mainline away from the origin. If the dimension is zero, the point is located on the mainline.

5. Distance from Point to Back Bent (DT TO BT).

The output data listed in this column is the distance from the point of intersection of the T-Line (or bent) with the longitudinal line to the Back bent. This distance is measured along the longitudinal line, regardless whether the longitudinal line is a curve or straight line, or a combination of both. If the distance is negative, this indicates that the point is back of the Back bent and located on the longitudinal line extended back from the Back bent (the point is not necessarily located on the same longitudinal line of the previous span). If the point is ahead of the Ahead bent, the point is located on the longitudinal line extended forward from the Ahead bent. This distance will be zero if the transverse line is the Back bent.

Note that the distance given for the Ahead bent intersection point will be the length of the longitudinal line from the Back bent to the Ahead bent. If the Ahead bent is coded to skip the longitudinal line, the length of the longitudinal line will not be listed in the output.

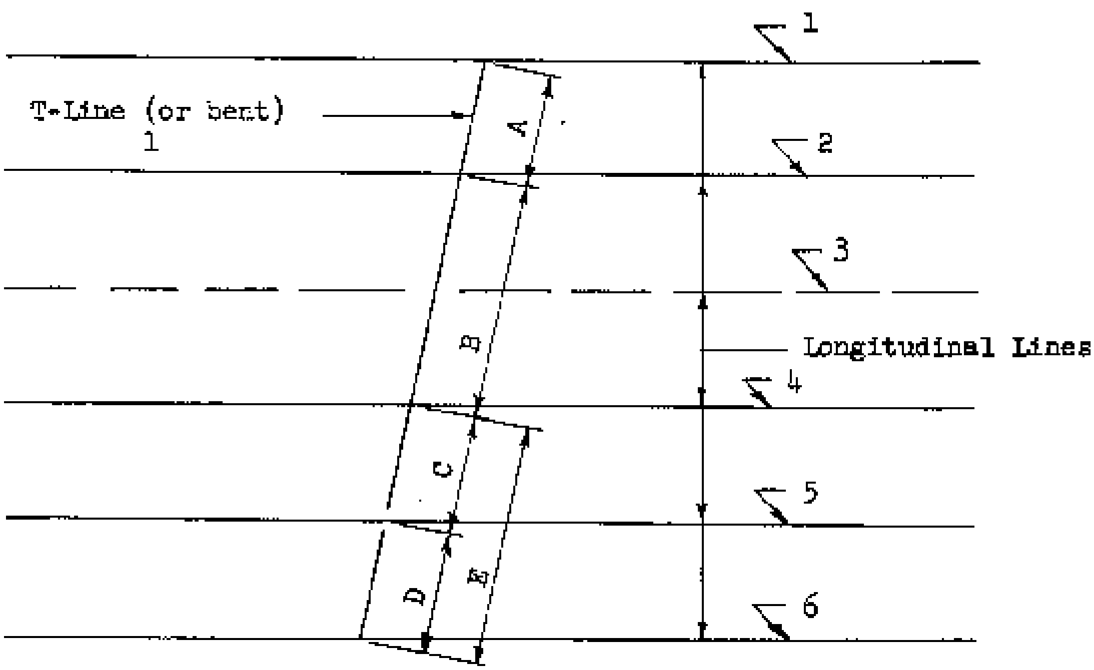
6. Distance from Point to Previous Point (DT TO PP).

This dimension is the distance from the point of intersection of the T-Line (or bent) with the longitudinal line to the point of intersection of the same T-Line (or bent) with the preceding longitudinal line. This distance, then, is measured along the T-Line (or bent) from longitudinal line to longitudinal line. All distances given for longitudinal line one are zero since in this case there is no preceding longitudinal line in the span.

If the T-Line is a "CONS/DIST" or "CONS/PROP" transverse line, this distance will be given a value of zero, since these types of T-Lines are actually a series of unrelated points and not necessarily a straight line. If the points fall on a straight line, then the "CONS" T-Line can be defined as some other type of T-Line, and the distance between the points would be given in the output.

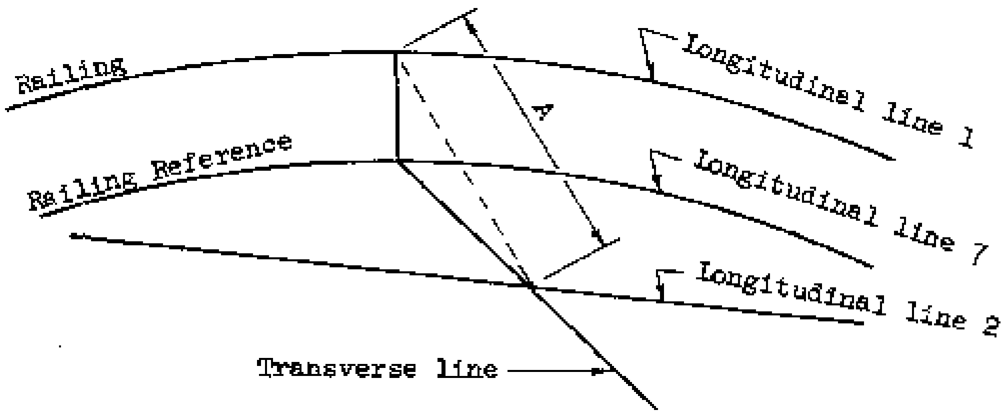
If the T-Line (or bent) has been coded to skip the preceding longitudinal line,, this "DT TO PP" dimension is given as zero. That is, the program will not compute the distance to the last point computed on that T-Line unless it is the point of intersection with the immediately preceding longitudinal line. Therefore, this dimension is the distance between adjacent longitudinal lines. However, if the preceding longitudinal line has been coded to skip all intersections (used as reference line only), the distance given will be to the point of intersection of the T-Line (or bent) with the longitudinal line preceding the longitudinal line that is skipped completely.

Following is a sketch showing the characteristics of this dimension.



given in the
output of longitudinal line two and four, respectively. Note that longitudinal line three has been coded to skip all intersections (used as reference only). The dimensions C, D or E are not computed since T-Line (or bent) one has been coded to skip longitudinal line five.

If the longitudinal line is a Railing and the transverse line is coded to intersect the Railing line by turning radially at the railing reference line, the "DT TO PP" dimension may be meaningless since the dimension may not be measured along the transverse line. In the sketch below the dimension A would be given in the output data of longitudinal line two if the transverse line is not coded to skip longitudinal line one or two. Note that the Railing reference line, which is located between longitudinal line 1 and 2, is defined out of location sequence as longitudinal line seven for illustration.



When the Engineer becomes more familiar with the above characteristics of this dimension, "DT TO PP", the sequence of the longitudinal lines, and the skips of the longitudinal or T-Lines (or bent) can be used more effectively. In no case should the first longitudinal line be coded to skip all intersections. It is suggested that all longitudinal lines so coded be defined last in the input data of the longitudinal lines.

7. Angle or Skew Angle (ANGLE).

The angle listed in this column of the output data depends on the type of transverse and longitudinal line. If the transverse line is a "CONS/DIST" or "CONS/PROP" T-Line, the angle is always given as zero, i.e., this type of T-Line is a series of points and not a straight line. For all other types of T-Lines (and bents) the angle depends on the type of longitudinal line. If the longitudinal line is straight at the point of intersection with the T-Line (or bent), the angle given in this column is the acute angle between the longitudinal line and the transverse line. When the longitudinal line is a curve at the point of intersection with the transverse line, the angle listed in this column is measured between a line radial to the longitudinal line at the intersection point and the transverse line, i.e., Skew Angle. However, if the longitudinal line is a Railing line and the transverse line is coded to turn radially at the Railing reference line and extend to intersect the Railing line, the angle is always given a value of zero for simplicity, i.e., the transverse line is always radial or perpendicular to the Railing line at the point of intersection.

The sign convention for an output Skew Angle is the same as the sign convention for a Skew Angle entered in the input data. An angle between the transverse and longitudinal line has the same sign convention as the angle required in the input data to define an "ANGL/DIST" or "ANGL/"PROP" T-Line.

8. X-Coordinate (X).

The X-Coordinate of the point of intersection of the transverse line with the longitudinal line is listed in this column of the output data. This coordinate is dependent on the orientation of the bridge given in the Location Data of the input data.

9. Y-Coordinate (Y).

The Y-Coordinate of the point of intersection of the transverse line with the longitudinal line is listed in this column of the output data. This coordinate is dependent on the orientation of the bridge given in the location Data of the input data.

10. Transverse Line Remarks (REMARKS).

The identifying remarks given in the input data of the transverse lines are listed in this column so that the intersection point can be easily recognized.

11. Transverse Line Type or Code (TYPE LINE).

This column contains the First and Second Code of a T-Line, or the Bent Type when the bent intersection point data is given.

This procedure of listing the data for the points of intersections of the transverse lines (Bents and T-Lines) with a longitudinal line is repeated for each longitudinal line beginning with longitudinal line one. After the last longitudinal line data is given, the processing of that span is complete, and the program proceeds to process any subsequent span or unit of coordinate input.

THE COORDINATE OUTPUT DATA

The output data given for the coordinate type input data is similar to the Span Output Data. The input data for each point is listed with the computed data for that point. The computed data output (Station, Elevation, DT TO ML) is the same as for the output data of the spans except that the point is defined by input data coordinates rather than by intersecting two lines. Note that the "Distance to Bent" and "Distance to Previous Point" dimensions and Angles are not given in this type of output since the coordinate points are not associated with any transverse or longitudinal lines.

V. ERROR MESSAGES

The program checks the validity of the procedure used to enter the input data and will print the following error message when an error is detected:

ERROR i PROB. NO. n

Where i is the error number and n is the number of the problem that was entered in the Identification Card.

Following is a list of the error numbers and the possible causes of each error.

ERROR NUMBER (i)	CAUSE OF ERROR
1	1. The first card of the problem does not contain an asterisk in c.c. 1. 2. An additional ID. card has been indicated but not found.
2	1. The Location Data card is missing or not in correct sequence. 2. The Reference Station is not in curve 2.
3	1. The Horizontal Curve Data card is missing or out of proper sequence. 2. The P.C. Station is ahead of the P.T. Station. 3. A degree-of-curve is negative.
4	1. The Vertical Curve Data station card is missing or in improper sequence.

ERROR NUMBER (i)		CAUSE OF ERROR
5	1.	The Vertical Curve Data grade and vertical curve length card is missing or out of correct sequence.
	2.	The length of a vertical curve is negative.
6	1.	The Crown and Lane Definitions card is missing or out of proper sequence.
	2.	The S.R. values are not in increasing sequence.
	3.	The inside lanes are not used and the outside lanes are used.
7	1.	The Superelevation Data card is expected but not found in proper sequence.
	2.	An illegal Superelevation Data Description code has been used.
	3.	The Description code does not contain "CONST" or "START" in the first Superelevation Data card.
	4.	More than ten Stations of transition superelevation are entered.
	5.	The last Description code of "FINIS" is missing when transition superelevation is being used.
	6.	The Stations of transition superelevation have not been entered in proper sequence.
8	1.	A Longitudinal Line card is missing or out of sequence.
	2.	An illegal Longitudinal Line Type Code has been used.
	3.	An illegal reference line has been used.
	4.	A Curve Taper Rate is zero (0).
	5.	More than thirty (30) Longitudinal Lines have been entered.

ERROR NUMBER (i)	CAUSE OF ERROR
8 (con'd)	6. An illegal Longitudinal Line skip has been used.
	7. The Control Station of a Curve Taper Longitudinal Line is not located in a mainline curve.
9	1. A "SPAN" or "COOR" type card is missing or out of proper sequence.
	2. The number of T-Lines is negative or greater than twenty (20).
10	1. The Back bent is not the first bent of the Span input.
	2. An illegal bent Type Code has been used.
	3. The "PREV" code has been used with the Back bent.
	4. The "SAME" code has been used with the Ahead bent.
	5. The "SAME" code is used with the first span of the problem.
	6. Bent A has not been found, or is out of proper sequence.
	7. An illegal "RIG INT" code has been entered.
11	1. A T-Line is expected but not found.
	2. A T-Line is out of sequence.
	3. An illegal First or Second Code has been found in a T-Line card.
	4. The Referenced Bent is not A or B in a T-Line card.
	5. An illegal Reference Line has been used in a T-Line card.
	6. An angle of zero magnitude has been used with an "ANGL" First Code T-Line.
	7. More than twenty (20) T-Lines have been defined.

ERROR NUMBER (i)	CAUSE OF ERROR
12	1. A "COOR" type card is expected but not found.
13	1. An elevation error has been found. A station computed by the program is behind the P.V.I.Z. Station. 2. A station computed by the program is outside the transition beginning and ending stations.
14	1. A Coordinate Point input card is missing. 2. The number of points in the "COOR" type card is in error.
15	1. The program has attempted to intersect two parallel lines. Check the Longitudinal and Transverse Lines. 2. An attempt has been made to intersect a straight line and circle that do not intersect. Check the Transverse Lines.
16	1. This error is caused by an internal date error, i.e., an error that should not have happened. The actual cause of this error is unknown.
17	1. A station has been found outside the Limiting Stations. Check the Limiting Stations, Bents, and Transverse Lines.

VI. EXAMPLE PROBLEM

Four Example Problems are given on the following pages for the purpose of illustrating the procedure used to enter the input data on the input forms. In addition to the input forms that contain the input data, a sketch of the bridge geometry and the output data will be given with each example. These problems do not represent an actual bridge structure. The examples are designed only to illustrate the numerous characteristics of the program.

Example Number One

Example 1 shows a two-span bridge located in a 30 curve. The four beams of each span are placed parallel to a centerline chord of that span, and the beams in the adjacent spans meet at a common point (concentric arc intersection) at the centerline of Bent 2. Bents 1 and 3 are parallel to Bent 2 and located by the known normal distances from Bent 2.

The Station of Bent 2 will be chosen as the Reference Point Station. Bents are placed parallel to the Y-axis by using a Reference Angle of 720. The Limiting Stations are arbitrarily chosen as 19+00 and 21+00. The roadway surface is at a constant rate of superelevation. The curb faces and sidewalks are set up as lanes of superelevation. This requires that six lanes of superelevation be defined. The Vertical Curve Data and dimensions for defining the lanes of superelevation are given in the sketch along with the superelevation rates.

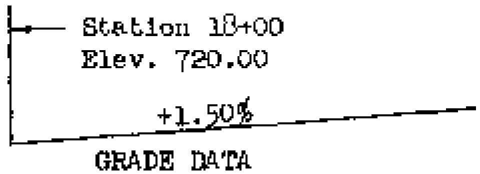
Two sets of Longitudinal Lines are defined in the problem. The beams of Span 1 are defined as PIA, and the beams of Span 2 are defined as PIB. Note that the centerline chord and beam lines are from the centerline of Bent 2 to the B.F.P.R. (Back Face Paving Rest) line of the end bents. The center lines of the railings are defined for the purpose of computing lengths for rail spacings. In addition, the finished grade elevations at the intersection of the railing lines with the bents will be given. Since the centerline chord and gutter lines are used only as reference lines in this problem, these lines are coded to be skipped in the output data.

The centerline-of-bearings and diaphragms are set up as T-Lines in each span. The diaphragms of Span 1 are located at the one-third points of the centerline chord. The positions of the diaphragms in Span 2 are detailed in the sketch. The centerline-of-bearings in Span 1 are defined as "CONS/DIST" T-Lines. In Span 2 the centerline-of - bearings are defined as "PARL/DIST” T-Lines. Note that in many instances a T-Line can be defined by several combinations of T-Line Codes.

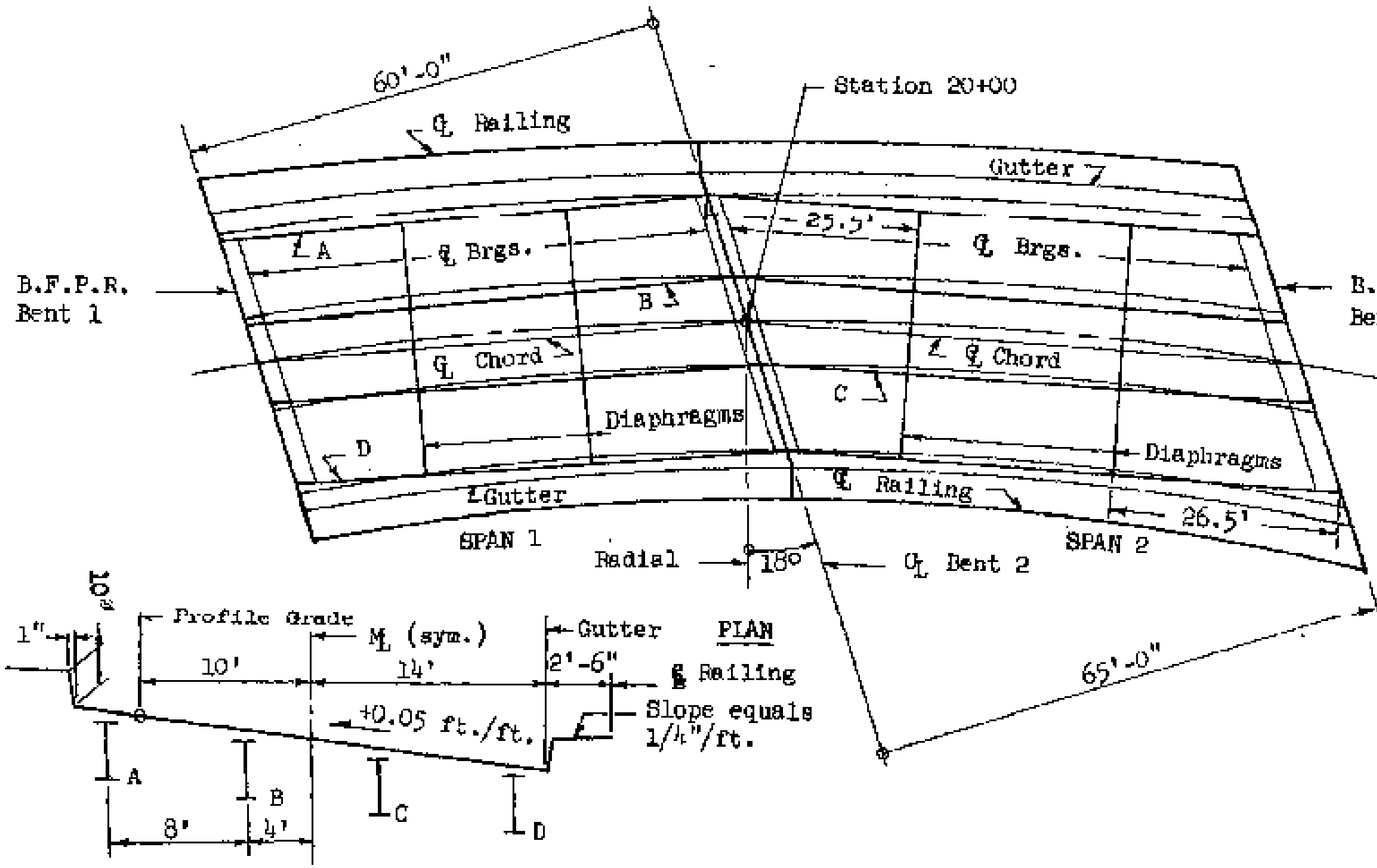
The purpose of this problem, in addition to the ones already stated, is to compute the following data.

1. Finished grade elevations at centerline-of-bearings.
2. Lengths of beams and diaphragms.
3. Position of diaphragms along each beam.
4. Distance between beams along bent lines.

EXAMPLE PROBLEM 1 (Continued)



The centerline-of-bearings are located 6 inches from the centerline of Bent 2 and 1'-6" from the B.F.P.R. of the end bents, along the beams.
Diaphragms are perpendicular to beams.
Beams are placed parallel to the centerline chord.
Beam spacings shown are concentric arc dimensions.
Entire bridge is in 3° curve.



CROSS SECTION

Example Number Two

Example 2 is a three-span bridge located on a tangent and 20 curve. Note that Span 1 is located entirely on a tangent; that Span 2 is located on the tangent and curve; and, that Span 3 is located entirely in the curve.

The Limiting Stations are chosen as 33+95 and 36+30. The P.C. Station is selected as the Station of Reference Point, and a Reference Angle of 450 is arbitrarily used. A value of 3,000 is assigned to the Reference Distance since the tangent portion will be defined as Curve No. 2. The 20 curve will be defined as Curve No. 3. Therefore, Curve No. 1 will not exist. The Vertical Curve Data is shown in the sketch.

In this problem, assume that the curb and railing lines are of no concern. Therefore, only one lane of superelevation is required to represent the bridge roadway. Since at least three lanes must be defined, lanes 1 and 3 will be given a zero width. lane 2 will be the roadway surface. The information required to define the lanes, and the superelevation transition, are given in the sketch of this example.

All beams (4) are placed on chords of concentric circles. The mainline arc is defined as a longitudinal line for use as a reference line and will be skipped in the output data. Note that if the distance measured along the bent lines from the mainline to the beams is desired in the output data, this longitudinal line should not be skipped.

The centerline-of-bearings and construction joints in each span are defined as T-Lines. The construction joint in Span 1 is located at mid-span. The construction joint in Span 2 is located at mid-span along the mainline and parallel to the adjacent bents. And, the construction joint in Span 3 is located on a line that connects the mid-points of the exterior beams.

The purpose of this problem is to compute the following data.

1. Finished grade elevations at centerline-of-bearings and construction joints.

2. Length of beam chords.

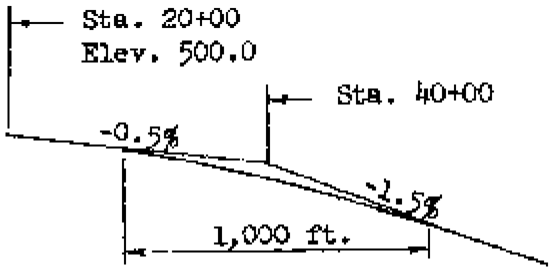
3. Position of construction joints along each beam.

4. Distances between beams along bent lines.

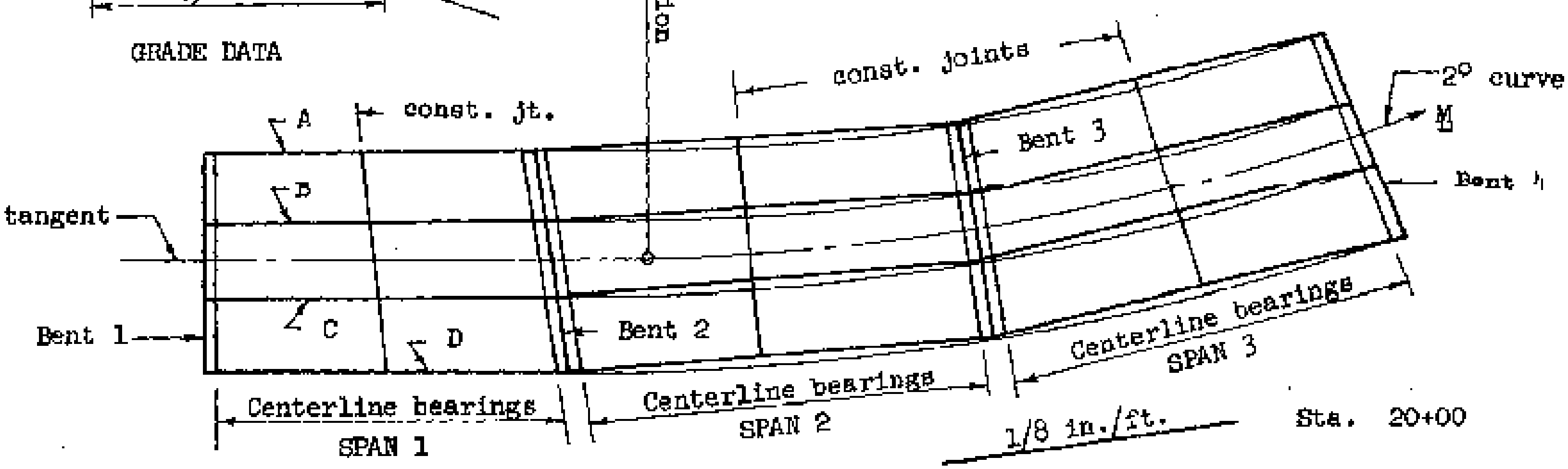
Note that the P.C. Station (35+00) is actually the P.C. Station of Curve No. 3 (20 curve) and, therefore, the P.T. Station of Curve No. 2 (tangent).

EXAMPLE PROBLEM 2 (Continued)

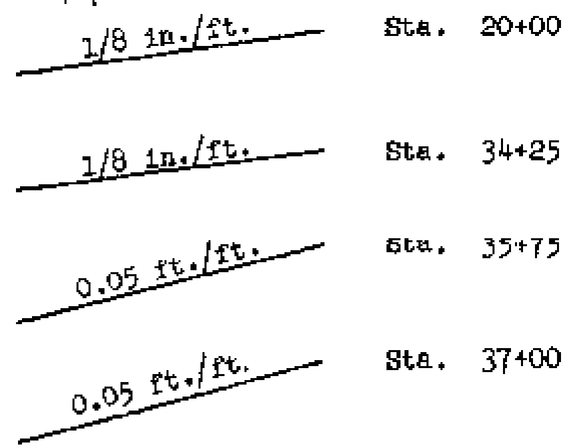
Bent 1 is located at Station 34+00 with a zero skew angle. Bent 2 is parallel to Bent 3 and located at Station 34+75. Bent 3 has a zero skew angle at Station 35+50. Bent 4 is located at Station 36+25 with a skew angle equal to zero. All centerline-of-bearings are located 6 inches from the bents along the beam lines.
Beam spacings shown are concentric arc dimensions.



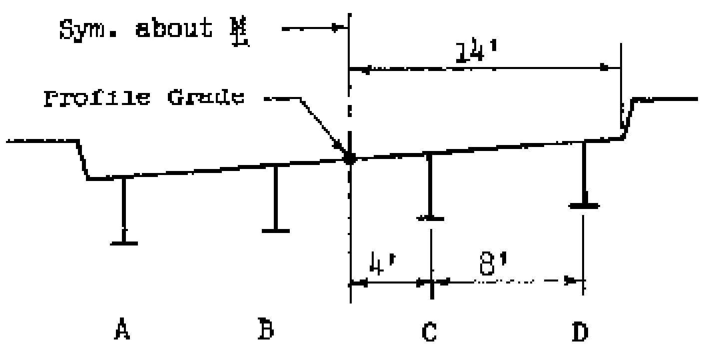
GRADE DATA



PLAN



TRANSITION



CROSS SECTION

- 9T -
H.D. 498-D
5-68
STATE HIGHWAY DEPARTMENT OF GEORGIA
BRIDGE DIVISION
SKEWED BRIDGE PROGRAM
⊕ CURVE ORIGIN IS ON THIS SIDE, SE

NOTE: NEGATIVE NUMBERS ARE DESIGNATED BY A MINUS (-) SIGN PRECEDING THE FIRST SIGNIFICANT DIGIT OF THE FIELD.

PROBLEM IDENTIFICATION, PROJECT, COUNTY, DATE, BY, ETC.

WRITE "CONT." IN C.C. 77-80 WHEN AN ADDIT'AL IDENT. CARD IS TO BE USED.

PROB. NO.		CONT.
EX. 2	EXAMPLE PROBLEM NUMBER TWO... NO PROJECT NUMBER	CONT.
	AUGUST 1, 1968, G. H. S.	

LOCATION DATA

MUST CONTAIN THOSE PORTIONS OF BRIDGE FOR WHICH A SOLUTION IS DESIRED

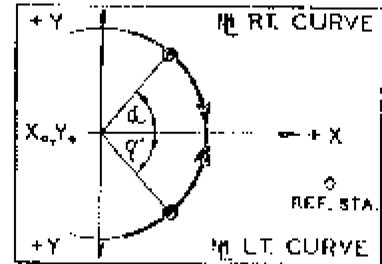
	LIMITING STATIONS BACK	LIMITING STATIONS AHEAD	STATION OF REFERENCE POINT	REF. ANGLE α DEG.	MIN.	SEC.	DIST. FR. ORIGIN X_o, Y_o TO REFERENCE POINT
1	3395.0000	3830.0000	3500.0000	45	00	00.00	3000.0000

REQUIRED ONLY WHEN CURVE 2 IS ON A TANGENT

HORIZONTAL CURVE DATA

	CURVE NO. 1 DEG.	MIN.	SEC.	CURVE NO. 2 (MUST CONTAIN THE REFERENCE POINT) P.C. STATION**	DEG.	MIN.	SEC.	P.T. STATION**	CURVE NO. 3 DEG.	MIN.	SEC.
2				3395.0000	0	00	00.00	3500.0000	2	00	00.00

ALWAYS DEFINED, ALL CASES (TYP.)



REF. ANGLE SKETCH

VERTICAL CURVE DATA**

	P.V.I. Z STA.	P.V.I. 1 STA.	P.V.I. 2 STA.
3	2000.0000	4000.0000	

	ELEV. P.V.I. 2	% GRADE Z-1	L.V.C. 1	% GRADE 1-2	L.V.C. 2	% GRADE 2-3
4	500.0000	-0.500000	100000.0	-1.500000		

** MAY BE WITHIN OR OUTSIDE OF LIMITING STATIONS

CROWN AND LANE DEFINITIONS

← USE THIS FORMAT TO DEFINE A PARABOLIC CROWN: DIST. FROM CROWN TO R/L GUTTER | ΔR FROM ℄ TO CROWN | DIST. FROM CROWN TO CONTROL PT. | DROP (INCHES) FROM CROWN TO CONTROL PT.

← USE THIS FORMAT TO DEFINE SUPERELEVATED LANES.

	CROWN CODE	ΔR TO BEGIN INSIDE S.E.	ΔR'S FROM ℄ TO INSIDE LANES S.R. 1	INSIDE PIVOT	S.R. 2	S.R. 3	ΔR TO BEGIN OUTSIDE S.E.	ΔR'S FROM ℄ TO OUTSIDE LANES S.R. 4	OUTSIDE PIVOT	S.R. 5	S.R. 6
5		-14.0000	-14.0000	0.0000	14.000	14.0000					

WRITE "LVL" IF CROWN CORRECTION IS TO BE IGNORED.
WRITE "PAR" FOR PARABOLIC CROWN
IGNORE FOR SUPERELEVATED LANES.

SUPERELEVATION DATA (MAX. NO. OF 10)

NOTE: THE PROGRAM WILL NOT RECOGNIZE A STATIONING "EQUALITY".

DESCRIPTION C.C. 2 3 4 5 6: C O N S T / S T A R T / F I N I S

	DESCRIPTION	AT STATION**	S.E. 1	S.E. 2	S.E. 3	S.E. 4	S.E. 5	S.E. 6
6	START	2000.0000	0.0000	0.1250	0.0000			
6		3425.0000	0.0000	0.1250	0.0000			
6		3575.0000	0.0000	0.8000	0.0000			
6	FINIS	3700.0000	0.0000	0.8000	0.0000			
6								
6								

GIVE SUPERELEVATIONS IN INCHES PER FOOT

⊕ ORIGIN +SE -SE
SIGNS

SHEET 1 OF 5

M.D. 498-L 5-68

SKEWED BRIDGE - LONGITUDINAL LINES

MAX. NUMBER OF LINES IS THIRTY (30).

THE LAST CODE GIVEN MUST BE "END"

←USE THIS FORMAT FOR RLG, ARC, CRD, STP, CTP, PAR, PIA, COS, PID CODES.

USE THIS FORMAT FOR COR CODE.

	SEQ. NO.	TYPE CODE	REF. CALL	POINT 1 X-COORDINATE (Δ R FROM ℄ IF COS, CTP, ARC, CRD, STP, RST LINE IF RLG, PAR, PIB, PIA)	POINT 1 Y-COORDINATE (IGNORE EXCEPT FOR STP, CTP & COS. ℄ CONTROL STA)	POINT 2 X-COORDINATE (TAPER RATE IF CTP, STP. RADIUS IF COS)	POINT 2 Y-COORDINATE	SKEW	REMARKS
1	2	4	7	9	19	29	39	49	50 – 80
7	01	CRD		-120000					BEAM A
7	02	CRD		-40000					BEAM B
7	03	CRD		40000					BEAM C
7	04	CRD		120000					BEAM D
7	05	ARC		00000					MAINLINE
7	06	END							
7	07								
7	08								
7	09								
7	10								
7	11								
7	12								
7	13								
7	14								
7	15								
7	16								
7	17								
7	18								
7	19								
7	20								
7	21								
7	22								
7	23								
7	24								
7	25								
7	26								
7	27								
7	28								
7	29								
7	30								
7	31								

← REQUIRED FOR RLG, PAR, PIB, AND PIA CODES.

TAPER RATES ARE IN FEET PER HUNDRED FEET.

SHEET 2 OF 5

H.D. 498-S
5-68

SKEWED BRIDGE-SPAN TYPE TRANSVERSE LINE DATA

NUMBER OF "T" LINES THIS SPAN — SPAN NO. — WRITE "LAST" IF LAST SPAN — REMARKS — WRITE "YES" IF LONGITUDINAL LINE DATA FOR SUBSEQUENT SPANS IS TO BE GIVEN

CC 1	2–?	Span No.	No. of T-lines	Last	Remarks
8	SPAN	1	3		SPAN 1 (ON TANGENT)

BENT CODE TYPES (CC 5 6 7 8)

SKEW
PARL
PSTA
SAME (B ONLY)
PREV (A ONLY)

USE DIGIT 1 FOR RLG. INT. CODE — USE THIS FORMAT FOR "SKEW" CODE. — USE THIS FORMAT FOR "PSTA" OR "PARL" CODES.

	Bent No.	Type Code	Station of Bent / Station of Reference Line	Skew Angle of Bent / Skew Angle of Reference Line	Sta. of Bent "PSTA" / Normal Dist. if "PARL"	Remarks	Longitudinal Line Skips — use digit 1
B	1	SKEW	34+00.0000	00 00 0.0		BF PR BT 1	
A	2	PSTA	35+50.0000	00 00 0.0	34 75.0000	CL BT 2	

STA. OF BENT IF "PREV" — OR — NORMAL DIST. IF "PREV"

T-LINE CODES

FIRST CODE	SECOND CODE
SKEW	STAT
CONS	DIST PROP
PARL	NORM DIST PROP
ANGL	DIST PROP
PTPT	DIST PROP COOR

*STATION MUST BE ON THE ℄ (CONTROL LINE)

Line No.	First Code	Second Code	Reference Bent	Station or Normal or Distance or Proportion or X Coordinate	Refer. Line	Angle or Skew Angle or Dist or Proportion or Y Coordinate	Reference Bent	Refer. Line	Use Digit 1 for RLG Int Code / Remarks	Longitudinal Line Skips — use digit 1
T01	PARL	NORM	B	0.5000					CL BRGS BT 1	
T02	CONS	PROP	B	0.5000					CONST JT 1	
T03	PTPT	DIST	A	-0.5000	1	-0.5000	A	4	CL BRGS BT 2BK	
T04										
T05										
T06										
T07										
T08										
T09										
T10										
T11										

STA. — NORM. or DIST. or PROP. or COOR. — DIST. or PROP. or COOR.

MAX NO OF T-LINES IS TWENTY (20)

SHEET 3 OF 5

H.D. 498-S
5-68

SKEWED BRIDGE-SPAN TYPE TRANSVERSE LINE DATA

NUMBER OF "T" LINES THIS SPAN — SPAN NO. — WRITE "LAST" IF LAST SPAN — REMARKS — WRITE "YES" IF LONGITUDINAL LINE DATA FOR SUBSEQUENT SPANS IS TO BE GIVEN

6 SPAN	2	3		SPAN 2 (TANGENT AND CURVE)

BENT CODE TYPES (CC 5 6 7 8): SKEW, PARL, PSTA, SAME (B ONLY), PREV (A ONLY)

USE DIGIT 1 FOR RLG INT. CODE — STATION OF BENT — SKEW ANGLE OF BENT — USE THIS FORMAT FOR "SKEW" CODE. — USE THIS FORMAT FOR "PSTA" OR "PARL" CODES.

	BENT NO.	TYPE CODE	STATION OF REFERENCE LINE	SKEW ANGLE OF REFERENCE LINE	STA. OF BENT "PSTA" NORMAL DIST. IF "PARL"	REMARKS	LONGITUDINAL LINE SKIPS - USE DIGIT 1
B		SAME	+				
			STA. OF BENT IF "PREV"	— OR —	NORMAL DIST IF "PREV"		
A	3	PREV	35+50.0000			CL. BT. 3	

T-LINE CODES

FIRST CODE	SECOND CODE
SKEW	STAT
CONS	DIST, PROP
PARL	NORM, DIST, PROP
ANGL	DIST, PROP
PTPT	DIST, PROP, COOR

*STATION MUST BE ON THE ℄ (CONTROL LINE)

	INF NO.	FIRST CODE	SECOND CODE	REFERENCE BENT	*STATION or NORMAL or DISTANCE or PROPORTION or X COORDINATE	REFER LINE	ANGLE or SKEW ANGLE or DIST or PROPORTION or Y COORDINATE	REFER LINE	REFERENCE BENT (USE DIGIT 1 FOR RLG INT CODE)	REMARKS	LONGITUDINAL LINES SKIPS - USE DIGIT 1
T	01	CONS	DIST	B	0.5000					CL. BRGS. BT. 2AH	
T	02	PARL	PROP	B	0.5000	5				CONST. JT. 2	
T	03	CONS	DIST	A	-0.5000					CL. BRGS. BT. 3BK	
T	04										
T	05										
T	06										
T	07										
T	08										
T	09										
T	10										
T	11										

STA. — + ; NORM. or DIST. or PROP. or COOR. ; DIST. or PROP. or COOR.

MAX. NO OF T-LINES IS TWENTY (20)

SHEET 4 OF 5

H.D. 498-S
5-68

SKEWED BRIDGE-SPAN TYPE TRANSVERSE LINE DATA

NUMBER OF "T" LINES THIS SPAN — SPAN NO. — WRITE "LAST" IF LAST SPAN — REMARKS — WRITE "YES" IF LONGITUDINAL LINE DATA FOR SUBSEQUENT SPANS IS TO BE GIVEN

CC	SPAN	Span No.	No. of T lines	Last	Remarks	Yes
8	SPAN	3	3	LAST	SPAN 3 (IN CURVE).	

BENT CODE TYPES
CC 5 6 7 8
SKEW
PARL
PSTA
SAME (B ONLY)
PREV (A ONLY)

USE DIGIT 1 FOR FLG. INT. CODE — STATION OF BENT — SKEW ANGLE OF BENT — USE THIS FORMAT FOR "SKEW" CODE.
USE THIS FORMAT FOR "PSTA" OR "PARL" CODES.

CC	Bent No.	Type Code	Station of Reference Line	Skew Angle of Reference Line	Sta. of Bent if "PSTA", Normal Dist. if "PARL"	Remarks	Longitudinal Line Skips (Use digit 1)
B		SAME	+				

STA. OF BENT IF "PREV" — OR — NORMAL DIST. IF "PREV"

CC	Bent No.	Type Code	Station	Skew Angle	Normal Dist.	Remarks	Longitudinal Line Skips
A	4	SKEW	36 25.0000	00.0000		BF PR BT 4	

T-LINE CODES

FIRST CODE	SECOND CODE
SKEW	STAT
CONS	DIST, PROP
PARL	NORM, DIST, PROP
ANGL	DIST, PROP
PTPT	DIST, PROP, COOR

*STATION MUST BE ON THE ℄ (CONTROL LINE).

REFERENCE BENT — *STATION or NORMAL or DISTANCE or PROPORTION or X COORDINATE — REFER LINE — ANGLE or SKEW ANGLE or DIST. or PROPORTION or Y COORDINATE — REFER LINE — REFERENCE BENT — USE DIGIT 1 FOR FLG. INT. CODE — REMARKS — LONGITUDINAL LINES SKIPS (USE DIGIT 1)

STA. + — NORM. or DIST. or PROP. or COOR. — DIST. or PROP. or COOR.

Line No.	First Code	Second Code	Ref. Bent	Station / Normal / Distance / Proportion / X Coordinate	Refer Line	Angle / Skew Angle / Dist. / Proportion / Y Coordinate	Ref. Bent	Refer Line	Flg. Int.	Remarks	Longitudinal Lines Skips
T01	CONS	DIST	B	0.5000						CL BRGS BT 3AH	
T02	PTPT	PROP	B	0.5000	1	0.5000	B	4		CONST JT 3	
T03	CONS	DIST	A	-0.5000						CL BRGS BT 4	
T04											
T05											
T06											
T07											
T08											
T09											
T10											
T11											

MAX. NO. OF T-LINES IS TWENTY (20).

SKEWED BRIDGE PROGRAM INPUT DATA PROB.NO. EX.2

EXAMPLE PROBLEM NUMBER TWO. NO PROJECT NUMBER CONT

AUGUST 1, 1968 C.H.S.

LOCATION DATA

BACK STA.	AHEAD STA.	REF. STA.	REF. ANGLE	REF. DIST.
3395.0000	3630.0000	3500.0000	45- 0- 0.0	3000.0000

HORIZONTAL CURVE DATA

CURVE NO. 1	P.C. STA.	CURVE NO. 2	P.T. STA.	CURVE NO. 3
0- 0- 0.0	3395.0000	0- 0- 0.0	3500.0000	2- 0- 0.0

VERTICAL CURVE DATA

PVI Z STA.	PVI 1 STA.	PVI 2 STA.
2000.0000	4000.0000	0.0

EL. PVI Z	% GR. Z-1	LVC 1	% GR. 1-2	LVC 2	% GR. 2-3
500.0000	-0.500000	1000.000	-1.500000	0.0	0.0

CROWN AND LANE DEFINITIONS

CODE	S.R.INS.	S.R. 1	INS.PIV.	S.R. 2	S.R. 3	S.R.OUTS.	S.R. 4	OUTS.PIV.	S.R. 5	S.R. 6
	-14.0000	-14.0000	0.0	14.0000	14.0000	0.0	0.0	0.0	0.0	0.0

SUPERELEVATION DATA

DESC.	AT STATION	S.E. 1	S.E. 2	S.E. 3	S.E. 4	S.E. 5	S.E. 6
START	2000.0000	0.0	0.1250	0.0	0.0	0.0	0.0
	3425.0000	0.0	0.1250	0.0	0.0	0.0	0.0
	3575.0000	0.0	0.6000	0.0	0.0	0.0	0.0
FINIS	3700.0000	0.0	0.6000	0.0	0.0	0.0	0.0

LONGITUDINAL LINES

NO.	TYPE	REF.	DR / X1	STA./ Y1	TR / R / X2	Y2	SK.	REMARKS
1	CRD	0	-12.0000	0.0	0.0	0.0	0	BEAM A
2	CRD	0	-4.0000	0.0	0.0	0.0	0	BEAM B
3	CRD	0	4.0000	0.0	0.0	0.0	0	BEAM C
4	CRD	0	12.0000	0.0	0.0	0.0	0	BEAM D
5	ARC	0	0.0	0.0	0.0	0.0	1	MAINLINE
6	END							

SPAN 1 INPUT DATA

3 T-LINES SPAN 1(ON TANGENT)

BENT DATA

	C	NO.	TYPE	STATION	SKEW ANGLE	STA./NORM.	REMARKS	LONGITUDINAL LINE SKIPS
B	0	1	SKEW	3400.0000	0- 0- 0.0	0.0	BFPR BT. 1	1 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
A	0	2	PSTA	3550.0000	0- 0- 0.0	3475.0000	CL. BT. 2	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

T-LINE DATA

NO.	LINE CODE	B	S/N/D/P/X	RL	A/S/D/P/Y	B	RL	C	REMARKS	LONGITUDINAL LINE SKIPS
1	PARL/NORM	B	0.5000	0	0.0		0	0	CL.BRGS. BT. 1	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2	CONS/PROP	B	0.5000	0	0.0		0	0	CONST. JT. 1	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
3	PTPT/DIST	A	-0.5000	1	-0.5000	A	4	0	CL.BRGS.BT.2BK	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

SPAN 1 OUTPUT DATA SPAN 1(ON TANGENT) PROB. NO. EX.2

BENT DATA

BT.	NO.	STATION	SKEW ANGLE	REMARKS	TYPE
B	1	34+00.0	0-00-00.0	BFPR BT. 1	SKEW
A	2	34+75.0000	-1-00-00.0	CL. BT. 2	PSTA

LONG. LINE 1 CRD BEAM A

T-LINE		STATION	ELEVATION	DT TO ML	DT TO BT	DT TO PP	ANGLE	X	Y	REMARKS	TYPE LINE
T	1	34+00.5000	492.8725	-12.0000	0.5000	0.0	90-00-00.0	2042.4779	2183.1922	CL.BRGS. BT. 1	PARL/NORM
T	2	34+37.3953	492.6488	-12.0000	37.3953	0.0	0-00-00.0	2068.5668	2157.1033	CONST. JT. 1	CONS/PROP
T	3	34+74.2905	492.3475	-12.0000	74.2905	0.0	89-00-00.0	2094.6557	2131.0144	CL.BRGS.BT.2BK	PTPT/DIST
B	2	34+74.7905	492.3434	-12.0000	74.7905	0.0	89-00-00.0	2095.0093	2130.6608	CL. BT. 2	PSTA

LONG. LINE 2 CRD BEAM B

T-LINE		STATION	ELEVATION	DT TO ML	DT TO BT	DT TO PP	ANGLE	X	Y	REMARKS	TYPE LINE
T	1	34+00.5000	492.9558	-4.0000	0.5000	8.0000	90-00-00.0	2048.1348	2188.8490	CL.BRGS. BT. 1	PARL/NORM
T	2	34+37.4651	492.7579	-4.0000	37.4651	0.0	0-00-00.0	2074.2731	2162.7108	CONST. JT. 1	CONS/PROP
T	3	34+74.4302	492.5340	-4.0000	74.4302	8.0012	89-00-00.0	2100.4113	2136.5725	CL.BRGS.BT.2BK	PTPT/DIST
B	2	34+74.9302	492.5310	-4.0000	74.9302	8.0012	89-00-00.0	2100.7649	2136.2190	CL. BT. 2	PSTA

LONG. LINE 3 CRD BEAM C

T-LINE		STATION	ELEVATION	DT TO ML	DT TO BT	DT TO PP	ANGLE	X	Y	REMARKS	TYPE LINE
T	1	34+00.5000	493.0392	4.0000	0.5000	8.0000	-90-00-00.0	2053.7916	2194.5059	CL.BRGS. BT. 1	PARL/NORM
T	2	34+37.5349	492.8672	4.0000	37.5349	0.0	0-00-00.0	2079.9793	2168.3183	CONST. JT. 1	CONS/PROP
T	3	34+74.5698	492.7211	4.0000	74.5698	8.0012	89-00-00.0	2106.1669	2142.1306	CL.BRGS.BT.2BK	PTPT/DIST
B	2	34+75.0698	492.7192	4.0000	75.0698	8.0012	89-00-00.0	2106.5205	2141.7771	CL. BT. 2	PSTA

LONG. LINE 4 CRD BEAM D

T-LINE		STATION	ELEVATION	DT TO ML	DT TO BT	DT TO PP	ANGLE	X	Y	REMARKS	TYPE LINE
T	1	34+00.5000	493.1225	12.0000	0.5000	8.0000	-90-00-00.0	2059.4485	2200.1627	CL.BRGS. BT. 1	PARL/NORM
T	2	34+37.6047	492.9769	12.0000	37.6047	0.0	0-00-00.0	2085.6855	2173.9257	CONST. JT. 1	CONS/PROP
T	3	34+74.7095	492.9089	12.0000	74.7095	8.0012	89-00-00.0	2111.9225	2147.6887	CL.BRGS.BT.2BK	PTPT/DIST
B	2	34+75.2095	492.9079	12.0000	75.2095	8.0012	89-00-00.0	2112.2761	2147.3352	CL. BT. 2	PSTA

SPAN 2 INPUT DATA

3 T-LINES SPAN 2(TANGENT AND CURVE)

BENT DATA

	C	NO.	TYPE	STATION	SKEW ANGLE	STA./NORM.	REMARKS	LONGITUDINAL LINE SKIPS
B	0		SAME	0.0	0- 0- 0.0	0.0		1 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
A	0	3	PREV	3550.0000	0- 0- 0.0	0.0	CL. BT. 3	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

T-LINE DATA

NO.	LINE CODE	B	S/N/D/P/X	RL	A/S/D/P/Y	B	RL	C	REMARKS	LONGITUDINAL LINE SKIPS
1	CONS/DIST	B	0.5000	0	0.0		0	0	CL.BRGS.BT.2AH	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2	PARL/PROP	B	0.5000	5	0.0		0	0	CONST. JT. 2	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
3	CONS/DIST	A	-0.5000	0	0.0		0	0	CL.BRGS.BT.3BK	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

SPAN 2 OUTPUT DATA SPAN 2(TANGENT AND CURVE) PROB. NO. EX.2

BENT DATA

BT.	NO.	STATION	SKEW ANGLE	REMARKS	TYPE
B	2	34+75.0000	-1-00-00.0	CL. BT. 2	SAME
A	3	35+50.0	0-00-00.0	CL. BT. 3	PREV

LONG. LINE 1 CRD BEAM A

T-LINE		STATION	ELEVATION	DT TO ML	DT TO BT	DT TO PP	ANGLE	X	Y	REMARKS	TYPE LINE
T	1	34+75.2905	492.3392	-12.0029	0.5000	0.0	0-00-00.0	2095.3608	2130.3052	CL.BRGS.BT.2AH	CONS/DIST
T	2	35+12.3397	492.0296	-12.1908	37.4973	0.0	89-19-55.0	2121.3698	2103.9931	CONST. JT. 2	PARL/PROP
T	3	35+49.4979	491.7208	-12.0058	74.4988	0.0	0-00-00.0	2147.3818	2077.6780	CL.BRGS.BT.3BK	CONS/DIST
B	3	35+50.0	491.7167	-12.0000	74.9988	0.0	89-19-55.0	2147.7333	2077.3224	CL. BT. 3	PREV

LONG. LINE 2 CRD BEAM B

T-LINE		STATION	ELEVATION	DT TO ML	DT TO BT	DT TO PP	ANGLE	X	Y	REMARKS	TYPE LINE
T	1	34+75.4302	492.5279	-4.0029	0.5000	0.0	0-00-00.0	2101.1164	2135.8634	CL.BRGS.BT.2AH	CONS/DIST
T	2	35+12.4451	492.2966	-4.1909	37.4973	8.0006	89-19-58.3	2127.1250	2109.5508	CONST. JT. 2	PARL/PROP
T	3	35+49.4993	492.0669	-4.0058	74.4987	0.0	0-00-00.0	2153.1365	2083.2352	CL.BRGS.BT.3BK	CONS/DIST
B	3	35+50.0	492.0639	-4.0000	74.9987	8.0000	89-19-58.3	2153.4880	2082.8796	CL. BT. 3	PREV

LONG. LINE 3 CRD BEAM C

T-LINE		STATION	ELEVATION	DT TO ML	DT TO BT	DT TO PP	ANGLE	X	Y	REMARKS	TYPE LINE
T	1	34+75.5698	492.7171	3.9971	0.5000	0.0	0-00-00.0	2106.8720	2141.4215	CL.BRGS.BT.2AH	CONS/DIST
T	2	35+12.5498	492.5641	3.8091	37.4973	8.0006	89-20-01.7	2132.8801	2115.1085	CONST. JT. 2	PARL/PROP
T	3	35+49.5007	492.4131	3.9942	74.4987	0.0	0-00-00.0	2158.8912	2088.7925	CL.BRGS.BT.3BK	CONS/DIST
B	3	35+50.0	492.4111	4.0000	74.9987	8.0000	89-20-01.7	2159.2427	2088.4369	CL. BT. 3	PREV

LONG. LINE 4 CRD BEAM D

T-LINE		STATION	ELEVATION	DT TO ML	DT TO BT	DT TO PP	ANGLE	X	Y	REMARKS	TYPE LINE
T	1	34+75.7095	492.9070	11.9971	0.5000	0.0	0-00-00.0	2112.6275	2146.9796	CL.BRGS.BT.2AH	CONS/DIST
T	2	35+12.6540	492.8321	11.8090	37.4973	8.0006	89-20-05.0	2138.6353	2120.6662	CONST. JT. 2	PARL/PROP
T	3	35+49.5021	492.7592	11.9942	74.4987	0.0	0-00-00.0	2164.6460	2094.3498	CL.BRGS.BT.3BK	CONS/DIST
B	3	35+50.0	492.7583	12.0000	74.9987	8.0000	89-20-05.0	2164.9974	2093.9942	CL. BT. 3	PREV

SPAN 3 INPUT DATA

3 T-LINES LAST SPAN 3(IN CURVE)

BENT DATA

	C	NO.	TYPE	STATION	SKEW ANGLE	STA./NORM.	REMARKS	LONGITUDINAL LINE SKIPS
B	0		SAME	0.0	0- 0- 0.0	0.0		1 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
A	0	4	SKEW	3625.0000	0- 0- 0.0	0.0	BFPR BT. 4	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

T-LINE DATA

NO.	LINE CODE	B	S/N/D/P/X	RL	A/S/D/P/Y	B	RL	C	REMARKS	LONGITUDINAL LINE SKIPS
1	CONS/DIST	B	0.5000	0	0.0		0	0	CL.BRGS.BT.3AH	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2	PTPT/PROP	B	0.5000	1	0.5000	B	4	0	CONST. JT. 3	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
3	CONS/DIST	A	-0.5000	0	0.0		0	0	CL.BRGS. BT. 4	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

SPAN 3 OUTPUT DATA SPAN 3(IN CURVE) PROB. NO. EX.2

BENT DATA

BT.	NO.	STATION	SKEW ANGLE	REMARKS	TYPE
B	3	35+50.0	0-00-00.0	CL. BT. 3	SAME
A	4	36+25.0000	0-00-00.0	BFPR BT. 4	SKEW

LONG. LINE 1 CRD BEAM A

T-LINE		STATION	ELEVATION	DT TO ML	DT TO BT	DT TO PP	ANGLE	X	Y	REMARKS	TYPE LINE
T	1	35+50.5021	491.7120	-12.0065	0.5000	0.0	0-00-00.0	2148.0759	2076.9582	CL.BRGS.BT.3AH	CONS/DIST
T	2	35+87.5000	491.4120	-12.2444	37.3419	0.0	90-00-00.0	2173.3193	2050.1237	CONST. JT. 3	PTPT/PROP
T	3	36+24.4979	491.1997	-12.0065	74.1837	0.0	0-00-00.0	2198.5627	2023.2891	CL.BRGS. BT. 4	CONS/DIST
B	4	36+25.0000	491.1969	-12.0000	74.6837	0.0	89-15-00.0	2198.9053	2022.9249	BFPR BT. 4	SKEW

LONG. LINE 2 CRD BEAM B

T-LINE		STATION	ELEVATION	DT TO ML	DT TO BT	DT TO PP	ANGLE	X	Y	REMARKS	TYPE LINE
T	1	35+50.5007	492.0603	-4.0065	0.5000	0.0	0-00-00.0	2153.8306	2082.5155	CL.BRGS.BT.3AH	CONS/DIST
T	2	35+87.5000	491.8120	-4.2451	37.4466	7.9993	90-00-00.0	2179.1458	2055.6046	CONST. JT. 3	PTPT/PROP
T	3	36+24.4993	491.5997	-4.0065	74.3931	0.0	0-00-00.0	2204.4609	2028.6938	CL.BRGS. BT. 4	CONS/DIST
B	4	36+25.0000	491.5969	-4.0000	74.8931	8.0000	89-15-00.0	2204.8035	2028.3297	BFPR BT. 4	SKEW

LONG. LINE 3 CRD BEAM C

T-LINE		STATION	ELEVATION	DT TO ML	DT TO BT	DT TO PP	ANGLE	X	Y	REMARKS	TYPE LINE
T	1	35+50.4993	492.4086	3.9935	0.5000	0.0	0-00-00.0	2159.5853	2088.0727	CL.BRGS.BT.3AH	CONS/DIST
T	2	35+87.5000	492.2119	3.7542	37.5513	7.9993	90-00-00.0	2184.9722	2061.0856	CONST. JT. 3	PTPT/PROP
T	3	36+24.5007	491.9997	3.9935	74.6026	0.0	0-00-00.0	2210.3591	2034.0986	CL.BRGS. BT. 4	CONS/DIST
B	4	36+25.0000	491.9969	4.0000	76.1026	8.0000	89-15-00.0	2210.7017	2038.7344	BFPR BT. 4	SKEW

LONG. LINE 4 CRD BEAM D

T-LINE		STATION	ELEVATION	DT TO ML	DT TO BT	DT TO PP	ANGLE	X	Y	REMARKS	TYPE LINE
T	1	35+50.4979	492.7569	11.9935	0.5000	0.0	0-00-00.0	2165.3400	2093.6300	CL.BRGS.BT.3AH	CONS/DIST
T	2	35+87.5000	492.6119	11.7535	37.6560	7.9993	90-00-00.0	2190.7987	2066.5666	CONST. JT. 3	PTPT/PROP
T	3	36+24.5021	492.3997	11.9935	74.8120	0.0	0-00-00.0	2216.2574	2039.5033	CL.BRGS. BT. 4	CONS/DIST
B	4	36+25.0000	492.3969	12.0000	75.3120	8.0000	89-15-00.0	2216.5999	2039.1391	BFPR BT. 4	SKEW

Example Number Three

Example 3 is a two-span bridge that is located on a tangent and 3 degree curve. Span 2 is located entirely within the curve, whereas Span 1 occupies a portion of the curve and tangent. The Limiting Stations are chosen as 19+00 and 21+50. The Station of Reference Point is selected as the P.C. Station, and a Reference Angle of 90 degrees is used in order to place the tangent parallel to the X-axis. Therefore, a portion of Span 1 will be placed in the second quadrant. Placing a bridge or portion of a bridge outside the first quadrant is not recommended; however, this program solution will be valid. In this example a working line is set up parallel to the tangent. The offset distance from the working line to any intersection point given in the output can be computed conveniently by subtracting a constant (Radius of 3 degrees curve plus four) from the Y-Coordinate of the intersection point. And the distance along the working line from the P.C. Station to the intersection point will be equal to the X-Coordinate of the point of intersection. The 3 degree curve will be defined as Curve No. 2, and the tangent will be defined as Curve No. 1. Curve No. 3 will not exist. Note that the Distance to Reference Point is not required since Curve No. 2 is actually a circular curve.

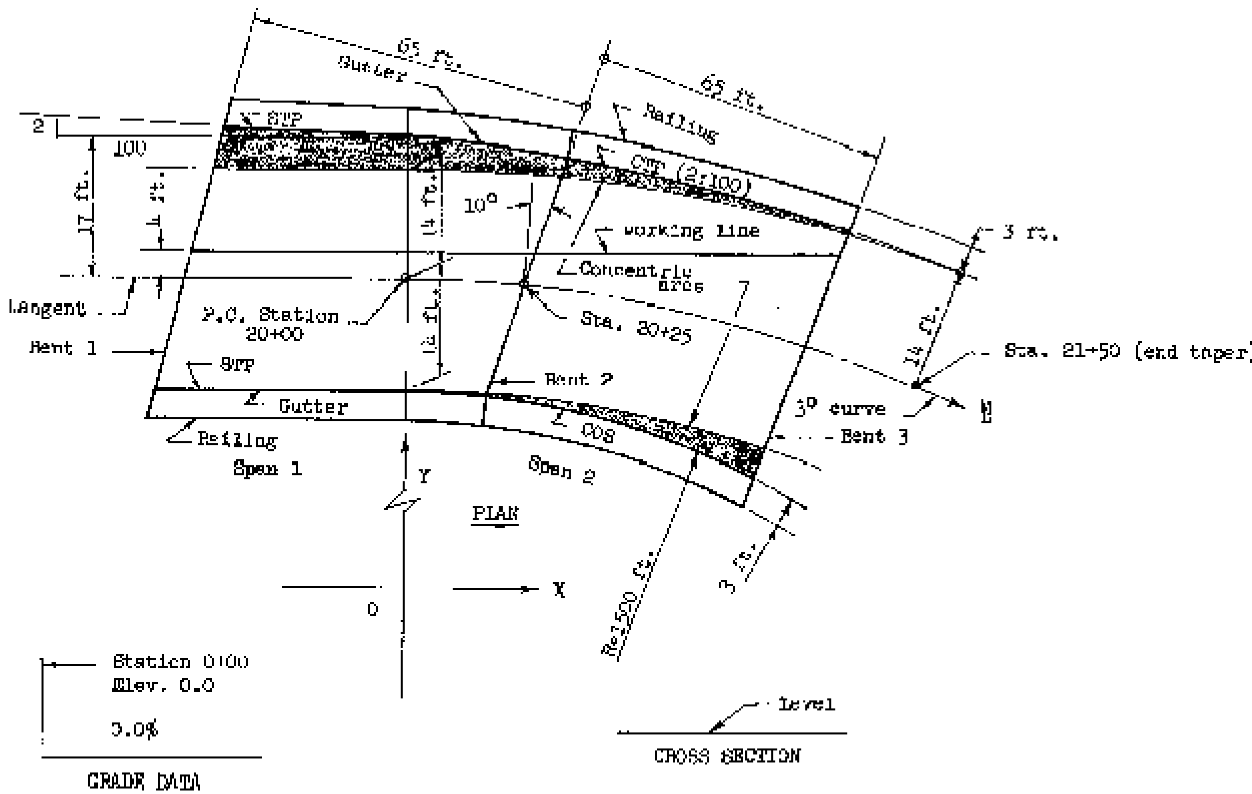
In this example, it is assumed that the elevations are of no concern. Therefore, all Grade Data is assigned a value of zero, and the roadway crown is defined as level.

The left side of the bridge (looking ahead) is in a taper throughout the entire length of the bridge. In the tangent portion the gutter will be a Straight Taper, and in the curve the gutter will conform to a Curve Taper (Spiral). The railing line is always at a constant distance from the gutter line. The right gutter line in the tangent portion is parallel to the mainline. However, in the curve portion the right gutter is a curve with a radius of 1,500 feet and will be defined as a curve offset.

In this example, the gutter and railing lines must be defined twice, i.e., defined for the tangent portion and again for the curve portion. The longitudinal lines defined for the curve portion of the bridge will be skipped in the tangent portion of the bridge, and vice versa. Note that if finished grade elevations were being computed, the elevations in the shaded portion (varying width) and/or on the curbs would have to be adjusted depending on the width assigned to the lane of superelevation that represents the roadway.

The line separating the tangent and curve (P.C. Station) will be defined as a T-Line in Span 1. (An alternate way to set this problem up is to divide Span 1 into two spans with the radial line at the P.C. Station as a bent line. Then define two sets of longitudinal lines.) No beams or additional T-Lines are given in this example. The purpose of the example is to compute the data necessary to define the curbs and railing in relation to a working line, and the lengths along the railing lines.

EXAMPLE PROBLEM 3 (Continued)



NOTE: NEGATIVE NUMBERS ARE DESIGNATED BY A MINUS (-) SIGN PRECEDING THE FIRST SIGNIFICANT DIGIT OF THE FIELD.

PROBLEM IDENTIFICATION, PROJECT, COUNTY, DATE, BY, ETC.

WRITE "CONT." IN C.C. 77-80 WHEN AN ADDITIONAL IDENT. CARD IS TO BE USED.

	PROB. NO.		
*	EX. 3	EXAMPLE PROBLEM NUMBER THREE. NO PROJECT NUMBER	CONT
*	AUGUST 1, 1968 BY G. H. S.		CONT

*BRIDGE DIVISON

LOCATION DATA

MUST CONTAIN THOSE PORTIONS OF BRIDGE FOR WHICH A SOLUTION IS DESIRED

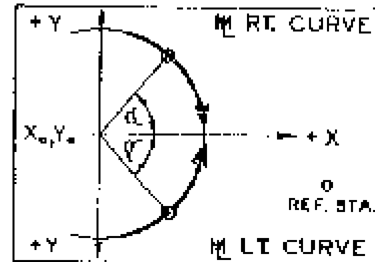
	LIMITING STATIONS BACK	LIMITING STATIONS AHEAD	STATION OF REFERENCE POINT	REF. ANGLE α DEG.	MIN.	SEC.	DIST. FR. ORIGIN X_o, Y_o TO REFERENCE POINT
1	19+00.0000	21+50.0000	20+00.0000	90	00	00.00	

← REQUIRED ONLY WHEN CURVE 2 IS ON A TANGENT

HORIZONTAL CURVE DATA

	CURVE NO. 1 DEG.	MIN.	SEC.	CURVE NO. 2 (MUST CONTAIN THE REFERENCE POINT) P.C. STATION **	DEG.	MIN.	SEC.	P.T. STATION **	CURVE NO. 3 DEG.	MIN.	SEC.
2	0	00	00.00	20+00.0000	3	00	00.00	21+50.0000			

ALWAYS DEFINED, ALL CASES (TYP.)



REF. ANGLE SKETCH

VERTICAL CURVE DATA **

	PVI Z STA.	PVI 1 STA.	PVI 2 STA.
3	0+00.0000	+	+

	ELEV. PVI Z	% GRADE Z-1	L.V.C. 1	% GRADE 1-2	L.V.C. 2	% GRADE 2-3
4	0.0000	0.000000				

**MAY BE WITHIN OR OUTSIDE OF LIMITING STATIONS

CROWN AND LANE DEFINITIONS

			DIST. FROM CROWN TO R/L GUTTER	ΔR FROM ℄ TO CROWN	DIST. FROM CROWN TO CONTROL PT.	DROP (INCHES) FROM CROWN TO CONTROL PT.					
	CROWN CODE	ΔR TO BEGIN INSIDE S.E.	ΔR'S FROM ℄ TO INSIDE LANES S.R. 1	INSIDE PIVOT	S.R. 2	S.R. 3	ΔR TO BEGIN OUTSIDE S.E.	ΔR'S FROM ℄ TO OUTSIDE LANES S.R. 4	OUTSIDE PIVOT	S.R. 5	S.R. 6
5	LVL										

←USE THIS FORMAT TO DEFINE A PARABOLIC CROWN.

←USE THIS FORMAT TO DEFINE SUPERELEVATED LANES

WRITE "LVL" IF CROWN CORRECTION IS TO BE IGNORED.
WRITE "PAR" FOR PARABOLIC CROWN.
IGNORE FOR SUPERELEVATED LANES.

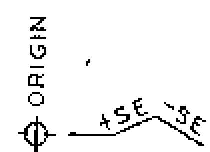
SUPERELEVATION DATA (MAX. NO. OF 10)

NOTE: THE PROGRAM WILL NOT RECOGNIZE A STATIONING "EQUALITY".

DESCRIPTION C.C. 2 3 4 5 6 CONST START FINIS

	DESCRIPTION	AT STATION **	S.E. 1	S.E. 2	S.E. 3	S.E. 4	S.E. 5	S.E. 6
6		+						
6		+						
6		+						
6		+						
6		+						
6		+						

GIVE SUPERELEVATIONS IN INCHES PER FOOT



SIGNS

SHEET 1 OF 4

H.D. 498-0 5-68

STATE HIGHWAY DEPARTMENT OF GEORGIA
BRIDGE DIVISION

SKEWED BRIDGE PROGRAM
℄ CURVE ORIGIN IS ON THIS SIDE S.E.

H.D. 498-L, 5-68

SKEWED BRIDGE - LONGITUDINAL LINES

MAX NUMBER OF LINES IS THIRTY (30).

THE LAST CODE GIVEN MUST BE "END"

USE THIS FORMAT FOR RLG, ARC, CRD, STP, CTP, PAR, PIA, COS, PIB CODES.

USE THIS FORMAT FOR COR CODE.

SEQ NO.	TYPE CODE	REF. CALL	POINT 1 X-COORDINATE (Δ R FROM ℄ IF COS, CTP, ARC, CRD, STP, REF LINE IF RLG, PAR, PIB, PIA)	POINT 1 Y-COORDINATE (IGNORE EXCEPT FOR STP, CTP & COS: ℄ CONTROL STA)	POINT 2 X-COORDINATE (TAPER RATE IF CTP, STP; RADIUS IF COS)	POINT 2 Y-COORDINATE	REMARKS
701	RLG	2	3.0000				LEFT RAILING (CURVE)
702	CTP		14.0000	21500000	-2.0000		LEFT GUTTER (CURVE)
703	COS		-14.0000	200000000	15000000		RIGHT GUTTER (CURVE)
704	RLG	3	-3.0000				RIGHT RAILING (CURVE)
705	STP		4.0000	200000000	0.0000		WORKING LINE (CURVE AND TANGENT)
706	RLG	7	3.0000				LEFT RAILING (TANGENT)
707	STP		17.0000	200000000	-2.0000		LEFT GUTTER (TANGENT)
708	STP		-14.0000	200000000	0.0000		RIGHT GUTTER (TANGENT)
709	RLG	8	-3.0000				RIGHT RAILING (TANGENT)
710	END						
711							
712							
713							
714							
715							
716							
717							
718							
719							
720							
721							
722							
723							
724							
725							
726							
727							
728							
729							
730							
731							

REQUIRED FOR RLG, PAR, PIB, AND PIA CODES.

TAPER RATES ARE IN FEET PER HUNDRED FEET.

SHEET 2 OF 4

H.D. 498-S
5-68

SKEWED BRIDGE-SPAN TYPE TRANSVERSE LINE DATA

NUMBER OF "T" LINES THIS SPAN — SPAN NO. — WRITE "LAST" IF LAST SPAN — REMARKS — WRITE "YES" IF LONGITUDINAL LINE DATA FOR SUBSEQUENT SPANS IS TO BE GIVEN

B	SPAN	1	1		SPAN ONE HANDRAIL LENGTHS

BENT CODE TYPES (C.C. 5 6 7 8): SKEW, PARL, PSTA, SAME (B ONLY), PREV (A ONLY)

USE THIS FORMAT FOR "SKEW" CODE. USE THIS FORMAT FOR "PSTA" OR "PARL" CODES.

	BENT NO. (USE DIGIT 1 FOR RLG INT. CODE)	TYPE CODE	STATION OF BENT / STATION OF REFERENCE LINE	SKEW ANGLE OF BENT / SKEW ANGLE OF REFERENCE LINE	STA. OF BENT IF "PSTA" / NORMAL DIST. IF "PARL"	REMARKS	LONGITUDINAL LINE SKIPS
B	1	PARL	20125.0000	-10.0000	-65.0000	F.F.C. BENT 1	
A	2	PREV	20125.0000 (STA. OF BENT IF "PREV") — OR —		(NORMAL DIST. IF "PREV")	C.L. BENT 2	

T-LINE CODES

FIRST CODE	SECOND CODE
SKEW	STAT
CONS	DIST PROP
PARL	NORM DIST PROP
ANGL	DIST PROP
PTPT	DIST PROP COOR

*STATION MUST BE ON THE ℄ (CONTROL LINE)

LINE NO.	REFERENCE BENT FIRST CODE	REFERENCE BENT SECOND CODE	*STATION or NORMAL or DISTANCE or PROPORTION or X COORDINATE	REFER LINE	ANGLE or SKEW ANGLE or DIST. or PROPORTION or Y COORDINATE	REFER LINE (REFERENCE BENT)	REMARKS (USE DIGIT 1 FOR RLG INT CODE)	LONGITUDINAL LINES SKIPS
T01	SKEW	STAT	2000.0000		00.0000		P.C. STATION	
T02								
T03								
T04								
T05								
T06								
T07								
T08								
T09								
T10								
T11								

MAX NO OF T-LINES IS TWENTY (20)

SHEET 3 OF 4

H.D. 498-S
5-68

SKEWED BRIDGE-SPAN TYPE TRANSVERSE LINE DATA

NUMBER OF "T" LINES THIS SPAN
SPAN NO.
WRITE "LAST" IF LAST SPAN
REMARKS
WRITE "YES" IF LONGITUDINAL LINE DATA FOR SUBSEQUENT SPANS IS TO BE GIVEN

8 SPAN 2 0 LAST SPAN TWO HANDRAIL LENGTHS

BENT CODE TYPES
CC 5 6 7 8
SKEW
PARL
PSTA
SAME (B ONLY)
PREV (A ONLY)

USE DIGIT I FOR RLG INT. CODE
STATION OF BENT
SKEW ANGLE OF BENT
— USE THIS FORMAT FOR "SKEW" CODE.
— USE THIS FORMAT FOR "PSTA" OR "PARL" CODES.

BENT NO. | TYPE CODE | STATION OF REFERENCE LINE | SKEW ANGLE OF REFERENCE LINE | STA. OF BENT "PSTA" NORMAL DIST. IF "PARL" | REMARKS | LONGITUDINAL LINE SKIPS - USE DIGIT 1

B SAME +

STA. OF BENT IF "PREV" — OR — NORMAL DIST. IF "PREV"

A 1 3 PREV + 65,000.0 FFC BENT 3

T-LINE CODES

FIRST CODE	SECOND CODE
SKEW	STAT
CONS	DIST PROP
PARL	NORM DIST PROP
ANGL	DIST PROP
PTPT	DIST PROP COOR

*STATION MUST BE ON THE ℄ (CONTROL LINE)

LINE NO. | REFERENCE BENT: FIRST CODE | SECOND CODE | *STATION or NORMAL or DISTANCE or PROPORTION or X COORDINATE | REFER LINE | ANGLE or SKEW ANGLE or DIST or PROPORTION or Y COORDINATE | REFERENCE BENT: REFER LINE | USE DIGIT 1 FOR RIG. INT. CODE | REMARKS | LONGITUDINAL LINES SKIPS - USE DIGIT 1

STA. — NORM or DIST. or PROP. or COOR. — DIST. or PROP. or COOR.

T01
T02
T03
T04
T05
T06
T07
T08
T09
T10
T11

MAX. NO. OF T-LINES IS TWENTY (20).

SHEET 4 OF 4

SKEWED BRIDGE PROGRAM INPUT DATA PROB.NO. EX.3

EXAMPLE PROBLEM NUMBER THREE. NO PROJECT NUMBER. CONT

AUGUST 1, 1968 BY G.H.S. CONT

BRIDGE DIVISION

LOCATION DATA

BACK STA.	AHEAD STA.	REF. STA.	REF. ANGLE	REF. DIST.
1900.0000	2150.0000	2000.0000	90- 0- 0.0	0.0

HORIZONTAL CURVE DATA

CURVE NO. 1	P.C. STA.	CURVE NO. 2	P.T. STA.	CURVE NO. 3
0- 0- 0.0	2000.0000	3- 0- 0.0	2150.0000	0- 0- 0.0

VERTICAL CURVE DATA

PVI Z STA.	PVI 1 STA.	PVI 2 STA.
0.0	0.0	0.0

EL. PVI Z	% GR. Z-1	LVC 1	% GR. 1-2	LVC 2	% GR. 2-3
0.0	0.0	0.0	0.0	0.0	0.0

CROWN AND LANE DEFINITIONS

CODE	S.R.INS.	S.R. 1	INS.PIV.	S.R. 2	S.R. 3	S.R.OUTS.	S.R. 4	OUTS.PIV.	S.R. 5	S.R. 6
LVL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

LONGITUDINAL LINES

NO.	TYPE	REF.	DR / X1	STA./ Y1	TR / R / X2	Y2	SK.	REMARKS
1	RLG	2	3.0000	0.0	0.0	0.0	0	LEFT RAILING(CURVE)
2	CTP	0	14.0000	2150.0000	-2.0000	0.0	0	LEFT GUTTER(CURVE)
3	COS	0	-14.0000	2000.0000	1500.0000	0.0	0	RIGHT GUTTER(CURVE)
4	RLG	3	-3.0000	0.0	0.0	0.0	0	RIGHT RAILING(CURVE)
5	STP	0	4.0000	2000.0000	0.0	0.0	0	WORKING LINE(CURVE AND TANGENT)
6	RLG	7	3.0000	0.0	0.0	0.0	0	LEFT RAILING(TANGENT)
7	STP	0	17.0000	2000.0000	-2.0000	0.0	0	LEFT GUTTER(TANGENT)
8	STP	0	-14.0000	2000.0000	0.0	0.0	0	RIGHT GUTTER(TANGENT)
9	RLG	8	-3.0000	0.0	0.0	0.0	0	RIGHT RAILING(TANGENT)
10	END							

SPAN 1 INPUT DATA

1 T-LINES SPAN ONE HANDRAIL LENGTHS

BENT DATA

	C	NO.	TYPE	STATION	SKEW ANGLE	STA./NORM.	REMARKS	LONGITUDINAL LINE SKIPS
B	1	1	PARL	2025.0000	-10- 0- 0.0	-65.0000	FFC BENT 1	1 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
A	0	2	PREV	2025.0000	0- 0- 0.0	0.0	CL. BENT 2	0 0 0 0 0 1 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

T-LINE DATA

NO.	LINE CODE	B	S/N/D/P/X	RL	A/S/D/P/Y	B	RL	C	REMARKS	LONGITUDINAL LINE SKIPS
1	SKEW/STAT		2000.0000	0	0- 0- 0.0		0	1	P.C. STATION	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

SPAN 1 OUTPUT DATA SPAN ONE HANDRAIL LENGTHS

PROB. NO. EX.3

BENT DATA

BT. NO.	STATION	SKEW ANGLE	REMARKS	TYPE
B 1	19+58.8692	-10-45-00.0	FFC BENT 1	PARL
A 2	20+25.0000	-10-00-00.0	CL. BENT 2	PREV

LONG. LINE 1 RLG LEFT RAILING(CURVE)

T-LINE	STATION	ELEVATION	DT TO ML	DT TO BT	DT TO PP	ANGLE	X	Y	REMARKS	TYPE LINE
T 1	20+00.0	0.0	20.0000	37.2644	0.0	0-00-00.0	0.0	1929.8593	P.C. STATION	SKEW/STAT
B 2	20+27.8741	0.0	19.4425	65.4319	0.0	0-00-00.0	28.1569	1929.0964	CL. BENT 2	PREV

LONG. LINE 2 CTP LEFT GUTTER(CURVE)

T-LINE	STATION	ELEVATION	DT TO ML	DT TO BT	DT TO PP	ANGLE	X	Y	REMARKS	TYPE LINE
T 1	20+00.0	0.0	17.0000	37.8339	3.0000	0-00-00.0	0.0	1926.8593	P.C. STATION	SKEW/STAT
B 2	20+27.8741	0.0	16.4425	65.9576	3.0000	-9-54-49.6	28.1131	1926.0967	CL. BENT 2	PREV

LONG. LINE 3 COS RIGHT GUTTER(CURVE)

T-LINE	STATION	ELEVATION	DT TO ML	DT TO BT	DT TO PP	ANGLE	X	Y	REMARKS	TYPE LINE
T 1	20+00.0	0.0	-14.0000	43.9171	31.0000	0-00-00.0	0.0	1895.8593	P.C. STATION	SKEW/STAT
B 2	20+22.5067	0.0	-14.0347	66.2587	30.9468	-9-53-47.8	22.3408	1895.6929	CL. BENT 2	PREV

LONG. LINE 4 RLG RIGHT RAILING(CURVE)

T-LINE	STATION	ELEVATION	DT TO ML	DT TO BT	DT TO PP	ANGLE	X	Y	REMARKS	TYPE LINE
T 1	20+00.0	0.0	-17.0000	44.4858	3.0000	0-00-00.0	0.0	1892.8593	P.C. STATION	SKEW/STAT
B 2	20+22.4973	0.0	-17.0347	66.7808	3.0000	0-00-00.0	22.2961	1892.6933	CL. BENT 2	PREV

LONG. LINE 5 STP WORKING LINE(CURVE AND TANGENT)

T-LINE	STATION	ELEVATION	DT TO ML	DT TO BT	DT TO PP	ANGLE	X	Y	REMARKS	TYPE LINE
B 1	19+59.6287	0.0	4.0000	0.0	0.0	79-15-00.0	-40.3713	1913.8593	FFC BENT 1	PARL
T 1	20+00.0	0.0	4.0000	40.3713	21.0000	90-00-00.0	0.0	1913.8593	P.C. STATION	SKEW/STAT
B 2	20+25.7343	0.0	4.1738	66.1611	21.4524	79-15-00.0	25.7898	1913.8593	CL. BENT 2	PREV

LONG. LINE 6 RLG LEFT RAILING(TANGENT)

T-LINE	STATION	ELEVATION	DT TO ML	DT TO BT	DT TO PP	ANGLE	X	Y	REMARKS	TYPE LINE
B 1	19+62.8077	0.0	20.7444	0.0	17.0436	80-23-44.7	-37.1923	1930.6038	FFC BENT 1	PARL
T 1	20+00.0	0.0	20.0006	37.1997	16.0006	-88-51-15.3	0.0	1929.8599	P.C. STATION	SKEW/STAT

LONG. LINE 7 STP LEFT GUTTER(TANGENT)

T-LINE	STATION	ELEVATION	DT TO ML	DT TO BT	DT TO PP	ANGLE	X	Y	REMARKS	TYPE LINE
B 1	19+62.2402	0.0	17.7552	0.0	3.0426	80-23-44.7	-37.7598	1927.6145	FFC BENT 1	PARL
T 1	20+00.0	0.0	17.0000	37.7674	3.0006	-88-51-15.3	0.0	1926.8593	P.C. STATION	SKEW/STAT

LONG. LINE 8 STP RIGHT GUTTER(TANGENT)

T-LINE	STATION	ELEVATION	DT TO ML	DT TO BT	DT TO PP	ANGLE	X	Y	REMARKS	TYPE LINE
B 1	19+56.2113	0.0	-14.0000	0.0	32.3224	79-15-00.0	-43.7887	1895.8593	FFC BENT 1	PARL
T 1	20+00.0	0.0	-14.0000	43.7887	31.0000	90-00-00.0	0.0	1895.8593	P.C. STATION	SKEW/STAT

LONG. LINE 9 RLG RIGHT RAILING(TANGENT)

T-LINE	STATION	ELEVATION	DT TO ML	DT TO BT	DT TO PP	ANGLE	X	Y	REMARKS	TYPE LINE
B 1	19+55.6417	0.0	-17.0000	0.0	3.0536	79-15-00.0	-44.3583	1892.8593	FFC BENT 1	PARL
T 1	20+00.0	0.0	-17.0000	44.3583	3.0000	90-00-00.0	0.0	1892.8593	P.C. STATION	SKEW/STAT

SPAN 2 INPUT DATA

0 T-LINES LAST SPAN TWO HANDRAIL LENGTHS

BENT DATA

	C	NO.	TYPE	STATION	SKEW ANGLE	STA./NORM.	REMARKS	LONGITUDINAL LINE SKIPS
B	0		SAME	0.0	0- 0- 0.0	0.0		0 0 0 0 0 1 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
A	1	3	PREV	0.0	0- 0- 0.0	65.0000	FFC BENT 3	0 0 0 0 0 1 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

SPAN 2 OUTPUT DATA SPAN TWO HANDRAIL LENGTHS

PROB. NO. EX.3

BENT DATA

BT. NO.	STATION	SKEW ANGLE	REMARKS	TYPE
B 2	20+25.0000	-10-00-00.0	CL. BENT 2	SAME
A 3	20+90.8158	-8-01-31.9	FFC BENT 3	PREV

LONG. LINE 1 RLG LEFT RAILING(CURVE)

T-LINE	STATION	ELEVATION	DT TO ML	DT TO BT	DT TO PP	ANGLE	X	Y	REMARKS	TYPE LINE
B 2	20+27.8741	0.0	19.4425	0.0	0.0	0-00-00.0	28.1569	1929.0964	CL. BENT 2	SAME
B 3	20+93.3482	0.0	18.1330	66.1311	0.0	-7-56-58.4	94.1970	1925.6899	FFC BENT 3	PREV

LONG. LINE 2 CTP LEFT GUTTER(CURVE)

T-LINE	STATION	ELEVATION	DT TO ML	DT TO BT	DT TO PP	ANGLE	X	Y	REMARKS	TYPE LINE
B 2	20+27.8741	0.0	16.4425	0.0	3.0000	-9-54-49.6	28.1131	1926.0967	CL. BENT 2	SAME
B 3	20+92.9337	0.0	15.1413	65.6104	3.0208	-7-57-43.2	93.6335	1922.7221	FFC BENT 3	PREV

LONG. LINE 3 COS RIGHT GUTTER(CURVE)

T-LINE	STATION	ELEVATION	DT TO ML	DT TO BT	DT TO PP	ANGLE	X	Y	REMARKS	TYPE LINE
B 2	20+22.5067	0.0	-14.0347	0.0	30.9468	-9-53-47.0	22.3400	1095.6929	CL. BENT 2	SAME
B 3	20+88.7499	0.0	-14.5401	65.7515	29.9749	-7-23-06.3	88.0425	1893.2733	FFC BENT 3	PREV

LONG. LINE 4 RLG RIGHT RAILING(CURVE)

T-LINE	STATION	ELEVATION	DT TO ML	DT TO BT	DT TO PP	ANGLE	X	Y	REMARKS	TYPE LINE
B 2	20+22.4973	0.0	-17.0347	0.0	3.0000	0-00-00.0	22.2961	1892.6933	CL. BENT 2	SAME
B 3	20+88.3203	0.0	-17.5351	69.8941	3.0251	-7-23-59.9	87.4782	1890.3012	FFC BENT 3	PREV

LONG. LINE 5 STP WORKING LINE(CURVE AND TANGENT)

T-LINE	STATION	ELEVATION	DT TO ML	DT TO BT	DT TO PP	ANGLE	X	Y	REMARKS	TYPE LINE
B 2	20+25.7343	0.0	4.1738	0.0	21.4524	79-15-00.0	25.7898	1913.8593	CL. BENT 2	SAME
B 3	20+91.6882	0.0	6.2076	66.1611	23.9789	79-15-00.0	91.9509	1913.8593	FFC BENT 3	PREV

(ADDITIONAL SPAN 2 OUTPUT DATA CONTAINS ONLY HEADINGS)

Example Number Four

Example 4 is a three-span (continuous unit) bridge that is located on a tangent. The bridge is placed parallel to the Y-axis by using a Reference Angle equal to zero. The Reference Point Station is chosen as 25+00 in order to place the entire bridge in the first quadrant. The Limiting Stations are selected as 22+00 and 25+00. The mainline is placed at a distance of 1,000 feet from the Y-axis by the Reference Distance. The tangent is defined as Curve No. 2 with a zero degree-of-curvature. Note that the bridge is in a portion of two vertical curves. The Grade Data and parabolic crown dimensions are given in the sketch of this example.

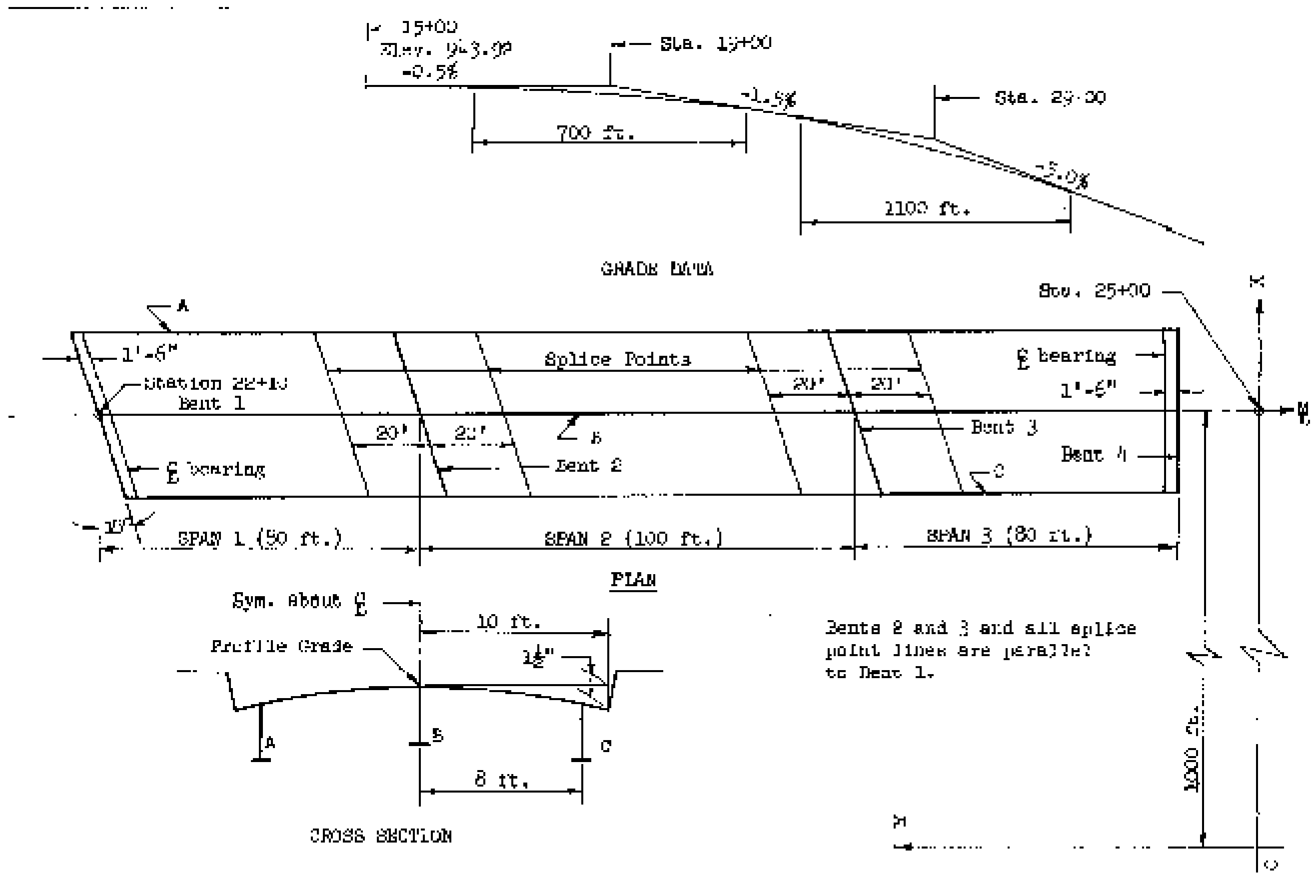
The centerline beam (B) is defined by coordinates since the coordinates are readily known. This definition by coordinates is for illustration only, since this beam could have been defined more conveniently as a Chord or Arc. Beams A and C are defined as Parallel to Beam B. These beams could also have been defined as Chords or Arcs.

The purpose of this example is to compute the elevations at the centerline-of-bearings of the end bents and splice points of the beams in order to compute the slopes of the beam segments and top of beam elevations. The entire bridge is set up as one span, and the centerline-of-bearings and splice points are defined as T-Lines within that span. All the bent lines will be skipped. For the purpose of illustration, the centerline-of-bearing of Bent 4 is defined by coordinates.

Bents 2 and 3 and all splice points are parallel to Bent 1. Bent 4 is perpendicular to the mainline, i.e., a Skew Angle equal to zero.

The coordinates of the intersection points that will be given in the Span Output Data have been computed beforehand and entered as Coordinate Type Input. This is done in order to illustrate the usage of the Coordinate Type-Input.

EXAMPLE PROBLEM 4 (Continued)



STATE HIGHWAY DEPARTMENT OF GEORGIA
BRIDGE DIVISION

SKEWED BRIDGE PROGRAM
⊕ CURVE ORIGIN IS ON THIS SIDE, S.E.

H.D. 498-D
5-68
- 174 -

NOTE: NEGATIVE NUMBERS ARE DESIGNATED BY A MINUS (-) SIGN PRECEDING THE FIRST SIGNIFICANT DIGIT OF THE FIELD.

PROBLEM IDENTIFICATION, PROJECT, COUNTY, DATE, BY, ETC.

WRITE "CONT." IN C.C. 77-80 WHEN AN ADDIT'NL. IDENT. CARD IS TO BE USED.

PROB. NO.	PROBLEM IDENTIFICATION, PROJECT, COUNTY, DATE, BY, ETC.	CONT.
EX. 4	EXAMPLE PROBLEM NUMBER FOUR., NO PROJECT NUMBER., AUGUST 1, 1968, C.H.S.	

LOCATION DATA

MUST CONTAIN THOSE PORTIONS OF BRIDGE FOR WHICH A SOLUTION IS DESIRED

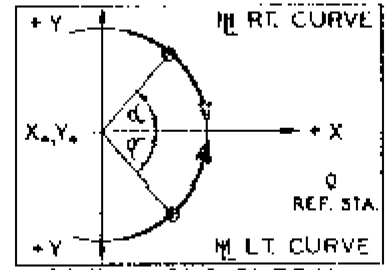
Card	LIMITING STATIONS BACK	LIMITING STATIONS AHEAD	STATION OF REFERENCE POINT	REF. ANGLE α DEG.	MIN	SEC.	DIST. FR. ORIGIN X_o, Y_o TO REFERENCE POINT
1	22+00.0000	25+00.0000	25+00.0000	0	00	00.00	1000.0000

← REQUIRED ONLY WHEN CURVE 2 IS ON A TANGENT

HORIZONTAL CURVE DATA

Card	CURVE NO. 1 DEG.	MIN.	SEC.	CURVE NO. 2 (MUST CONTAIN THE REFERENCE POINT) P.C. STATION **	DEG.	MIN.	SEC.	P.T. STATION **	CURVE NO. 3 DEG.	MIN.	SEC.
2				+	0	00	00.00				

ALWAYS DEFINED, ALL CASES (TYP)



REF. ANGLE SKETCH

VERTICAL CURVE DATA**

Card	P.V.I. Z STA.	P.V.I. 1 STA.	P.V.I. 2 STA.
3	15+00.0000	19+00.0000	29+00.0000

Card	ELEV. P.V.I. Z	% GRADE Z-1	L.V.C. 1	% GRADE 1-2	L.V.C. 2	% GRADE 2-3
4	943.9200	-0.500000	700.000	-1.500000	1100.000	-.5000000

** MAY BE WITHIN OR OUTSIDE OF LIMITING STATIONS

CROWN AND LANE DEFINITIONS

Card	CROWN CODE	ΔR TO BEGIN INSIDE S.E.	DIST FROM CROWN TO R/L GUTTER / ΔR'S FROM ℄ TO INSIDE LANES S.R. 1	AR FROM ℄ TO CROWN / INSIDE PIVOT	DIST. FROM CROWN TO CONTROL PT. / S.R. 2	DROP (INCHES) FROM CROWN TO CONTROL PT. / S.R. 3	ΔR TO BEGIN OUTSIDE S.E.	ΔR'S FROM ℄ TO OUTSIDE LANES S.R. 4	OUTSIDE PIVOT	S.R. 5	S.R. 6
5	PAR		10.0000	0.0000	10.0000	1.5000					

←USE THIS FORMAT TO DEFINE A PARABOLIC CROWN.
←USE THIS FORMAT TO DEFINE SUPERELEVATED LANES.

WRITE "LVL" IF CROWN CORRECTION IS TO BE IGNORED.
WRITE "PAR" FOR PARABOLIC CROWN.
IGNORE FOR SUPERELEVATED LANES.

SUPERELEVATION DATA (MAX. NO. OF 10)

NOTE: THE PROGRAM WILL NOT RECOGNIZE A STATIONING "EQUALITY".

DESCRIPTION
C.C. 2 3 4 5 6
C O N S T
S T A R T
F I N I S

Card	DESCRIPTION	AT STATION **	S.E. 1	S.E. 2	S.E. 3	S.E. 4	S.E. 5	S.E. 6
6		+						
6		+						
6		+						
6		+						
6		+						
6		+						

←GIVE SUPERELEVATIONS IN INCHES PER FOOT→

⊕ ORIGIN

+SE -SE
SIGNS

SHEET 1 OF 4

H.D. 498-L, 5-68

SKEWED BRIDGE - LONGITUDINAL LINES

MAX. NUMBER OF LINES IS THIRTY (30).

THE LAST CODE GIVEN MUST BE "END"

← USE THIS FORMAT FOR RLG, ARC, CRD, STP, CTP, PAR, PIA, COS, PIB CODES: Δ R FROM ℄ IF COS, CTP, ARC, CRD, STP, REF. LINE IF RLG, PAR, PIB, PIA | IGNORE EXCEPT FOR STP, CTP & COS: ℄ CONTROL STA | TAPER RATE IF CTP, STP. RADIUS IF COS

USE THIS FORMAT FOR COR CODE: POINT 1 X-COORDINATE, Y-COORDINATE; POINT 2 X-COORDINATE, Y-COORDINATE

SEQ. NO.	TYPE CODE	REF. CALL	POINT 1 X-COORDINATE	POINT 1 Y-COORDINATE	POINT 2 X-COORDINATE	POINT 2 Y-COORDINATE	SKIP	REMARKS
7 01	PAR	2	8.0000					BEAM A
7 02	COR		1000.0000	1000.00000	1000.0000	0.0000		BEAM B
7 03	PAR	2	-8.0000					BEAM C
7 04	END							
7 05								
7 06								
7 07								
7 08								
7 09								
7 10								
7 11								
7 12								
7 13								
7 14								
7 15								
7 16								
7 17								
7 18								
7 19								
7 20								
7 21								
7 22								
7 23								
7 24								
7 25								
7 26								
7 27								
7 28								
7 29								
7 30								
7 31								

REQUIRED FOR RLG, PAR, PIB, AND PIA CODES.

TAPER RATES ARE IN FEET PER HUNDRED FEET.

SHEET 2 OF 4

H.D. 498-S
5-66

SKEWED BRIDGE-SPAN TYPE TRANSVERSE LINE DATA

NUMBER OF "T" LINES THIS SPAN — SPAN NO. — WRITE "LAST" IF LAST SPAN — REMARKS — WRITE "YES" IF LONGITUDINAL LINE DATA FOR SUBSEQUENT SPANS IS TO BE GIVEN

8	SPAN		6		SPAN 1, 2, 3

BENT CODE TYPES (C.C. 5 6 7 8): SKEW, PARL, PSTA, SAME (B ONLY), PREV (A ONLY)

USE THIS FORMAT FOR "SKEW" CODE. USE THIS FORMAT FOR "PSTA" OR "PARL" CODES.

USE DIGIT 1 FOR RLG INT. CODE	BENT NO.	TYPE CODE	STATION OF BENT / STATION OF REFERENCE LINE	SKEW ANGLE OF BENT / SKEW ANGLE OF REFERENCE LINE	STA. OF BENT "PSTA" / NORMAL DIST IF "PARL"	REMARKS	LONGITUDINAL LINE SKIPS
B	1	SKEW	2210,0000	180,000.0		BENT 1	
A	4	SKEW	2470,0000 (STA. OF BENT IF "PREV")	00000.0 (OR)	(NORMAL DIST. IF "PREV")	BENT 4	

T-LINE CODES

FIRST CODE	SECOND CODE
SKEW	STAT
CONS	DIST PROP
PARL	NORM DIST PROP
ANGL	DIST PROP
PTPT	DIST PROP COOR

*STATION MUST BE ON THE ℄ (CONTROL LINE)

LINE NO.	FIRST CODE	SECOND CODE	REFERENCE BENT	*STATION or NORMAL or DISTANCE or PROPORTION or X COORDINATE	REFER LINE	ANGLE or SKEW ANGLE or DIST. or PROPORTION or Y COORDINATE	REFER LINE	USE DIGIT 1 FOR RLG INT. CODE	REMARKS	LONGITUDINAL LINES SKIPS
T01	PARL	DIST	B	15.000	2				CL. BRG. BENT 1	
T02	PARL	DIST	B	60.0000	2				SPLICE PT. 1	
T03	PARL	DIST	B	100.0000	2				SPLICE PT. 2	
T04	PARL	DIST	B	160.0000	2				SPLICE PT. 3	
T05	PARL	DIST	B	200.0000	2				SPLICE PT. 4	
T06	PTPT	COOR		0.0000		315.000			CL. BRG. BENT 4	
T				1000.0000		31'5000				
T07										
T08										
T09										
T10										
T11										

STA. — NORM or DIST. or PROP. or COOR. — DIST. or PROP. or COOR.

MAX. NO. OF T-LINES IS TWENTY (20)

SHEET 3 OF 4

H.D. 498-C
5-68

SKEWED BRIDGE - COORDINATE TYPE INPUT

NUMBER OF POINTS THIS UNIT — WRITE "LAST" IF LAST UNIT — REMARKS

MUST BE INCLUDED WITH EACH UNIT OF COORDINATE TYPE INPUT

1	2	6	10	12	13	17	18
B	COOR		18		LAST		CENTERLINE BRGS. SPLICE POINTS

1	SEQ. NO. (2)	POINT IDENT. (5)	X - COORDINATE (9)	Y - COORDINATE (19)	REMARKS (29–48)
C	P01	A B1	10080000	2910994	BEAM A CL. BRG. BT. 1
C	P02	A S1	10080000	2325994	BEAM A SPLICE PT. 1
C	P03	A S2	10080000	1925994	BEAM A SPLICE PT. 2
C	P04	A S3	10080000	1325994	BEAM A SPLICE PT. 3
C	P05	A S4	10080000	925994	BEAM A SPLICE PT. 4
C	P06	A B4	10080000	315000	BEAM A CL. BRG. BT. 4
C	P07	B B1	10000000	2885000	BEAM B CL. BRG. BT. 1
C	P08	B S1	10000000	2300000	BEAM B SPLICE PT. 1
C	P09	B S2	10000000	1900000	BEAM B SPLICE PT. 2
C	P10	B S3	10000000	1300000	BEAM B SPLICE PT. 3
C	P11	B S4	10000000	900000	BEAM B SPLICE PT. 4
C	P12	B B4	10000000	315000	BEAM B CL. BRG. BT. 4
C	P13	C B1	9920000	2859006	BEAM C CL. BRG. BT. 1
C	P14	C S1	9920000	2274006	BEAM C SPLICE PT. 1
C	P15	C S2	9920000	1874006	BEAM C SPLICE PT. 2
C	P16	C S3	9920000	1274006	BEAM C SPLICE PT. 3
C	P17	C S4	9920000	874006	BEAM C SPLICE PT. 4
C	P18	C B4	9920000	315000	BEAM C CL. BRG. BT. 4
C	P19				
C	P20				
C	P21				
C	P22				
C	P23				
C	P24				
C	P25				
C	P26				
C	P27				
C	P28				
C	P29				
C	P30				

SHEET 4 OF 4

SKEWED BRIDGE PROGRAM INPUT DATA PROB.NO. EX.4

EXAMPLE PROBLEM NUMBER FOUR. NO PROJECT NUMBER AUGUST 1, 1968 G.H.S.

LOCATION DATA

BACK STA.	AHEAD STA.	REF. STA.	REF. ANGLE	REF. DIST.
2200.0000	2500.0000	2500.0000	0- 0- 0.0	1000.0000

HORIZONTAL CURVE DATA

CURVE NO. 1	P.C. STA.	CURVE NO. 2	P.T. STA.	CURVE NO. 3
0- 0- 0.0	0.0	0- 0- 0.0	0.0	0- 0- 0.0

VERTICAL CURVE DATA

PVI Z STA.	PVI 1 STA.	PVI 2 STA.
1500.0000	1900.0000	2900.0000

EL. PVI Z	% GR. Z-1	LVC 1	% GR. 1-2	LVC 2	% GR. 2-3
943.9200	-0.500000	700.000	-1.500000	1100.000	-5.000000

CROWN AND LANE DEFINITIONS

CODE	S.R.INS.	S.R. 1	INS.PIV.	S.R. 2	S.R. 3	S.R.OUTS.	S.R. 4	OUTS.PIV.	S.R. 5	S.R. 6
PAR	0.0	10.0000	0.0	10.0000	1.5000	0.0	0.0	0.0	0.0	0.0

I
t4i

LONGITUDINAL LINES

NO.	TYPE	REF.	DR / X1	STA./ Y1	TR / R / X2	Y2	SK.	REMARKS
1	PAR	2	8.0000	0.0	0.0	0.0	0	BEAM A
2	COR	0	1000.0000	1000.0000	1000.0000	0.0	0	BEAM B
3	PAR	2	-8.0000	0.0	0.0	0.0	0	BEAM C
4	END							

SPAN INPUT DATA

6 T-LINES SPAN 1,2,3

BENT DATA

	C	NO.	TYPE	STATION	SKEW ANGLE	STA./NORM.	REMARKS	LONGITUDINAL LINE SKIPS
B	0	1	SKEW	2210.0000	18- 0- 0.0	0.0	BENT 1	1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
A	0	4	SKEW	2470.0000	0- 0- 0.0	0.0	BENT 4	1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

T-LINE DATA

NO.	LINE CODE	B	S/N/D/P/X	RL	A/S/D/P/Y	B	RL	C	REMARKS	LONGITUDINAL LINE SKIPS
1	PARL/DIST	B	1.5000	2	0.0		0	0	CL.BRG.BENT 1	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2	PARL/DIST	B	60.0000	2	0.0		0	0	SPLICE PT. 1	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
3	PARL/DIST	B	100.0000	2	0.0		0	0	SPLICE PT. 2	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
4	PARL/DIST	B	160.0000	2	0.0		0	0	SPLICE PT. 3	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
5	PARL/DIST	B	200.0000	2	0.0		0	0	SPLICE PT. 4	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
6	PTPT/COOR		0.0	0	31.5000		0	0	CL.BRG.BENT 4	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
			1000.0000		31.5000					

SPAN OUTPUT DATA SPAN 1,2,3 PROB. NO. EX.4

BENT DATA

BT. NO.		STATION	SKEW ANGLE	REMARKS	TYPE
B	1	22+10.0	18-00-00.0	BENT 1	SKEW
A	4	24+70.0	0-00-00.0	BENT 4	SKEW

LONG. LINE 1 PAR BEAM A

T-LINE	STATION	ELEVATION	DT TO ML	DT TO BT	DT TO PP	ANGLE	X	Y	REMARKS	TYPE LINE
T 1	22+08.9006	937.1944	8.0000	1.5000	0.0	-72-00-00.0	1008.0000	291.0994	CL.BRG.BENT 1	PARL/DIST
T 2	22+67.4006	936.3290	8.0000	60.0000	0.0	-72-00-00.0	1008.0000	232.5994	SPLICE PT. 1	PARL/DIST
T 3	23+07.4006	935.7290	8.0000	100.0000	0.0	-72-00-00.0	1008.0000	192.5994	SPLICE PT. 2	PARL/DIST
T 4	23+67.4006	934.8242	8.0000	160.0000	0.0	-72-00-00.0	1008.0000	132.5994	SPLICE PT. 3	PARL/DIST
T 5	24+07.4006	934.1766	8.0000	200.0000	0.0	-72-00-00.0	1008.0000	92.5994	SPLICE PT. 4	PARL/DIST
T 6	24+68.5000	933.0891	8.0000	261.0994	0.0	90-00-00.0	1008.0000	31.5000	CL.BRG.BENT 4	PTPT/COOR

LONG. LINE 2 COR BEAM B

T-LINE	STATION	ELEVATION	DT TO ML	DT TO BT	DT TO PP	ANGLE	X	Y	REMARKS	TYPE LINE
T 1	22+11.5000	937.2369	0.0	1.5000	8.4117	-72-00-00.0	1000.0000	288.5000	CL.BRG.BENT 1	PARL/DIST
T 2	22+70.0	936.3700	0.0	60.0000	8.4117	-72-00-00.0	1000.0000	230.0000	SPLICE PT. 1	PARL/DIST
T 3	23+10.0	935.7700	0.0	100.0000	8.4117	-72-00-00.0	1000.0000	190.0000	SPLICE PT. 2	PARL/DIST
T 4	23+70.0	934.8636	0.0	160.0000	8.4117	-72-00-00.0	1000.0000	130.0000	SPLICE PT. 3	PARL/DIST
T 5	24+10.0	934.2127	0.0	200.0000	8.4117	-72-00-00.0	1000.0000	90.0000	SPLICE PT. 4	PARL/DIST
T 6	24+68.5000	933.1691	0.0	258.5000	8.0000	90-00-00.0	1000.0000	31.5000	CL.BRG.BENT 4	PTPT/COOR

LONG. LINE 3 PAR BEAM C

T-LINE	STATION	ELEVATION	DT TO ML	DT TO BT	DT TO PP	ANGLE	X	Y	REMARKS	TYPE LINE
T 1	22+14.0994	937.1193	-8.0000	1.5000	8.4117	-72-00-00.0	992.0000	285.9006	CL.BRG.BENT 1	PARL/DIST
T 2	22+72.5994	936.2510	-8.0000	60.0000	8.4117	-72-00-00.0	992.0000	227.4006	SPLICE PT. 1	PARL/DIST
T 3	23+12.5994	935.6510	-8.0000	100.0000	8.4117	-72-00-00.0	992.0000	187.4006	SPLICE PT. 2	PARL/DIST
T 4	23+72.5994	934.7429	-8.0000	160.0000	8.4117	-72-00-00.0	992.0000	127.4006	SPLICE PT. 3	PARL/DIST
T 5	24+12.5994	934.0887	-8.0000	200.0000	8.4117	-72-00-00.0	992.0000	87.4006	SPLICE PT. 4	PARL/DIST
T 6	24+68.5000	933.0891	-8.0000	255.9006	8.0000	90-00-00.0	992.0000	31.5000	DL.GRG.BENT 4	PTPT/COOR

COORDINATE OUTPUT DATA   CENTERLINE BRGS., SPLICE POINTS   PROB. NO. EX.4

COOR	STATION	ELEVATION	DT TO ML	X	Y	PT.	REMARKS	
P 1	22+08.9006	937.1944	8.0000	1008.0000	291.0994	A B1	BEAM A	CL.BRG.BT.1
P 2	22+67.4006	936.3290	8.0000	1008.0000	232.5994	A S1	BEAM A	SPLICE PT.1
P 3	23+07.4006	935.7290	8.0000	1008.0000	192.5994	A S2	BEAM A	SPLICE PT.2
P 4	23+67.4006	934.8242	8.0000	1008.0000	132.5994	A S3	BEAM A	SPLICE PT.3
P 5	24+07.4006	934.1766	8.0000	1008.0000	92.5994	A S4	BEAM A	SPLICE PT.4
P 6	24+68.5000	933.0891	8.0000	1008.0000	31.5000	A B4	BEAM A	CL.BRG.BT.4
P 7	22+11.5000	937.2369	0.0	1000.0000	288.5000	B B1	BEAM B	CL.BRG.BT.1
P 8	22+70.0	936.3700	0.0	1000.0000	230.0000	B S1	BEAM B	SPLICE PT.1
P 9	23+10.0	935.7700	0.0	1000.0000	190.0000	B S2	BEAM B	SPLICE PT.2
P 10	23+70.0	934.8636	0.0	1000.0000	130.0000	B S3	BEAM B	SPLICE PT.3
P 11	24+10.0	934.2127	0.0	1000.0000	90.0000	B S4	BEAM B	SPLICE PT.4
P 12	24+68.5000	933.1691	0.0	1000.0000	31.5000	B B4	BEAM B	CL.BRG.BT.4
P 13	22+14.0994	937.1193	-8.0000	992.0000	285.9006	C B1	BEAM C	CL.BRG.BT.1
P 14	22+72.5994	936.2510	-8.0000	992.0000	227.4006	C S1	BEAM C	SPLICE PT.1
P 15	23+12.5994	935.6510	-8.0000	992.0000	187.4006	C S2	BEAM C	SPLICE PT.2
P 16	23+72.5994	934.7429	-8.0000	992.0000	127.4006	C S3	BEAM C	SPLICE PT.3
P 17	24+12.5994	934.0887	-8.0000	992.0000	87.4006	C S4	BEAM C	SPLICE PT.4
P 18	24+68.5000	933.0891	-8.0000	992.0000	31.5000	C B4	BEAM C	CL.BRG.BT.4

VII. OPERATING PROCEDURE

The State Highway Department of Georgia has in operation at the present time (August, 1968) an IBM 360 Model 30 Computer System with 65 thousand core storage positions. This System is to be replaced by a Model 50 IBM 36o with 262 thousand core storage positions in January of 1969.

The "Skewed Bridge" computer program has been compiled, tested, and is currently being run on our present computer system using the Disk Operating System (DOS)., Release 13.

COMPATIBILITY

The "Skewed Bridge" computer program is written in Basic Fortran IV programming language primarily to obtain computer independency. However, there are two features of the program which may not be compatible with other computer systems,, and following is a discussion of each.

1. Alphabetic Constants.

    One, three, and four character alphabetic constants are used by the program to check the various codes that are used in the input data. These alphabetic characters are defined by their integer binary equivalent. The integer equivalents are assigned by program statements (instructions). If this program is compiled on a computer system other than an IBM 360, the procedure would be to change, if required, the integer equivalent of the alphabetic characters. This should require only a few minutes. Following is a list of the characters in the order that they are defined in the program.

    1, 2, 3, 4, 5, 6, 7, 8, 9, *, A, B, C, T, LVL, PAR, CRD, ARC, RLG, PIA, PIB, COR, STP, CTP, COS, END, YES, CONT, CONS, STAR, blank, FINI, SPAN, COOR, LAST, PARL, SKEW, PSTA, SAME, PREV, ANGL, PTPT, DIST, PROP, NORM

2. Double Precision.

    All floating-point computations are done using the long (double precision) form of floating-point data representation. Constants are defined at the beginning of the program, and used in the program, by using the “D” code, which indicates double precision data. This form of data representation may have to be revised or altered when compiling on a computer system other than an IBM 360.

Except in the case of the aforementioned features, this program should be computer independent, both in terms of models and manufacturers. However, low core capacity and the unavailability of a Fortran IV compiler would naturally limit the use of the program.

COMPILING THE PROGRAM

The "Skewed Bridge" computer program, which is written in Basic Fortran IV programming language, is divided into two parts: a Mainline program which is referred to as Phase I, and a Subroutine which is referred to as Phase II. This division was necessitated by the 500 statement number limitation of the Fortran IV computer (COS Release 13). The Mainline or Phase I program CALLS the Subroutine or Phase II portion of the program.

The core storage requirements are approximately 58,000 positions (bytes) which does not include any supervisor program. This capacity plus the supervisor require almost the entire core storage of a 65k computer. If the program is going to be used on a computer system with less than 65k core storage, the program could be divided into individual program phases. Then, a master program could be written to call and overlay the different phases as required by the computations. If the computer system has a sufficiently large core storage capacity, the compilation process will consist simply of compiling the Mainline (PH. I) and Subroutine (PH. II), linkage-editing, and cataloging the program into the systems library (core image and/or relocatable) with an appropriate name. Following is the sequence of the Control Cards and source decks that is used when compiling, linkage-editing, and cataloging (core image library) the program under the Disk Operating System.

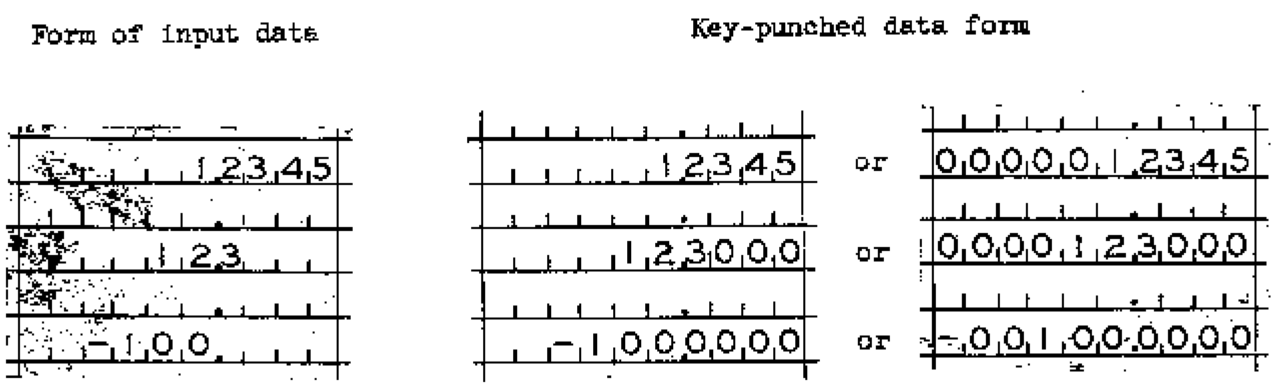
```
// JOB SKEWBR

//OPTION CATAL

 PHASE SKEWBR,*

//EXEC FORTRAN

    Source Deck (PH. I)
/*

//EXEC FORTRAN

    Source Deck (PH. II)
/*

// EXEC LNKEDT
/&
```

Note that the name "SKEWBR" has been chosen for the program; however, the name assigned to the program is immaterial. The name of the program is left to the user's prerogative.

KEY-PUNCH INSTRUCTIONS

The input data will consist of several input sheets per problem with each line of the input data sheets representing a card. The numbers of the card columns are given in the headings of the various types of input lines for reference during and after punching. Note that the position of the decimal that is shown on the input form does not occupy a card column and should not be punched. However, on occasions a decimal will be entered in a card column and, in this instance, the decimal should be punched. Plus signs (+) are included in some of the input data. However, these signs do not occupy a card column and should not be punched. Care should be taken to prevent the overlooking of a minus sign (a dash) in the input data fields.

All blank data fields or card columns may be punched as zeros except in the alphabetic fields. These data fields are read as alphabetic characters and, therefore, a blank or zero would have a significant meaning. In addition, zeros should not be punched in a data field immediately preceding a minus sign of that field. In general, the input data should be punched exactly as given on input data forms. Following are examples of how the input data is most likely to be entered in the input data fields and how the data fields may be punched.



Only the lines that contain data entered by hand (data that is not a part of the green ink of the input data form) should be punched. The input data should be punched in the same sequence as given on the input data forms. That is, the key-punch operator should punch the input data in the same sequence that it is received. Any exception to this will be clearly noted on the input forms by the Engineer. On occasions, input data will be entered on the forms between the input data lines. In this case, punch the data in the sequence given as if the space between the input lines was another input line.

COMPUTER OPERATOR INSTRUCTIONS

No instructions on the manual operation of the computer will be given here. The computer operator is assumed to be fully versed on the computer operation. Primarily, this discussion will present the characteristics of the program which the computer operator is required to know in order to process the program.

The input data (cards) should be received from the key-punch section in the correct sequence, i.e., there should be no reason to rearrange the sequence of the input data cards. All input data to the program is from punched cards, and all output from the program is listed by the printer. No other I/0 devices are used. The program has the ability to process one or several problems requiring only one EXECute Control Card with the first problem, i.e., the program automatically continues from one problem to another. The output form is automatically skipped by the program before printing the output data of each problem. The output data will consist of from three to several sheets per problem. The running time required per problem will vary depending on the amount and type of input data with the average problem requiring approximately one and one-half minutes. The input data cards should be entered in the card reader device in the following order:

1. // JOB SKEWBR (Job Control Card)
2. // EXEC SKEWBR (Execute Control Card)
3. Input data for all problems (Input data cards)
4. 9 ("Last Card" Control Card to Program)
5. /* (End of Data Control Card)
6. /& (End of Job Control Card)

All Control Cards except the "Last Card" Control Card are dependent on the operating system. The Control Cards shown above are for the IBM Disk Operating System. The "Last Card" Control Card is used by the program to indicate the end of the last problem and to transfer control to the Supervisor. This type of Control Card makes it possible for the program to read out all the remaining cards of a problem when an error is detected and proceed to the next problem. The "Last Card" Control Card should have a nine (9) in card column one (1) with all other card columns left blank.

After completing the processing of all problems, separate the output data of the various problems and return the output data along with the input data forms to the Engineer. The first line of output of each problem will contain:

"SKEWED BRIDGE PROGRAM INPUT DATA PROB. NO. XXXX"

where XXXX is the Problem Number which is given in card columns 2-5 of the Identification card of the Layout Data (first sheet of each problem). This will be of assistance when separating the output data of the various problems.

The program has a procedure for checking the validity of the input data, and will print an error message after detecting an error in the input data. The error message will be given in the list of the output data of the problem in error. After an error the rest of that problem's input data cards are read out and the program proceeds to the next problem. Actually, the only way the computer operator will know that an error has been detected is to observe the output data.

The procedure after an error message is to first, check the input data cards of the problem in error for key-punch errors, and second, check the sequence of the input data cards. If the input data cards are found to be punched correctly and in the proper sequence, return the output data with the error message and input data forms to the Engineer; if not, make the appropriate correction and rerun the problem from the beginning.