COLORADO
Department of Transportation
Division of Project Support

BRIDGE GEOMETRY MANUAL

STAFF BRIDGE BRANCH

2017

Table of Contents

Chapter 1 Synopsis

The CDOT Bridge Geometry program computes three-dimensional coordinates of points on a structure and on the roadway approaches to a structure. The input data consists of nine essential items:

1. At least one information record containing the structure ID
2. Horizontal alignment data
3. Vertical alignment data
4. Superelevation and cross-slope data
5. Reference line and layout data
6. Girder (longitudinal) lines
7. Bent (transverse) lines
8. Dead load deflections
9. Roadway approach data

The surface deck of the structure is considered a grid of intersecting girder (longitudinal) lines and bent (transverse) lines. Output results include the coordinates of each intersection point, together with intermediate “fractional” points, printed sequentially along each girder line. Two independent coordinate systems locate the points in the horizontal plane: (1) the surveyor's station and offset from the horizontal control line, and (2) a right-hand rectangular Cartesian coordinate system (X,Y) with respect to a selected layout line.

Results printed for intersection and fractional points include: finished elevation, elevation adjusted for dead load deflection, girder line length, and roadway cross-slope (when continuous). For intersection points, bent line length and the skew angle of the bent line (with respect to the girder line) are also printed.

On roadway approaches, finished grade elevations and roadway cross-slopes are printed at given stations for each designated offset line.

This Manual uses the United States Standard Measure (English units)

The Bridge Geometry program was originally based on computer input cards & forms. It was revised for the input to be done using a graphic user interface (GUI).

The instructions in this Manual reference both the GUI and the original input forms (see Appendix B).

Chapter 2 Bridge Geometry Overview

TERMINOLOGY

"***Input file***" refers to the (*.dat) input file.

"***Tab***" refers to the tab at the top of the Graphic User Interface (GUI.)

"***Record***" refers to an 80 character line in the input file.

"***Field***" refers to space in a record or the GUI for a single item.

"***Col***" means a character position (1 to 80) in the input text file. Every input record begins with a two col Record Type field, automatically inserted by the GUI.

"***Default***" value refers to the number, amount or option that will be used if a field is blank. In many cases default and zero have the same effect.

Input coding for the GUI.

1. Dimensions to be input in feet (or inches as required) ,with an explicit decimal point and appropriate sign
2. Stations to be input as SSSFF.DDDD, SSS FF.DDDD, OR SSS+FF.DDDD
3. Angles to be input as DD MM SS.DD
4. Cross slopes in ft./ft. with appropriate sign

Decimal points are implicit in most of the *.dat file

Except in the instance of normal crown section, "normal" is used in the sense of perpendicular (at right angles).

Directions such as left/right, back/ahead, in/out, or begin/end are with respect to ahead station unless otherwise specified.

Throughout this manual, the term "girder line" is used in a generic sense to mean any longitudinal line; i.e., a line running the length of the structure which intersects each bent line. Thus outside edge of deck, gutter line, back tangent, layout line (LOL) and profile line are all examples of girder lines. Similarly, "bent line" is used generically to mean any transverse line (more accurately, a transverse vertical plane); i.e., a line running across the structure which intersects each girder line. Thus splice line, diaphragm, centerline of bearing, face of cap, and back face of abutment are all examples of bent lines. Girder lines have the attribute of elevation; bent lines do not.

A "straight" line means that its projection in the horizontal plane (disregarding elevation) is straight.

Unless otherwise specified the terms "reference bent," "reference line," or "reference bent line" mean the primary reference (bent) line. Each set of 04-07 records is associated with a single primary reference line; there may be many secondary reference lines or none in a set.

After the program has located all bent lines, they are sorted in order of increasing station (at the point where they cross the HCL). This means that the order of 06 records is not significant: a group of 06 records may be shuffled in any order without significantly affecting output. References to order of bent lines (such as "first," "next" or "last") refer to this sorted order, not to the sequence of 06 records on input.

Two girder lines are always known to the program: (1) The station line controls horizontal alignment and is the line where, even though a curve, one station is equal to 100 feet; it is

commonly (but not always) coincident with the profile (vertical control) line. (2) The LOL is a straight line determined by parameters on 04 record.

The term “intersection point” is used for points at the intersection of a girder line and a bent line. “Intermediate points” or “fractional points” occur in a “span” between two (not necessarily consecutive) intersection points. A “span” of deflection points corresponds to a “span” of fractional points.

The skew of a bent line, with respect to a girder line, is the angle measured from a normal on the girder line (drawn at the point of intersection) to the bent line. When the angle turns to the right, (clockwise) the skew is positive; to the left (counter-clockwise) is negative, as shown in Figure 1.

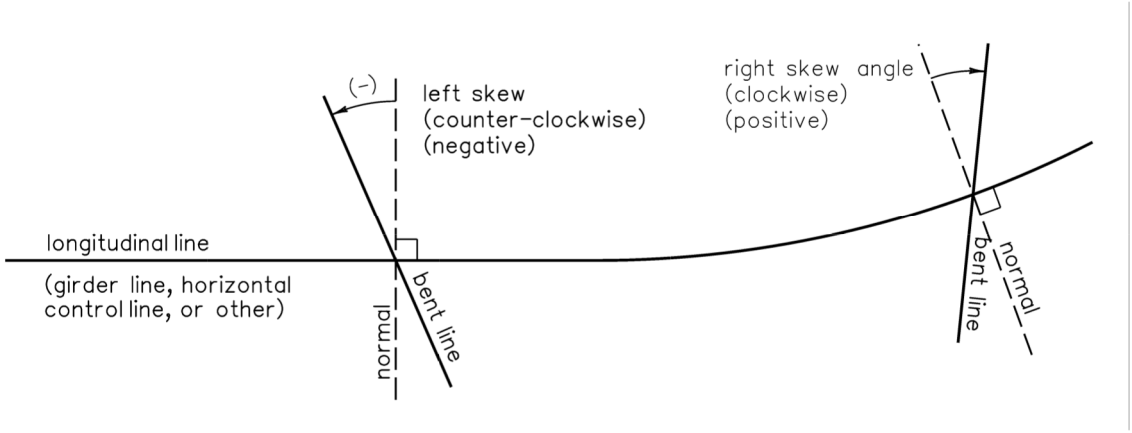


Figure 1 : Skew Convention

“Finished” elevation does not necessarily mean finished grade. The finished surface of the deck means top of concrete, which may be below finished grade if, for example, a 3 inch asphalt overlay is to be required. Finished elevation for a line representing bottom of girder may be several feet below finished grade.

In the GUI, options are selected using radio buttons or by option pull-downs.

DATA SET ORGANIZATION

The input data set (*.dat) consists of a set of 00 through 08 records for one structure. Only one structure may be processed at a time.

One data set for a structure consists of:

- One 01 (Horizontal Alignment) record
- One 02 (Vertical Alignment) record
- At least one (at least one (or arbitrarily many) 00 (Information) record(s)
- Or up to 16) 03 (Cross Slope and Transition Data) record(s)
- At least one (or arbitrarily many) sequence(s) 04 (Reference Line) record(s)
- At least one (or up to 100) 05 (Girder Line) record(s)
- At least one (or up to 80) 06 (Bent Line) record(s)
- (up to 200) optional 07 (Dead Load Deflection) records
- Optional 08 (Roadway Approach) record

Records with Record Type 99 are transparent to the program; they may be used for comments anywhere in the “deck”.

If the program fails to find a required record in this sequence, it will ignore the record read and continue reading and ignoring records until it finds the record type for which it is searching. In this case a fatal error message, listing (at least some of) the records that were ignored, will be printed at the end of the output.

The Graphic User Interface (GUI)

The GUI is provided to allow an orderly input into Bridge Geometry. It may be accessed by clicking on the BRIDGE GEOMETRY icon on the desktop or clicking the Bridge Geometry item in the Start menu.

Figure 1 - The Startup Pane

Main Menu Bar

File

New

Starts a new input file with blank input tabs. Filename and folder path should adhere to MS-DOS convention.

Open

Opens an existing *.dat file for editing.

Save

Saves the edited file to the same filename. Does not create the *.lis (output) file.

Save as...

Saves the file to a new filename. The original file is unchanged.
Does not create the *.lis (output) file.

Save and Run

Saves the file and runs the Geometry program.
Creates the *.lis file.

Run

Geometry

Runs the selected *.dat to create the *.lis file.
The *.dat file need not be loaded into the GUI.

Project Coordinates

Brings up a dialog box for entering the transform data for the coordinates
Creates Easting and Northing coordinates in a *.lis file to produce a *.pcf file.
The *.pcf file is to be used for the Paste-up of the Elevation sheets in the Bridge Plans
Filename and Folder path should be in MS-DOS protocol

Camber

Creates camber cutting and blocking information for a welded steel plate girder
*.lis file must have dead load deflection information.
Creates input (*.cmb) file for the Camber utility from the *.lis file.
Automatically runs the Camber utility to create the *.out file to be used in the creation of the Bridge Plans

Stick Figure

Creates a 3-D Graphic file of the bridge super-structure.
The only viable option in the dialog box at present is DXF.
Creates a *.dxf file
Filename and Folder path should be in MSDOS protocol.

View

Toggles Tool Bar at top of pane on or off
Toggles Status Bar at bottom of pane on or off.

Options

Set Output Editor

Installs a text editor which automatically loads a copy of the *.lis output for review
Recommended Editors:

- ✓ notepad.exe
- ✓ PFE32.EXE (May be found at \\public\Bridge Common\PFE32\new pfe32 that works.)
- ✓ Other text editors may be used according to personal taste.
- ✓ Not selecting an editor will result in a "Run Time Error 05."

Help: Brings up a rather rudimentary help file

Tool Bar - The Tool Bar contains three icons:

NEW: Begins a new *.dat file input.
OPEN: Opens an Existing *.dat file for editing.
SAVE: Saves the edited *.dat file. New files should be renamed from the beginning.

Status Bar - The Status Bar contains a list of startup commands, time and date

Tab Pane - Tab Pane appears when a New or Open command is given from either the Menu Bar or the Tool bar. The 9 individual tabs are covered in Chapter 3 Input Data.

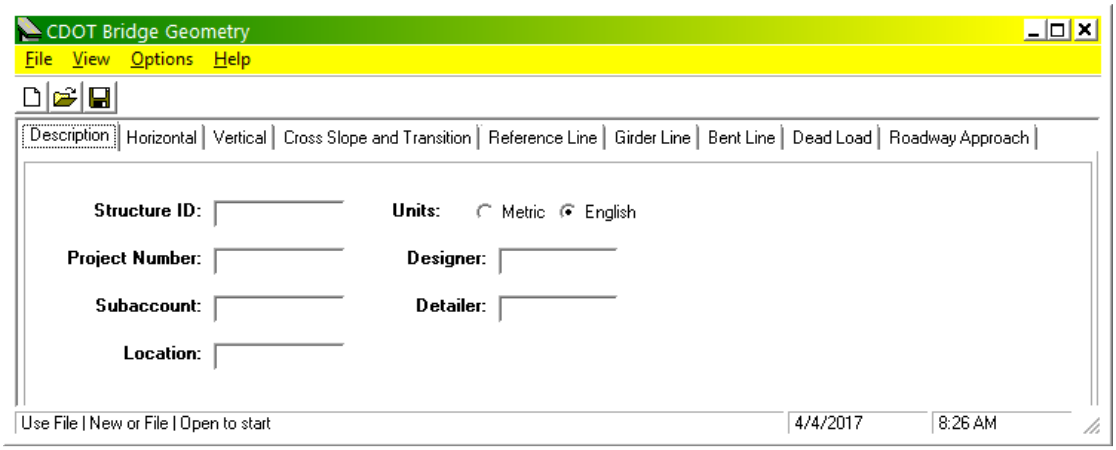


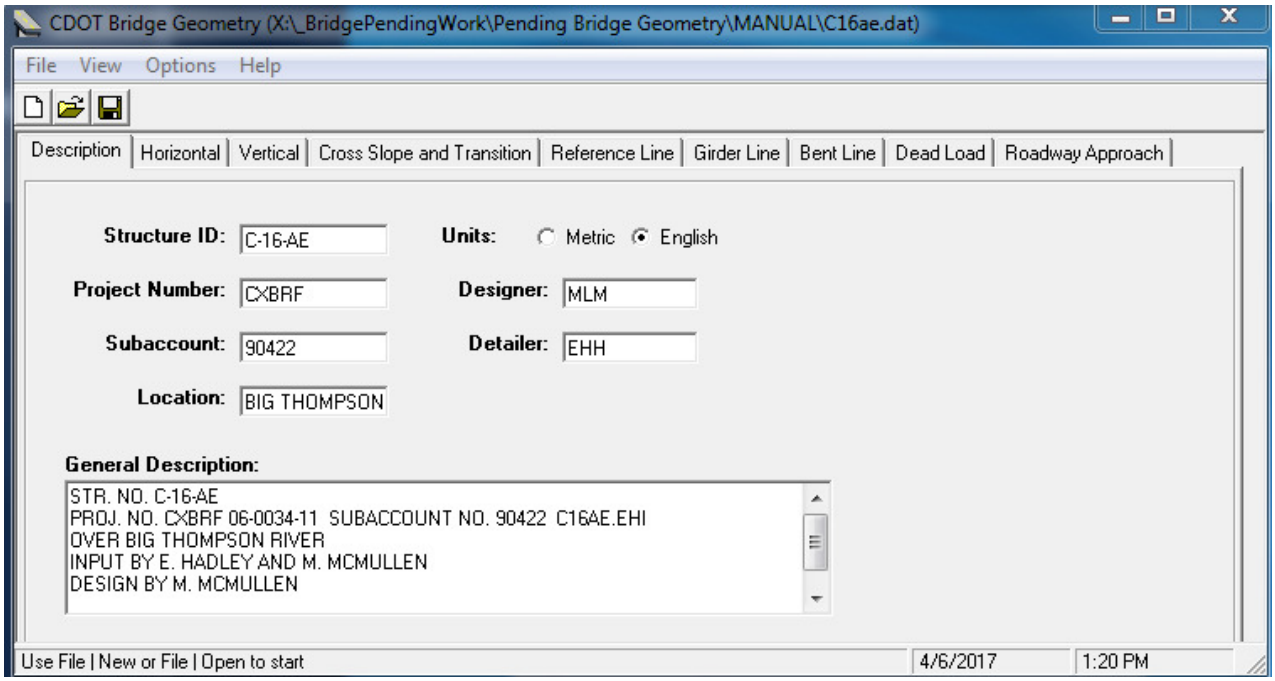
Figure 2 – The Tab Pane

Chapter 3 Input Data

1. DESCRIPTION TAB

Description tab (00 RECORDS) (refer: “IDENTIFICATION AND ALIGNMENT” Form)

This tab provides input for general project information and description.



Tab No. 1 Record Type 00 General Information

STRUCTURE ID (cols 3-12, first record only)

This field provides a ten character identification which will appear in the banner line at the top of each page of output.

METRIC OR ENGLISH RADIO BUTTONS (Column 80) (First 00 record only)

Select the button for the desired system.

For the *.dat input, place an “M” in column 80 of the first 00 record for metric. For English, leave this column blank.

DESCRIPTION (cols 3-80)

Provide a detailed description of the structure and its design including:

- project number,
- designer,
- detailer,
- location,
- method and materials of construction, span lengths, etc.

In unusual or complicated situations, also include remarks regarding special considerations made for the input data, such as:

- nonstandard treatment of superelevation
- station equations or curves resulting in begin or end station coded in 04 record, cols 59-80
- nominal offsets specified on 05 records (line type 4)
- non-uniform elevation shifts on 05 records
- reasons for any adjustment to alignment data taken from line sheets
- I.D of individual preparing input if different from the Designer/Detailer

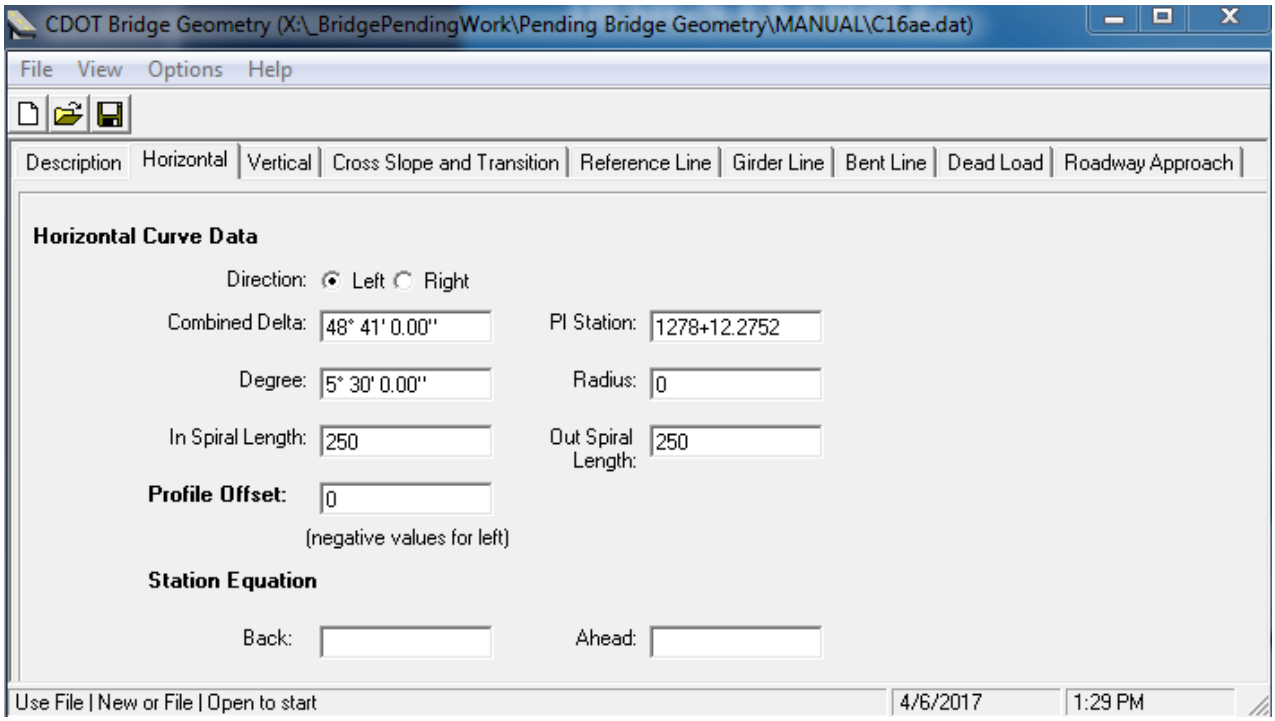
An unlimited number of 00 (Information) records may be used, so make remarks thorough, detailed and complete. Formatting for double spaced lines may be accomplished by inserting blank records as appropriate.

The information on this tab will be printed on the first page of output.

2. HORIZONTAL TAB

Horizontal tab (01 RECORD) (refer: “IDENTIFICATION AND ALIGNMENT” Form)

This tab provides input for the Horizontal Curve data



Tab No. 2 Record type 01 Horizontal

NOTES:

When the entire structure and roadway approaches lie on a horizontal tangent, the profile offset is zero, and no station equation is used, all input fields (cols 3-80) may be blank.

CAUTION: It is usually better to code a proximal horizontal (or vertical) curve than to assume it will not affect elevations. For example, a bridge begins at station 36+75.0, just after a horizontal curve with P.T. at station 33+50.0 and with 150 foot transitions. It is calculated that the end of transition (station 35+15.0) occurs before the beginning of the 150 foot roadway approach (station 35+20.0); so the horizontal curve is omitted.

Later, it is decided to run the same input file for elevation sheet plots with 200 foot roadway approaches. If the approach length on the Roadway Approach tab (08 record) only is changed to 200.0, the output file will have errors in elevation at the first three stations of the approach.

A similar problem can occur with vertical curves near the structure. To prevent such problems, make full use of the Limits of Valid Elevation and Cross-Slope Data field in the Reference Line Tab (04 record, cols 59-80).

The program processes only one horizontal curve per run. If the structure is on two or more horizontal curves, a separate run must be made for each curve.

DIRECTION (radio buttons)
Choose left or right deflection. Code “L” or “R” in column 3 of the *.dat file.

DELTA (cols 3-12)
Code the central deflection angle (including spirals) in degrees, minutes and seconds.

Equivalent to an L is a minus sign for left deflections; equivalent to an R is a plus, a blank or any character other than L or minus.

Allowable range for delta is: 0° 00’ 04.13” < |DELTA|< 179° 59’ 55.87”

P.I. STATION (cols 13-23)
Code the station of the P.I. of the horizontal curve. This is a station, on the tangent at the point of intersection; not a station on the HCL.

DEGREE (of curve) (cols 24-31)
Code the degree of curve (Dc in degrees per 100 feet of arc) in degrees, minutes and seconds and leave the radius field blank.

Allowable ranges for curvature are: 0º 03' 24.21" ≤ Dc ≤ 40º 55' 32.06"

RADIUS (of curve) (cols 52-58)
Code the radius in feet with EXPLICIT decimal point and leave the degree field blank. The radius will be shown in the output under “Horizontal Alignment Data.”

Allowable range for radius is: 140feet $\leq$ rad $\leq$ 101000 feet.

Exception: If spirals are not used (simple curve), a shorter radius may be used. The minimum radius permitted in this case is 10.0 feet.

IN SPIRAL LENGTH and **OUT SPIRAL LENGTH** fields (cols 32-37 & 38-43)
Code the length in feet of spiral transitions into and out of the curve. If spirals are not used (simple curve), leave these fields blank; but see “Crown and Super-elevation Data” (03 records) regarding smooth profiles.

PROFILE OFFSET (cols 44-51)
If the HCL is also the profile line, leave this field blank. If not, code the offset in feet from HCL to profile line. Positive offset indicates profile line is to the right of HCL and negative indicates offset is to the left.

STATION EQUATION Back (cols 59-69) and **Ahead** (cols 70-80)
If an equation occurs in the neighborhood of the structure, code the back station and ahead station of the equation in these fields. A station equation is permitted only at tangent alignment, never in the middle of a horizontal curve.

The first col of every station field (see list below) is for an equation number, a digit that “floats” in front of the station. If the equation is non overlapping (i.e., back station is less than ahead

station), equation numbers are never required. For an overlapping equation (i.e., back station is greater than ahead station), equation numbers are required

When equation numbers are required (for overlapping equations), equation number in the Back Station field may be any digit from 0 to 8 (blank is equivalent to zero); equation number in the Ahead Station field must be (at least) one greater than the digit in Back Station field.

When equation numbers are used (whether equation is overlapping or not), all stations in ALL station fields MUST be coded consistently with the required equation number. The following are station fields:

- Horizontal Tab, P.I. Station (01record, cols 01 13-23)
- Horizontal tab, Back and Ahead Stations (01 record, cols 59-69 and 70-80)
- Vertical tab, P.I. Stations (02 record, cols 18-26 and 48-56)
- Cross Slope and Transitions tab, Optional Superelevation Overrides (optional 03 records, cols 3-11)
- Reference Line tab, Reference Station (04 record, cols 3-13)
- Reference Line Tab, Begin and End Stations (04 record, cols 59-69 and 70-80)

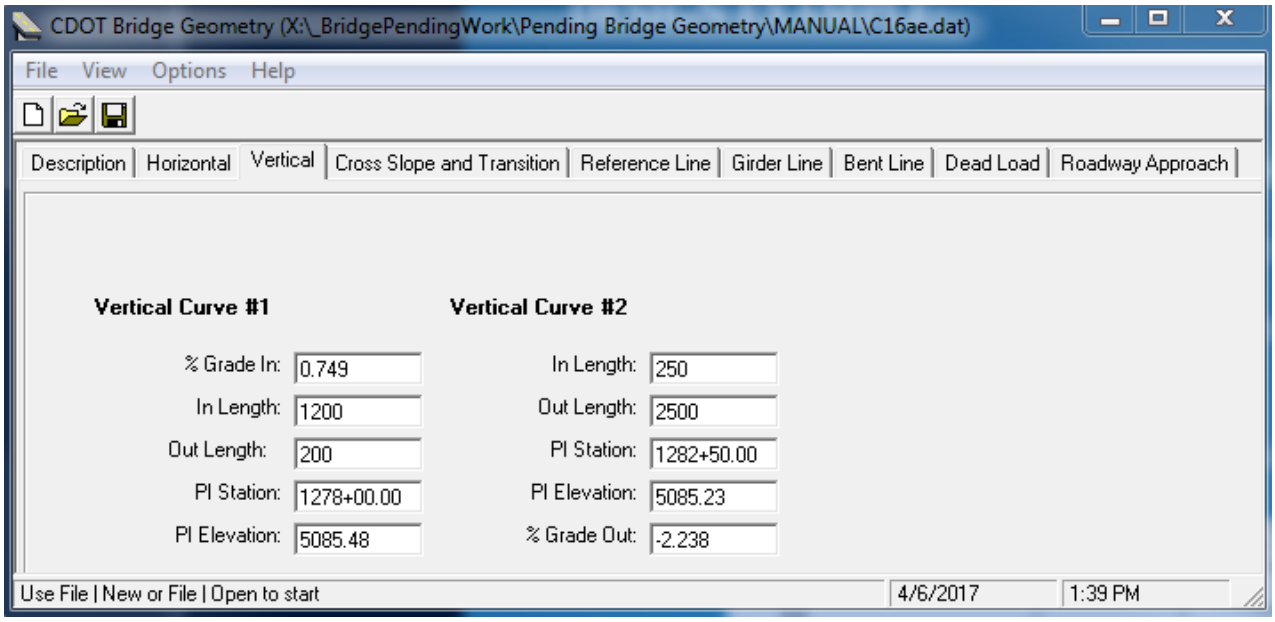
- Roadway Approach tab, Begin and End Structure (08 record, cols 3-9 and 10-16)

Stations with equation numbers must be input into the *.dat file with a text editor.

3. VERTICAL TAB

Vertical tab (02 RECORD) (refer: "IDENTIFICATION AND ALIGNMENT" Form

This tab provides input tor the vertical alignment



Tab No. 3 Record Type 02 Vertical

NOTE

It is usually better to code this record fully for the two vertical curves nearest the structure than to assume that roadway approaches will not extend into curves. (See caution given under "Horizontal Alignment Tab.") Certain abbreviated forms, however, are acceptable:

When the entire structure and roadway approaches lie on vertical tangent, give either

A. two P.I. stations and elevations, or
B. a grade (either field) and P.I. (either field)

For reasons of accuracy (see % Grade In, cols 3-11) the first method is recommended.

Curve lengths are ignored in this case. When the entire structure and roadway approaches lie on a single vertical curve, give either

A. a grade (either field, as appropriate) and two P.I.'s with associated elevation and in and out lengths, or
B. two grades and a P.I. with associated elevation and in and out lengths, (either field). Again, for reasons of accuracy, the first method is recommended and a curve length for the P.I. not associated with a change in grades is ignored.
C. The program processes only two vertical curves per run. If the structure is on three or more vertical curves, a separate run shall be made for the additional curves.

% GRADE IN (cols 3-11)
Code the signed percent grade (feet per 100 feet of run) approaching the first vertical curve P.I. Note: Grades on line sheets are frequently given to four decimal places or less. Better accuracy can be obtained by recomputing these grades (from P.I. stations and elevations) to six decimal places, especially when the structure is some distance away

LENGTH OF VERTICAL CURVE IN (cols 12-17 (1^{ST} curve) & 42-47 (2^{nd} curve))
Code the in length of the vertical curve (that portion of the curve before the P.I.) in feet. In the usual case of a symmetrical curve, this will be half the total curve length.

STATION OF P.I. (cols 18-26 (1^{st} curve) & 48-56 (2^{nd} curve))
Code the stations of the P.I.'s of the vertical curve.

ELEVATION OF P.I. (cols 27-35 (1^{st} curve) & 57-65 (2^{nd} curve))
Code the tangent elevation of the P.I. (in feet above sea level).

There is a difference between "elevation of the P.I." and "grade elevation at the P.I. station"; this field is NOT a grade elevation.

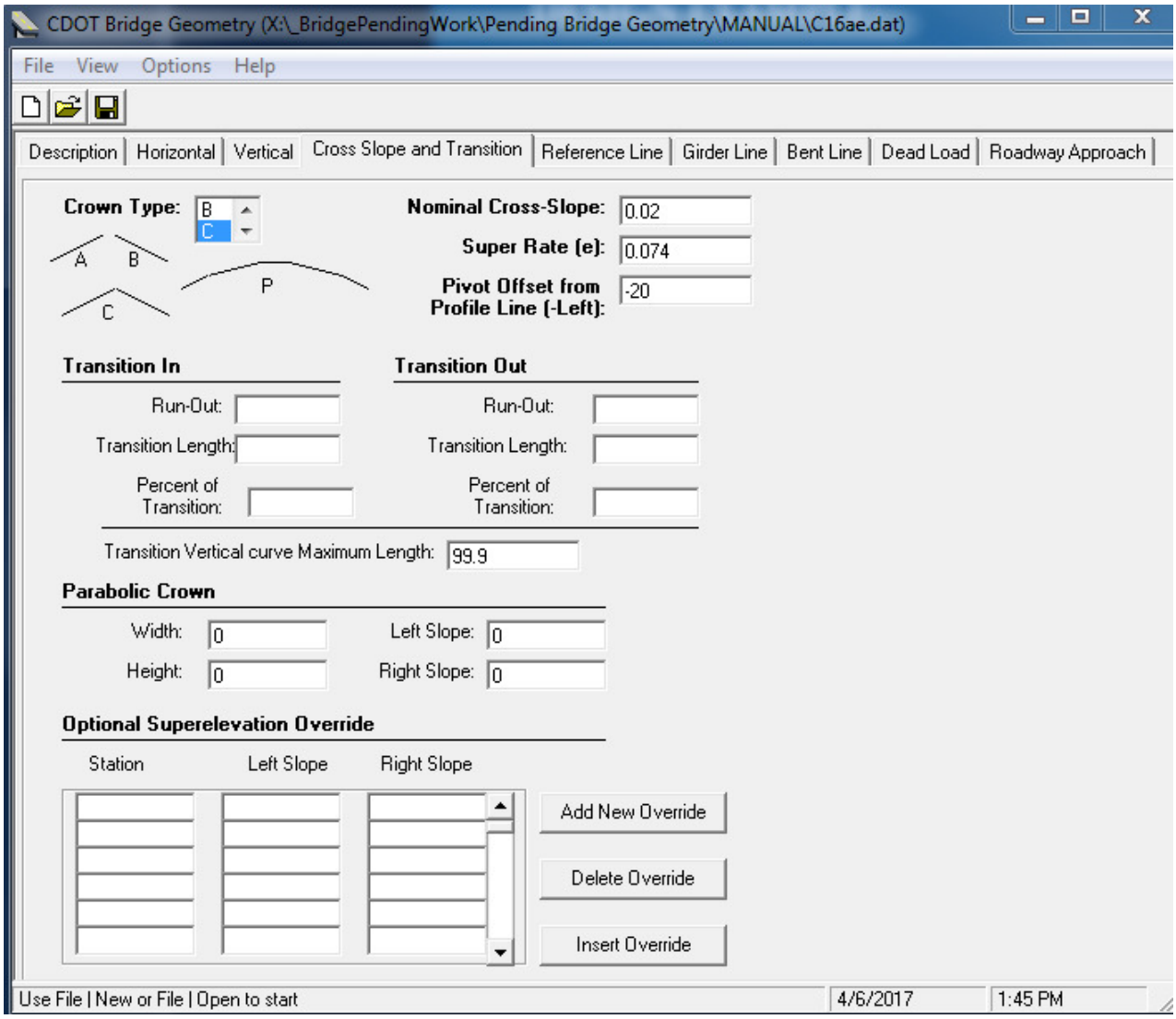
LENGTH OF VERTICAL CURVE OUT (cols 36-41 (1^{st} curve) & 66-71 (2^{nd} curve))
If the vertical curve is asymmetrical, code the post P.I. length of the vertical curve (that portion of the curve beyond the P.I.) . In the usual case of a symmetrical curve, the half-length need be given only once (in either the IN or OUT field) with the other field blank.

% GRADE OUT (cols 72-80)
Similar to % Percent Grade In (see above) for the grade beyond the second (or only) vertical curve. The grade between the P.I.'s is calculated within the program

4. CROWN AND TRANSITION TAB

03 RECORD; (refer: "SUPERELEVATION AND LAYOUT DATA" Form)

This tab provides input for cross-slope and superelevation data



Tab No. 4 Record Type 03 Crown and Transition

NOTE

The initial 03 record is required for each data set. It may optionally be followed by up to fifteen superelevation override 03 records for nonparabolic crowns only; parabolic crowns are not superelevated.

To obtain smooth profiles along girder lines (especially important for welded-plate steel girders and precast box girders), the program will insert a transition vertical curve (75 foot default) at every station where the cross-slope changes nonlinearly. See Chapter 4, "Table of Roadway Cross-Slopes," for a complete description of transition vertical curves. This applies to all superelevated crowns (see Maximum Length of Transition Vertical Curve, cols 51-53). There

remain two situations where a kink (a discontinuity in the first derivative of elevation as a function of length) can occur and the user is cautioned to avoid them unless the significance of the kink is clearly understood and is considered negligible.

One situation occurs at the P.C. or P.T. of a horizontal curve that does not have spiral transitions (simple curve). Regardless of whether the curve is superelevated, a kink will occur at this station in any girder line that is some distance from the HCL. The severity of the kink depends on the offset from HCL and on the radius of curve. The best way to avoid this situation is to put spiral transitions 50 feet in length when not superelevated [e=NC] or transition length when superelevated) in all horizontal curves.

The second situation occurs in the middle of a center crown (crown type C) when a girder line runs across the crown at a significant skew, or when curved and not superelevated with segmented girder lines (line type 1). This situation may be avoided by calling for a parabolic crown (crown type P) and adjusting vertical P.I. elevations downward or by NOT selecting offset option for segmented girder pattern shift (04 record, col 29).

CROWN TYPE (col 3)

Scroll to the desired typical section crown type. Or, in the .dat. file by coding A, B, C or P in this field:

A. shoulder crown, high side right
B. shoulder crown, high side left
C. center crown (center pivot or shoulder pivot)
P. parabolic crown (see cols 57-80 below)

(The characters 1, 2 and 3 are equivalent to A, B and C respectively. Equivalent to a P is any character other than A, B, C, 1, 2 or 3.)

NOMINAL CROSS-SLOPE (cols 4-8)

Code the typical section cross-slope (on tangent) in feet per foot with or without a sign.

SUPER RATE (e) (cols 9-12)

Code the maximum rate of superelevation (never less than zero) in feet Per foot for the horizontal curve. If e=RC (remove adverse crown), code this field the same as nominal cross-slope. If e=NC (nominal crown), leave this field and cols 21-50 blank.

If the superelevation transitions meet in the middle of the horizontal curve, a 75.0 foot transition vertical curve will prevent the cross-slope from actually attaining e. The table of roadway cross-slopes printed on output will give the maximum cross-slope attained. In such cases, it may be advantageous to slightly augment the value given for e so that this maximum more nearly approximates the desired e value.

PIVOT OFFSET FROM PROFILE LINE (cols 13-20)

Code the offset feet from profile line to the pivot point

This dimension, usually found on the roadway typical section, may depend on the direction of the horizontal curve. For example, a center crown with shoulder pivot may have a pivot offset of + 25.0 feet for a curve to the right or -25.0 feet for a curve to the left.

TRANSITION LENGTH FOR SIMPLE CURVE (cols 26-30 & 41-45)

If the horizontal curve does not have spiral transitions, code the length of transition for superelevation in feet. Transition Length field for Transition Out (Cols 41-45) may be blank if transition out is the same length as transition in.

PERCENT OF TRANSITION OUTSIDE SIMPLE CURVE (cols 31-35 & 46-50)

Code the percent of superelevation transition length to be placed before the P.C. (cols 31-35) and after the P.T. (cols 46-50) only if it is not the standard 60 percent. See Standards M-203-11and M-203 -12.

MAXIMUM LENGTH OF TRANSITION VERTICAL CURVE (cols 51-53)

Default value for curve lengths is 75.0 feet. If no transition curves are desired, code zero in this field. See Chapter 4, “Table of Roadway Cross-Slopes” for a complete description of transition vertical curves.

PHANTOM FIELDS (cols 54-55, 56 & 57-65)

In general, these phantom fields should be blank. If they are required they must be input into the *.dat file using a text editor

Cols 54-55 are provided as an overflow for Maximum Length of Transition Vertical Curve field, so that a maximum length greater than 100 feet may be input by coding an explicit decimal point

Col 56 provides an option to override the insertion of a 75.0 foot vertical curve at a vertical P.I. that has no vertical curve. Standard roadway design practice allows: “Vertical curves are not required where algebraic difference in grades “is less than 0.20 percent.” When this condition is encountered (and cols 51-53 are blank or nonzero), the program will automatically insert a vertical curve at the P.I. unless overridden by selecting this option.

Cols 57-65 provide a correction factor for superelevation of type C crowns when the high point (profile line) is not in the center of the roadway.

PARABOLIC CROWN DATA (cols 57-80)

Crown type P may also be useful in cases of a three-piece template with a level median since zero (level) is a valid crown height. Usefulness of this method is limited by the restriction that parabolic crowns may not be superelevated.

Optional superelevation override fields (03 records) may not be used with parabolic crown.

OPTIONAL SUPERELEVATION OVERRIDE

03 RECORD (refer: "SUPERELEVATION AND LAYOUT DATA" Form)

Superelevation transitions that conform to Standards M-203-11, and -12, as well as most transitions that do not conform for reasons of asymmetry, can be handled with the single 03 record. Some nonstandard transitions, however, may require quite different methods.

One such case arises when the standard transition needs to be overridden only in a localized area. For example, when a cross-street forms an intersection in the middle of a spiral transition on the mainline, the superelevation must be held constant across the intersection. Code the initial 03 record for the standard superelevation transition, calculate the super rate at the middle of the intersection, and add two extra 03 records with this cross-slope (adjusted for grade when appropriate) specified at stations before and after the intersection.

A sample table of roadway cross-slopes for such an instance might resemble:

Station	Slope-left	Slope-right	VC length	
(ON TANGENT)		.0200	-.0200	75.0 (MAX)
1+96.6000	-.0200	.0200	75.0	begin run-out
2+66.6000	0.0000	0.0000	75.0	begin 350 ft. spiral
3+90..0000	-.0333	.0333	75.0 -U-	24 ft. cross street @ sta.4+22.0
4+54.0000	-.0333	.0333	75.0 -U-	
6+16..0000	-.0750	.0750	75.0	end spiral
. . . etc. . . .				

The "-U-" note indicates a user-specified cross-slope from optional 03 records. The three 03 records used in this instance were:

```
03 B .020 .075 -4.0
03 3+90 -.0333
03 4+54 -.0333
```

Stations were adjusted to put most of transition vertical curves outside of the 24 ft. intersection. Cross-slopes were calculated assuming mainline grade was negligible.

Such cases arise with compound curves, reversing curves or any instance where transitions are crowded together. In these cases, it is often preferable to inhibit the program's standard Other superelevation by leaving the Super Rate field.(cols 9-12) blank (e=NC) and to code an optional Super Elevation Override record (03 record) for every station where the cross-slope changes nonlinearly. Up to fifteen optional Super Elevation Override records may be used in a structure data set.

STATION FIELD (cols 3-11)

Code the station at which the given cross-slope is to be attained. In any instance where this station conflicts (tolerance 1.0 feet with a station computed by the program, cross-slopes given on optional Super Elevation Override records (03 record) will override those computed by the program.

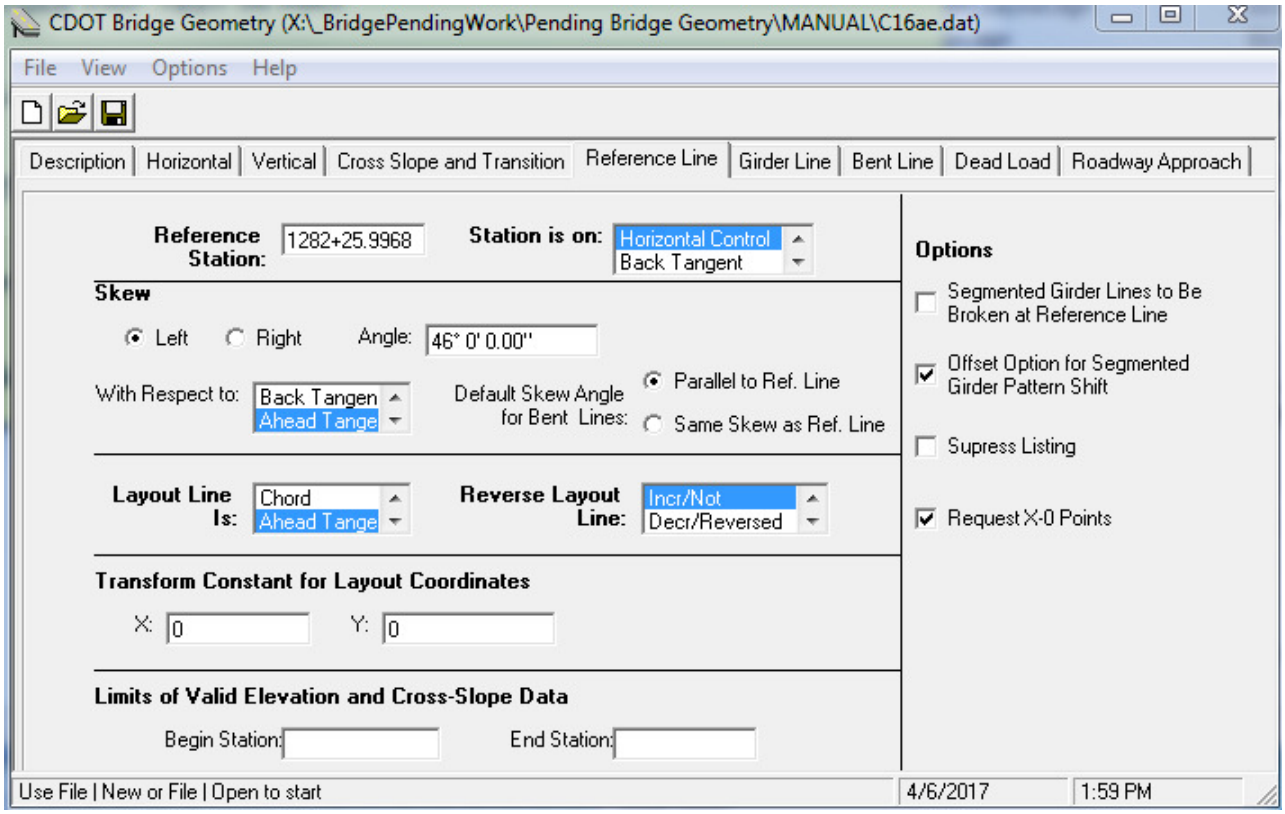
LEFT SLOPE /RIGHT SLOPE (cols 12-16 & 17-21)

Code cross-slopes in feet per foot using the sign convention shown on forms. For crown types A and B, only one field need be coded; if both are given, slope given in Slope Right field, cols 17-21, will be ignored. For crown type C, both fields must be coded; a blank field will be considered zero (level).

5. REFERENCE LINE TAB

Reference Line tab; (04 RECORD) (refer: "SUPERELEVATION AND LAYOUT DATA" Form)

This tab provides input tor the layout line and the reference line



Tab No. 5 Record Type 04 Reference Line

NOTE:

The orientation of the rectangular coordinate system is determined by the "reference line" and the "layout line." The layout line is a straight longitudinal line which may be defined in a number of different ways (see Layout Line Definition field, col 26). The reference line is a bent line defined by station and skew given in the Reference Station field; (cols 3-14 and the Skew Angle field; cols. 15-24. The origin of the coordinate axes is located at the intersection of the reference line and the layout line (unless altered by use of Transform Constant field, cols 41-58. The Y-axis is directed along the layout line, in the direction of ahead station unless reversed by col 30. The X-axis is normal to the layout line directed by the right-hand rule (i.e., i crossed into j is "up").

The reference line may be located at any convenient station on the HCL or tangent lines. It should, however, be located on or near the structure

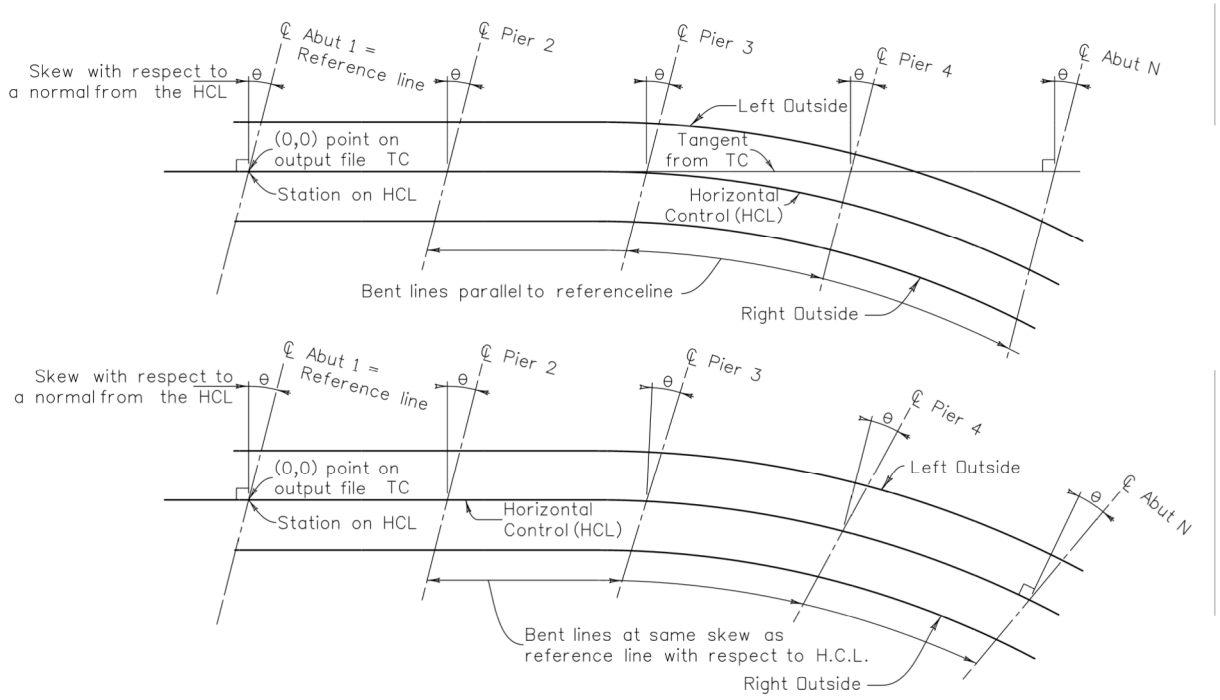


Figure 2 REFERENCE LINE

REFERENCE STATION (cols 3-13)

Code the station of a point on the reference line. This point locates the reference line and must be located on either the HCL, the back tangent or the ahead tangent (of the horizontal curve).

STATION IS ON scroll bar (col 14)

Scroll to indicate whether the reference station in the previous field is a station on HCL, back tangent or ahead tangent. or by coding, 0, 1 or 2 respectively in the *.dat file If no horizontal curve data were given on 01 record, these three options are all equivalent. If the reference station is before the T.S. (or P.C.), options 0 and 1 are equivalent. Similarly if the reference station is beyond the S.T. (or P.T.), options 0 and 2 are equivalent.

If the structure has been sectioned with more than one sequence of 04-07 records (see Chapter 2, “Data Set Organization”), any 04 record after the first may have col 14 designated 3, indicating that reference and layout lines from the previous section are to be left unchanged in the current section. Any 04 record with a 3 in this field should have only blanks in cols 3-13, 15-24, 26, 30, 34-80; information coded in these fields will be ignored. Conversely, all other columns (* fields on form) must be specified as needed.

SKEW (cols 15-24)

Indicate whether the skew is to the left or right using the appropriate radio button. Code the skew angle of the reference line in degrees, minutes and seconds. In the *.dat file the equivalent to an L is a minus sign for left skews; equivalent to an R is a plus, a blank or any character other than L or minus.

WITH RESPECT TO scroll bar (col. 24)

In the Layout Line scroll field, scroll to indicate whether the skew is with respect to the HCL, the layout line, the back tangent or the ahead tangent. In col. 24 of the *.dat by coding 1, 2, 3 or 4 respectively.

A. the HCL
B. the layout line
C. the back tangent
D. the ahead tangent

In general, skew type 1 should be used only if station type (col 14) is designated 0 (on HCL). If no horizontal curve data were given on 01 record, skew types 1, 3 and 4 are equivalent.

DEFAULT SKEW ANGLE FOR BENT LINES (col. 25)

“Parallel” and “Same Skew” radio buttons

This option determines the skew to be used for bent lines (06 records) that have distance type (col 11) 0, 1, 2 or 3 and that have blank skew field (cols 12-21).

These bent lines will be constructed either parallel to the reference line (“Parallel” radio button) or at the same skew (with respect to HCL) as the reference line (Same Skew radio button) In the *.dat file this field is coded with 0 or 1 respectively. Equivalent to 1 is any character other than 0 or blank.

This field has no effect for 06 records having, distance types 4, 6 or 7 (default is parallel to primary or secondary reference line) or having skew type other than default.

In general, when Same Skew as Reference Line (col 25 is designated 1,) any 06 record with default skew (blank or zero in col 21) should NOT have distance type (col 11) designated 1, 2, or 3.

LAYOUT LINE IS scroll bar (col. 26)

In the scroll field select the Back Tangent or Ahead Tangent if layout line is to be the back tangent or ahead tangent of the horizontal curve. If no horizontal curve data were given on 01 record, either of these options will locate the layout line at the HCL

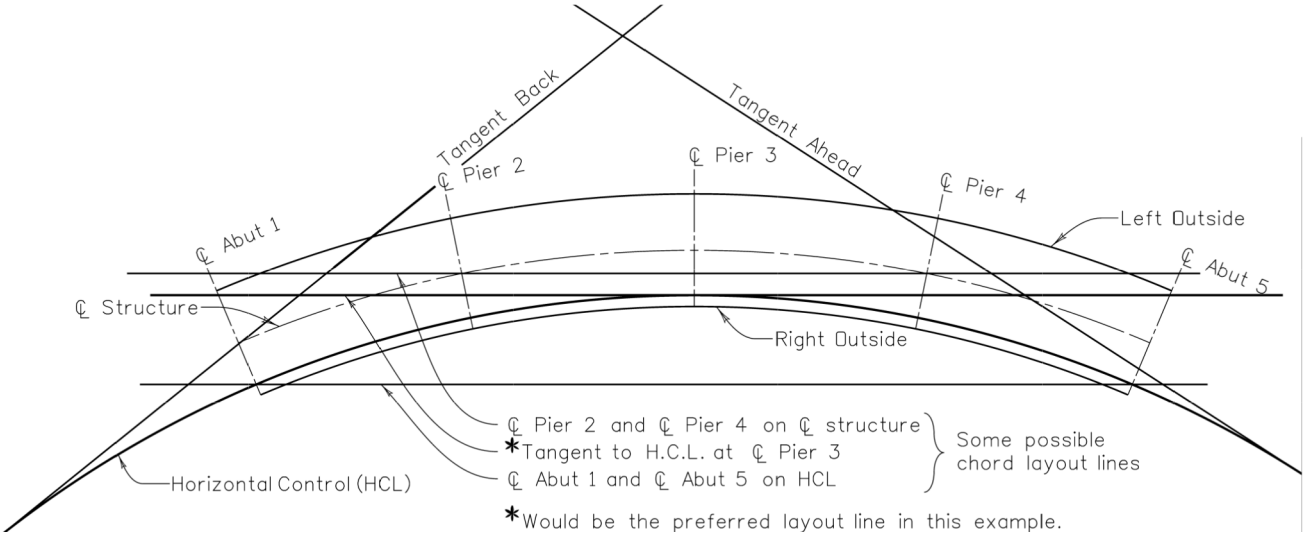


Figure 3 LAYOUT LINE EXAMPLES

For all other layout line defining methods select the Chord definition (2).

With this option, three methods for defining the layout line are available:

A. no 05 records have “Layout Line is a Chord in the Options field selected (col 51);
B. the 05 record designated “Layout Line is a Chord” (col 51) selected is a girder line of type 0 (parallel to HCL); and
C. the 05 record designated “Layout Line is a Chord” in col 51 is a girder line of type 3 (flared girder line).

First method: no girder line designated. In this case, the layout line is constructed as a chord on the HCL between two bent lines (06 records) designated in col 41 (define chord layout line).

A line tangent to some point on the horizontal curve may be approximated by making the two bent lines very close together. In most cases, “very close” should be taken as not closer than 0.0004 feet; for a very short radius 200 feet, 0.0002 feet will suffice.

Second method: type 0 girder line designated. In this case, similar to the first method, the points of intersection of the designated girder line with each of two bent lines (06 records) designated in col 41 (define chord layout line) are found. The layout line is then constructed to pass through these two intersection points.

This method may be used to construct a layout line parallel to and offset from the back (or ahead) tangent by putting the two bent lines before the T.S. (or after the S.T.). A better alternative in this situation would be to define the layout line as the back (ahead) tangent by coding a 1 (3) in col 26 and to shift the Y-axis by coding the appropriate offset in the X field (cols 41-49) of the transform constant for layout coordinates.

With either first or second method, when no horizontal curve data have been given on 01 record, col 41 of 06 records is ignored.

Third method: type 3 girder line designated. In this case, the flared girder line is constructed in the usual manner (see “Girder Line Data” [05 records], line type 3), and the layout line will be that same line. Col 41 of 06 records is ignored in this case.

When this method is used, care must be taken to ensure that the designated flared girder line is located independent of the layout line; that is, e.g., a 06 record designated in col 40 may not have distance type 1 (along layout line).

SEGMENTED GIRDER LINES TO BE BROKEN AT REFERENCE LINE (col. 27) Radio button
This field was to have the same effect for the reference line as 06 record, col 39 has for other bent lines. Unfortunately it does not work properly at the present time, and should not be used . See “Girder Line Data” (05 records), line type 1.

SUPPRESS LISTING (col 28) Radio button
Obsolete. Originally intended to suppress reference line points on a special output formatted for the Elevation sheet paste-up.

OFFSET OPTION FOR SEGMENTED GIRDER PATTERN SHIFT (col 29) Radio button
The purpose of this option is to make base chords balance on the curved girder line. When this option is selected, each base chord for segmented girder lines is shifted (before segmented girder offsets are measured) by an offset equal to half the maximum divergence (from base chord) of the girder line chosen for base chords (05 record designated in col 50).

The effect is to shift the entire girder pattern toward the outside of the curve by an offset that is independent for each span and is proportional to the net change in central deflection through the span. Offsets depend on radius of the girder line chosen for base chords, length of span, and eccentricity of spirals; but are independent of bent line skews, offsets of segmented girder lines, and whether or not fractional points are used.

This option is particularly useful in a situation of slight (or no) skew where the girder line chosen for base chords represents centerline of the structure. Selecting this option will then make base chords that are more equally balanced in the center of the structure.

REVERSE LAYOUT LINE (col 30) scroll field

In unusual situations it may be desirable to have points on output listed in order of decreasing, (rather than increasing) stations, or to have the positive Y direction in the direction of decreasing (rather than increasing) stations. Using this field, four options are available:

0) print by increasing station, layout line not reversed (default)
1) print by DECREASING station, layout line REVERSED
2) print by DECREASING station, layout line not reversed
3) print by increasing station, layout line REVERSED

In general, options 0 and 1 will print in order of increasing Y ordinate, options 2 and 3 in order of decreasing Y ordinate.

Note: For a data set that already has a non-zero Transform Constant field (cols 41-58), deciding to reverse the layout line (by options 1 or 3) will require reversing the sign of both elements of the transform constant.

This option may be used when the HCL reverses on itself (as by a cumulative delta greater than 90.0 degrees), the structure is broken into more than one structure data set (see Chapter 2, “Deck Organization”), and it is necessary to use the same layout line in both data sets: use option 3. This option may also be useful when two station lines are stationed in opposite directions: use option 1.

This option affects listing of girder lines only, not roadway approaches. Use of this option has no effect on the program's orientation of back/ahead, left/right, begin/end.

REQUEST X-0 POINTS (col 31) Radio button

Select this option to request X-type fractional points (X-0 and X-n points) opposite the intersection points at beginning and end of each span of fractional points (in addition to those opposite the intermediate points). See “Girder Line Data” (05 records), X-type Fractional Points, cols 52-53.

EXTENDED PRINT CAPABILITY (col 33)

Not available on input tab; may be input in the *.dat file with a text editor;

Because a slight error in punching Fractional Points fields (06 records, cols 22-28) may result in an excessive number of points on output of girder lines, the program will estimate the number of points to be printed, and if it seems to be a large number, will terminate (after printing one girder line) with a fatal error. A “large number” means more than 200 points per girder line, approximately five pages of output, with more than three girder lines.

If Fractional Points fields have been carefully checked, one may select this option to override the error detection and indicate to the program that a large number of points is expected. When this option is selected or when fewer than four girder lines are being run, the program has the capacity to handle up to 2,000 points (per girder line), approximately 50 pages of output.

TRANSFORM CONSTANT FOR LAYOUT COORDINATES

X-input (cols 41-49); Y-input (cols. 50-58) (Superseded by Project Coordinates)

To move the origin of the coordinate axes to any desired location (by translation without rotation), code the desired coordinates of the reference-line-layout-line intersection in these fields.

For example:

If the origin is currently at the intersection of reference line and layout line and the desired location of the origin is a point that currently has coordinates (-16.47, 23.85), one would code these fields as:

X	Y
16.47	-23.85

For a data set that already has a non-zero Transform Constant field, deciding to reverse the layout line (by use of col 30, see above) will require reversing the sign of both elements of the transform constant.

LIMITS OF VALID ELEVATION AND CROSS-SLOPE DATA

Station back (cols 59-69); Station ahead (70-80)

Code in these fields the limits of valid station, elevation and cross-slope data known to the program. Any intersection point, fractional point, or roadway approach point that has a station before the Begin Station entry or after the End Station entry will not be printed.

The Begin (or End) Station limit is generally determined by whichever of the following four conditions occurs nearest the beginning (end) of the structure:

A. a superelevation transition not given on 03 records
B. the P.T. (. a station equation not given on 01 record
C. P.C.) of a vertical curve not given on 02 record
D. the S.T. or P.T. (T.S. or P.C.) of a horizontal curve not given on 01 record

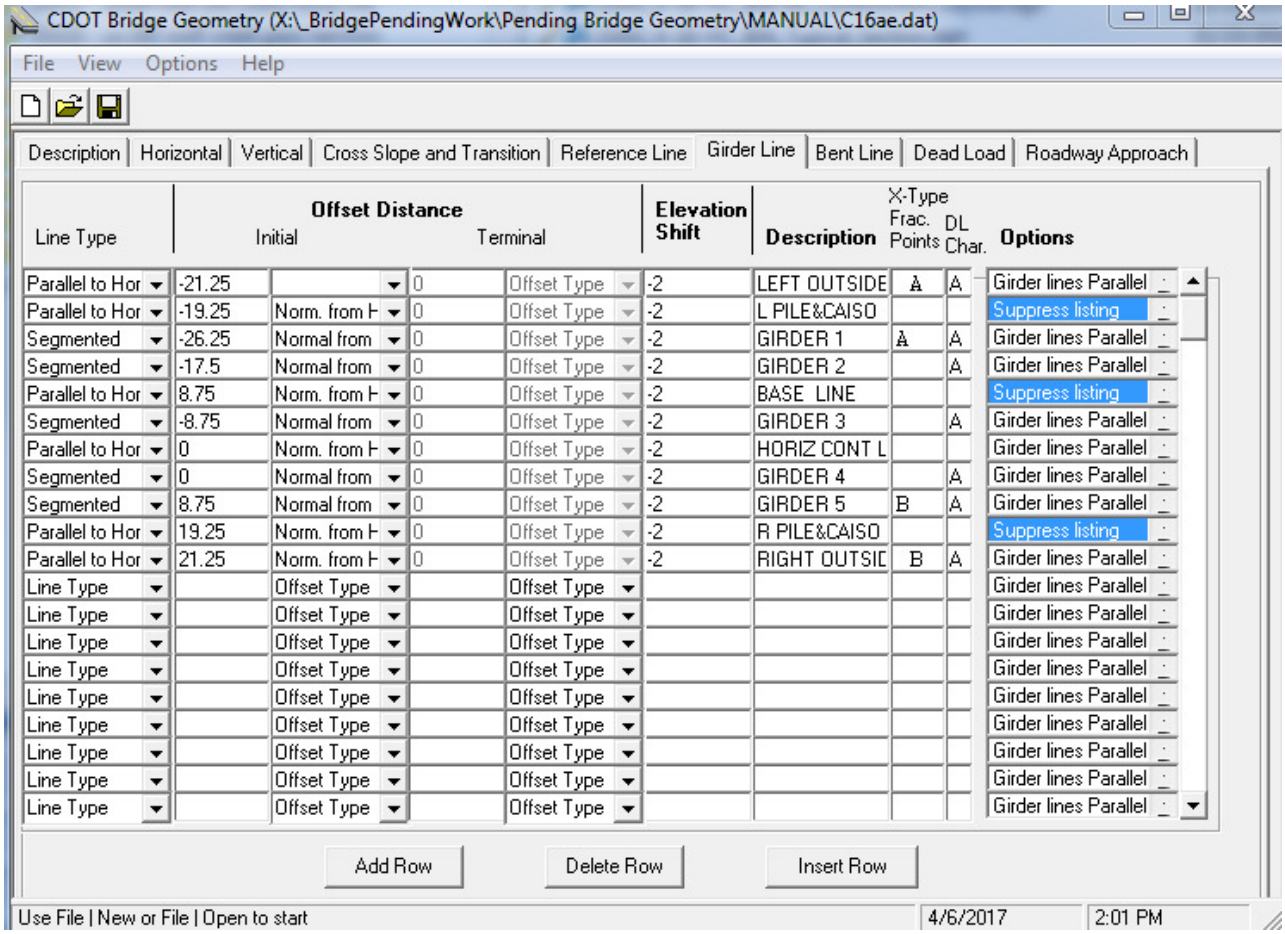
Use of these fields is optional; if either field is blank, valid station and elevation data are assumed to be unlimited at that end. See caution given under “Horizontal Alignment Data”; also see Chapter 4, “Table of Roadway Cross-Slopes,” for other limiting conditions.

This field may be used only on the first 04 record (following a set of 03 records). When more than one set of 04 thru 07 records occurs (in the same set of 00 thru 08 records), this field is ignored on all 04 records after the first set of 04 thru 07 records.

6. GIRDER LINE TAB

Girder Line tab (05 RECORDS) (refer to GIRDER LINE DATA form)

This tab provides input for Girder Line data.



Tab No. 6 Record type 05 Girder Line

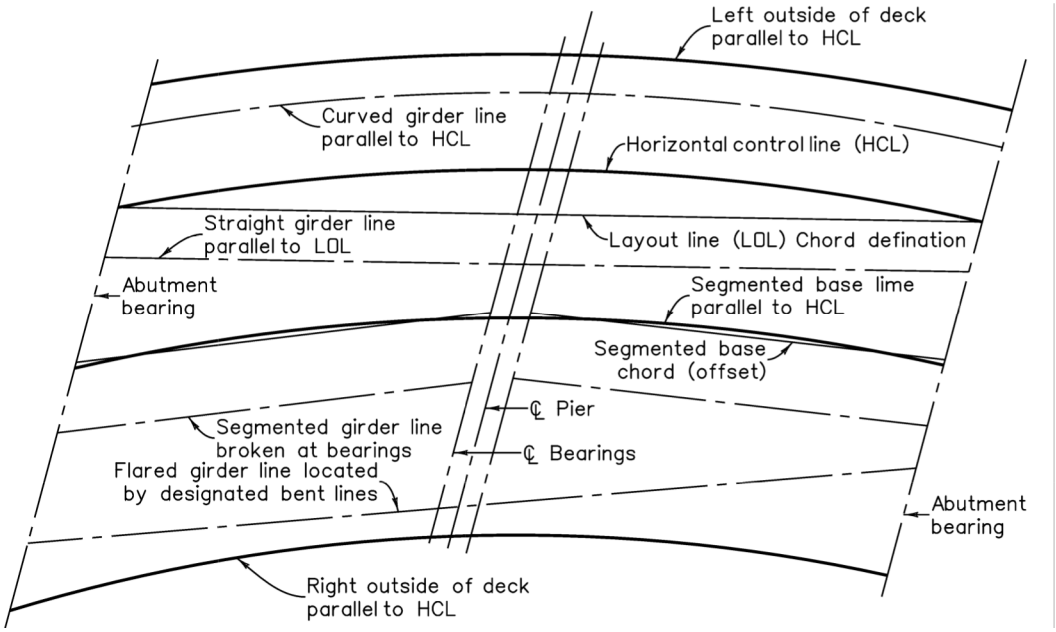


Figure 4 GIRDER LINE TYPES

Line Type (Column 3)

A. Parallel to HCL (Type 0)
B. Segmented (Type 1)

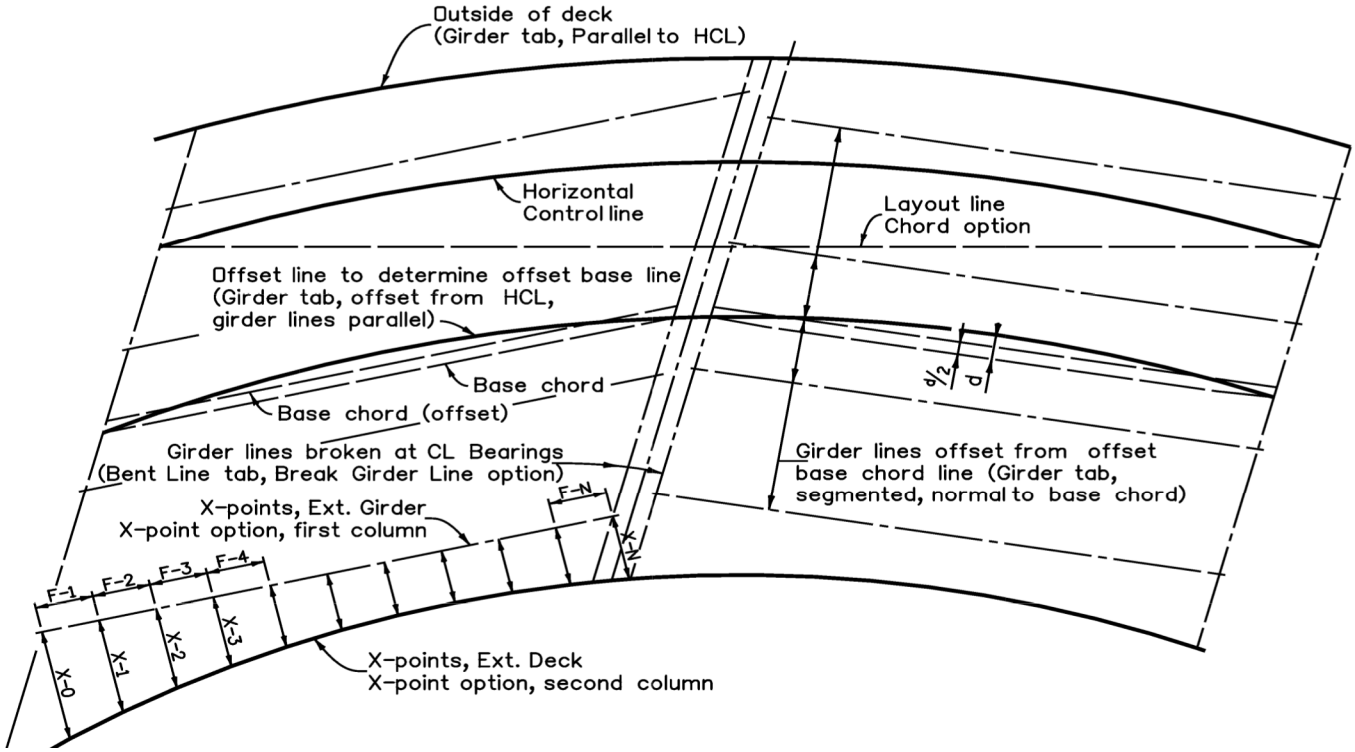


Figure 5 SEGMENTED GIRDERS (type 1)

C. Parallel to LOL (Type 2)
D. Flared (Type 3)

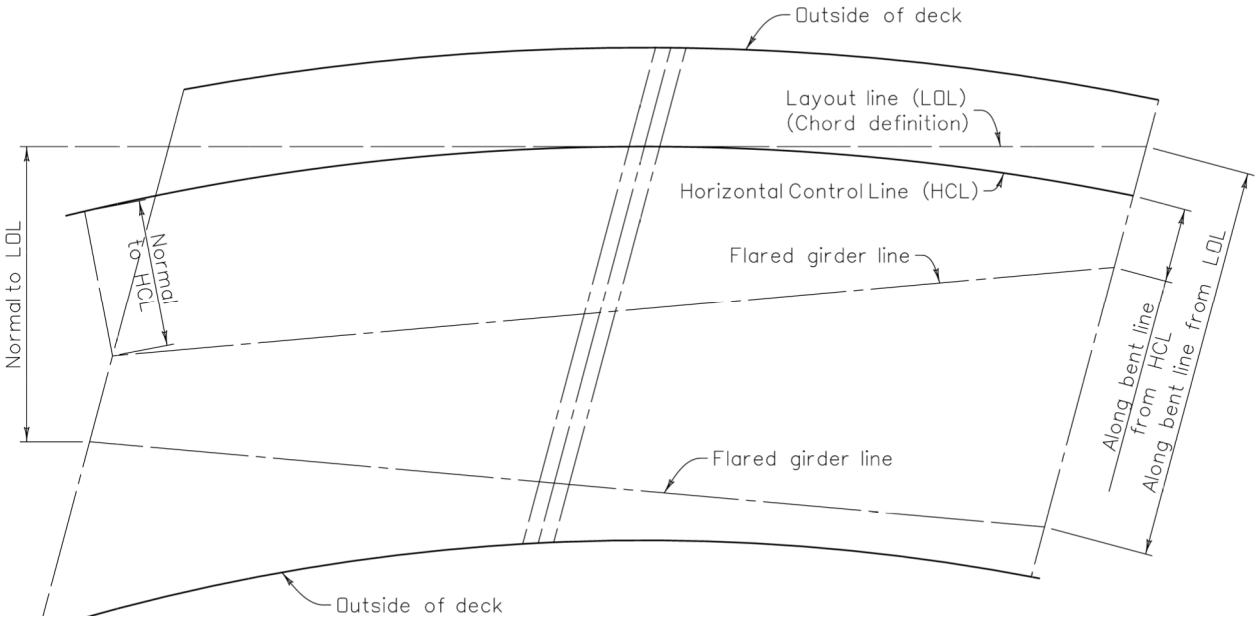


Figure 6 FLARED GIRDER LINES (type 3)

E. Offset varies (Type 4)

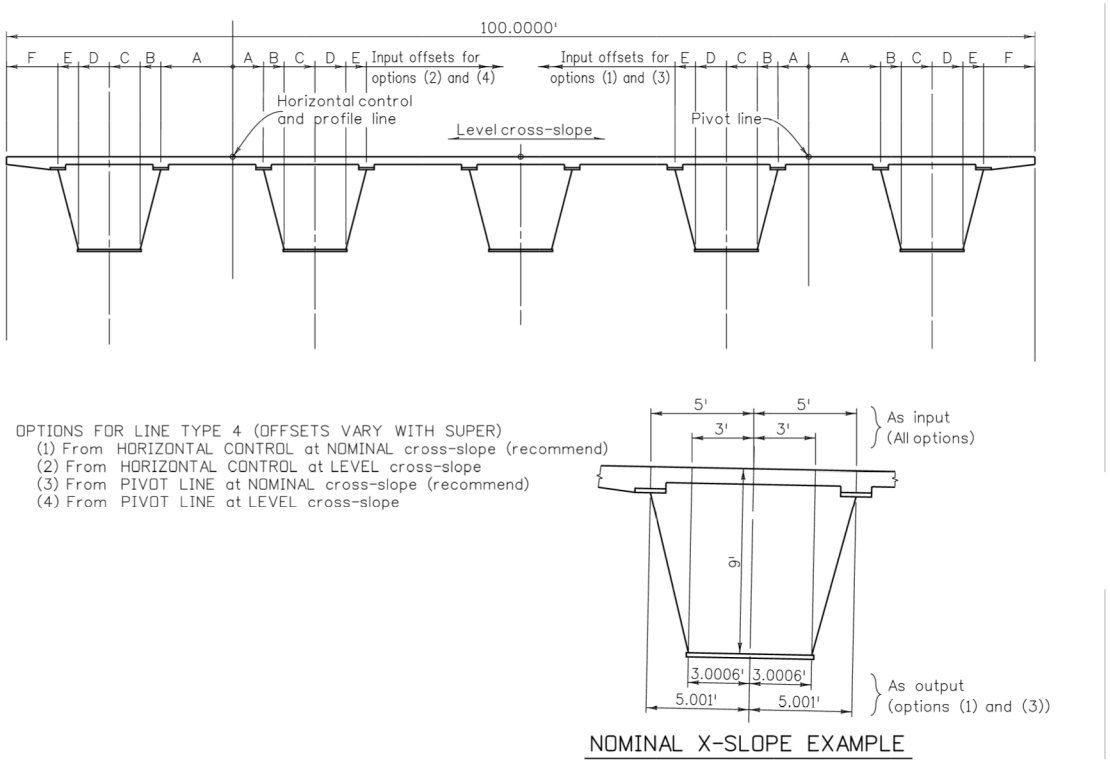


Figure 7 CONSTANT OFFSET LINES

Offset Distance Initial Offset (cols 4-11)

A. Distance (columns 4-11): Use explicit decimal point - left, + right
B. Distance type (Column 12)
C. For parallel to HCL (type 0, parallel to LOL (Type 2,) or Flared Girder Line (initial bent) (type 3):
    a. Along a bent line from LOL
    b. Along a normal from LOL
    c. Along a bent line from HCL
    d. Along a normal from HCL
D. For a segmented Girder line (Type 1): Normal offset from Base Chord
E. For Constant Offset
    1. From HCL at nominal cross slope (Type 4)
    2. From HCL at level cross slope
    3. From Pivot line at nominal cross slope
    4. From Pivot Line at level cross slope

Terminal Offset Distance (col. 12)

For Flared Girder Line only (Second designated bent line) (Type 3)

Distance type

a. Along a bent line from LOL
b. Along a normal from LOL
c. Along a bent line from HCL
d. Along a normal from HCL

Elevation Shift (cols 22-29)

For all line types, except Constant Offset: code distance in inches with explicit decimal point (+ above, - below) finished grade.

For Constant Offset line type: code normal offset from finished grade in feet (+ above, - below) with explicit decimal.

Description (cols 30-49)

Provide a twenty character (maximum) name (longer names work better in the output)

X-Type points (col. 52, 53)

Normal distance from a straight interior girder line to a curved edge of deck

1. Designate the straight girder line with a character in the first position of the range
2. Designate the curved girder line(s) with a matching character in the second position of the range
3. Dimension output is along a normal from the fractional points on the straight girder
4. X-0 (and X-N) points are requested with the check box on the Reference Line record

Selective intersections (col. 53)

With Selective intersection option on bent line tab

1. Any character (A-Z or 0-9) will intersect with any bent line with the same character in the selective intersection option
2. A girder line with any digit (1-9) will intersect with an having a 0 in the Second position X-Type field (column 53)
3. Works in conjunction selective intersection option bent line

DL Character (col. 54)

Corrects deck elevations to allow for dead load deflection of the girder

1. Match girder line character on Dead Load Deflection record
2. Corrects elevation at each fractional point Options

Options

A. Girder lines parallel (col. 50)
   1. Establishes base chords on this line for segmented girder lines
   2. Segmented girder lines are parallel to and measured from chords on this line
   3. Chords determined by designated bent lines (Parallel to HCL (Type 0)) line types only (default is HCL)
B. Layout line is a chord (col. 51)
   1. Constructs a layout line at the intersections of the girder line and two designated bent lines
   2. Line types 0 or 3 only
   3. Special case tangent
      a. Construct bent lines very close (0.01 ft., or less) on either side of the tangent point
C. Camber cutting diagram
   1. This option not used.
   2. Use Camber application to obtain camber cutting information for a welded plate girder
D. Type 4 Constant offset (col. 55)

Establishes a line offset from the HCL from which offsets for Offset Varies lines are measured

E. Suppress Listing

Has no effect at this time; originally used in a special paste-up format.

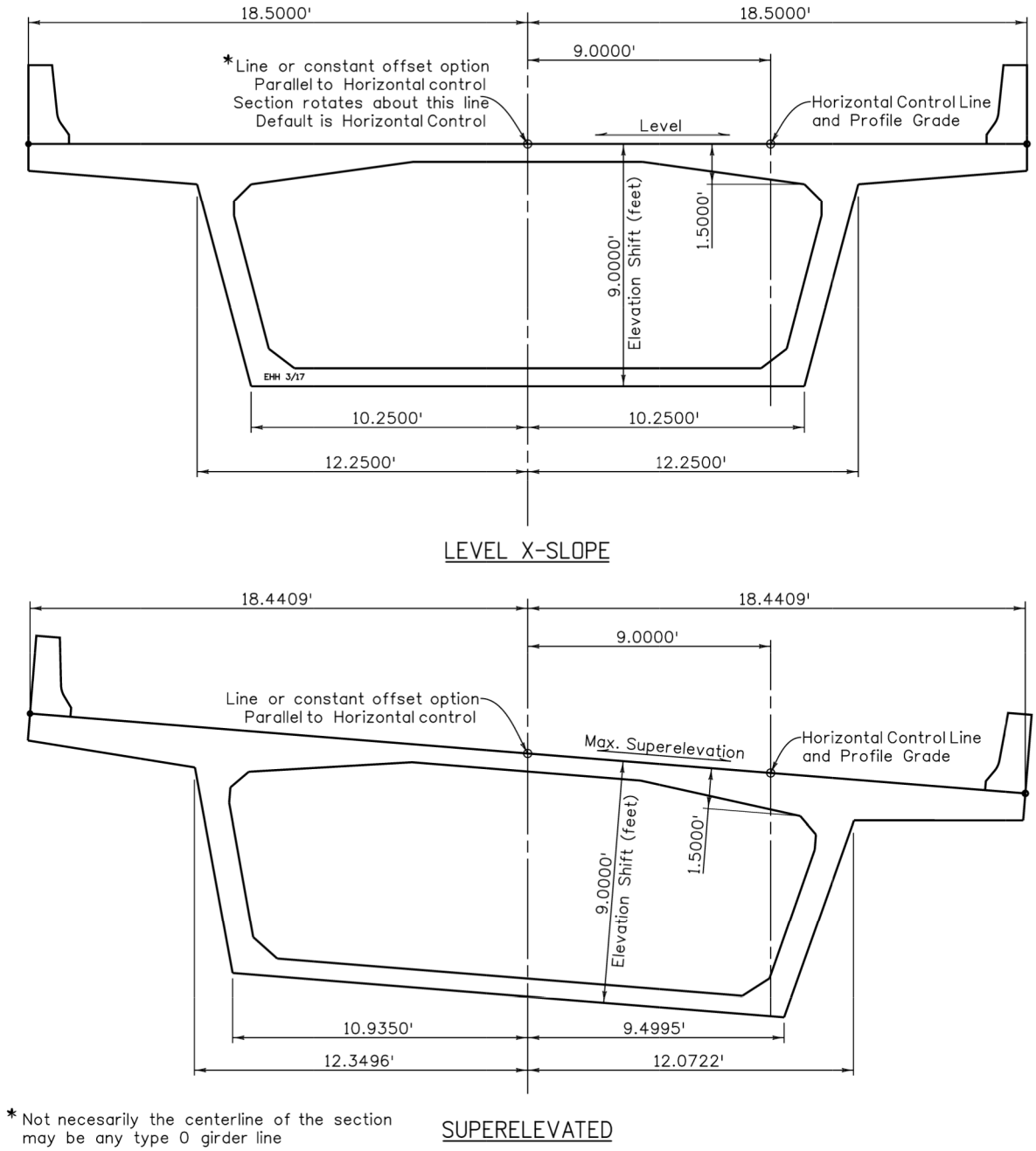


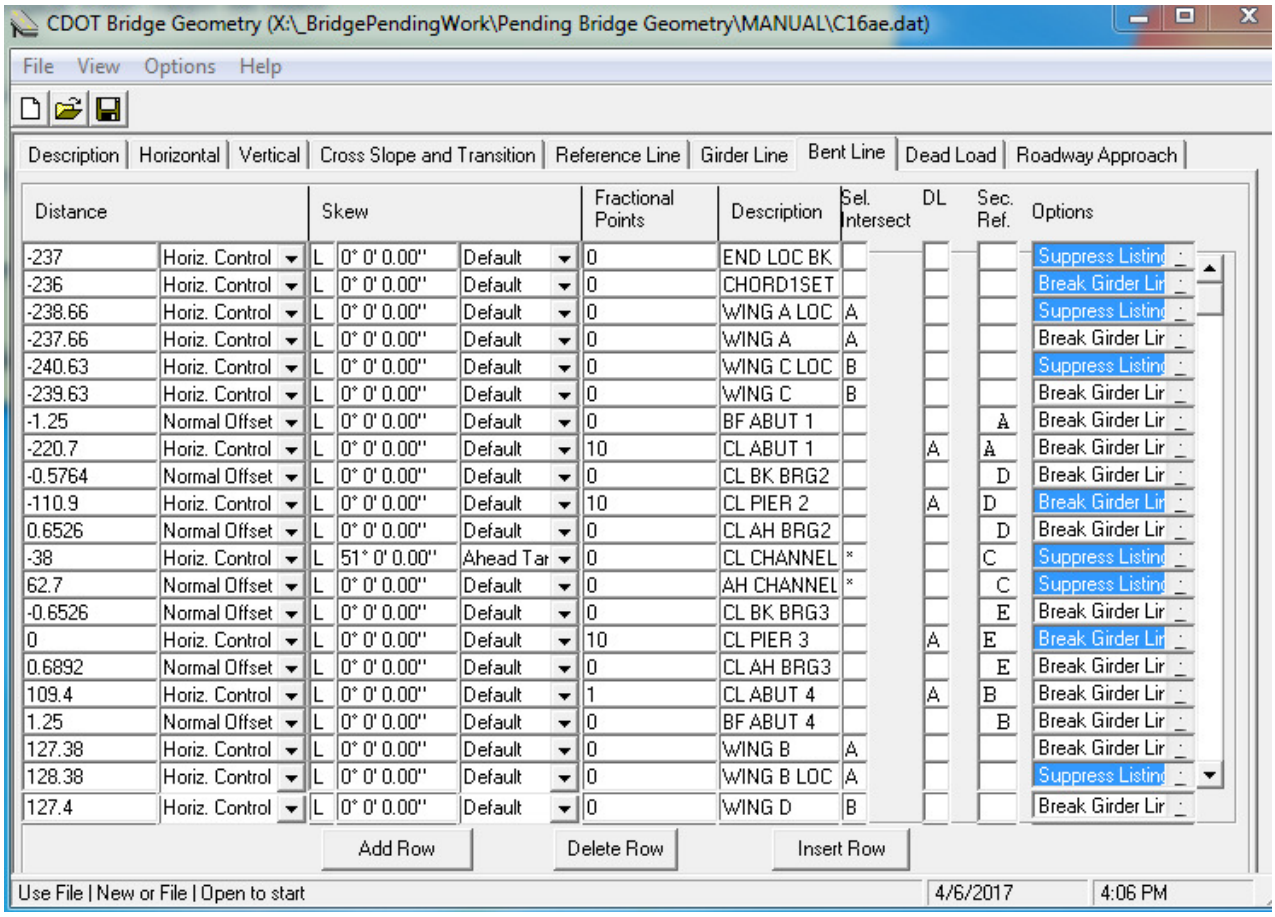
Figure 8 LINE OF CONSTANT OFFSET

All constant offset lines (Type 4) offset from this line

7. BENT LINE TAB

Bent Line tab (06 Records) (Refer to BENT LINE DATA form)

This tab provides input for the Bent Lines.



Distance		Skew		Fractional Points	Description	Sel. Intersect	DL	Sec. Ref.	Options
-237	Horiz. Control	L 0° 0' 0.00"	Default	0	END LOC BK				Suppress Listing
-236	Horiz. Control	L 0° 0' 0.00"	Default	0	CHORD1SET				Break Girder Lir
-238.66	Horiz. Control	L 0° 0' 0.00"	Default	0	WING A LOC	A			Suppress Listing
-237.66	Horiz. Control	L 0° 0' 0.00"	Default	0	WING A	A			Break Girder Lir
-240.63	Horiz. Control	L 0° 0' 0.00"	Default	0	WING C LOC	B			Suppress Listing
-239.63	Horiz. Control	L 0° 0' 0.00"	Default	0	WING C	B			Break Girder Lir
-1.25	Normal Offset	L 0° 0' 0.00"	Default	0	BF ABUT 1			A	Break Girder Lir
-220.7	Horiz. Control	L 0° 0' 0.00"	Default	10	CL ABUT 1		A	A	Break Girder Lir
-0.5764	Normal Offset	L 0° 0' 0.00"	Default	0	CL BK BRG2			D	Break Girder Lir
-110.9	Horiz. Control	L 0° 0' 0.00"	Default	10	CL PIER 2		A	D	Break Girder Lir
0.6526	Normal Offset	L 0° 0' 0.00"	Default	0	CL AH BRG2			D	Break Girder Lir
-38	Horiz. Control	L 51° 0' 0.00"	Ahead Tar	0	CL CHANNEL	*		C	Suppress Listing
62.7	Normal Offset	L 0° 0' 0.00"	Default	0	AH CHANNEL	*		C	Suppress Listing
-0.6526	Normal Offset	L 0° 0' 0.00"	Default	0	CL BK BRG3			E	Break Girder Lir
0	Horiz. Control	L 0° 0' 0.00"	Default	10	CL PIER 3		A	E	Break Girder Lir
0.6892	Normal Offset	L 0° 0' 0.00"	Default	0	CL AH BRG3			E	Break Girder Lir
109.4	Horiz. Control	L 0° 0' 0.00"	Default	1	CL ABUT 4		A	B	Break Girder Lir
1.25	Normal Offset	L 0° 0' 0.00"	Default	0	BF ABUT 4			B	Break Girder Lir
127.38	Horiz. Control	L 0° 0' 0.00"	Default	0	WING B	A			Break Girder Lir
128.38	Horiz. Control	L 0° 0' 0.00"	Default	0	WING B LOC	A			Suppress Listing
127.4	Horiz. Control	L 0° 0' 0.00"	Default	0	WING D	B			Break Girder Lir

Tab no. 7 record type 06 Bent Line Distance

Distance (cols 3-11)

A. Code distance in feet with explicit decimal point (cols 3-10)

   Negative (-) behind reference line; positive (+) ahead of reference line

B. Distance type - From reference line (col 11) - Scroll bars:
   a. Horizontal control (type 0)
   b. Layout line (type 1)
   c. Back tangent (type 2)
   d. Ahead tangent (type 3)
   e. Normal to Reference Line (type 4)

C. From secondary reference line (SRL) - Scroll bars
   a. Normal to SLR
   b. Along a segmented girder line

Skew angle (cols 12-21)

Used to override the default skew of the reference line

1. The angle from a normal to the designated girder line
2. For counter-clockwise (L); for clockwise (R) (col. 12)

Angle (cols 13-20)

3. Input angle as DD MM SS.SS with leading and trailing zeros
4. With reference to (column 21):
   a. Default (type 0) (defaults to Reference Line angle)
   b. HCL (type 1)
   c. LOL (type 2)
   d. Back tangent (type 3)
   e. Ahead tangent (type 4)

Fractional Points (col. 22-28)

Divide girder lines into incremental sections

F-type points:

1. Begin an F-point 'set' with an integer (10, 20, or ?) in the field
2. Integer determines the number of equal distances the girder is divided into
3. End the 'set' with a '1' ('1th') point or an integer to begin a new 'set' for the desired bent
4. Any bent lines between the beginning and the end of the 'set' should have a blank in this field

D-type and E-type points divide girder lines into specified distances

5. Useful for placing expansion joints or other bent lines in midspan
6. Do not work with GUI at this time

D-type points begin a point 'set' with distance coded into the first line of the 'set in columns 22-28. There is an implicit decimal point between columns 24 and 25.

E-Type points are a mirror of D-type points in that they begin at the end of the 'set with the remainder at the beginning of the set. They are coded as a negative distances at the beginning of the 'set'.

X-type points are actually normal horizontal distances from D, E, or F type points on a straight girder line to designated curved girder lines

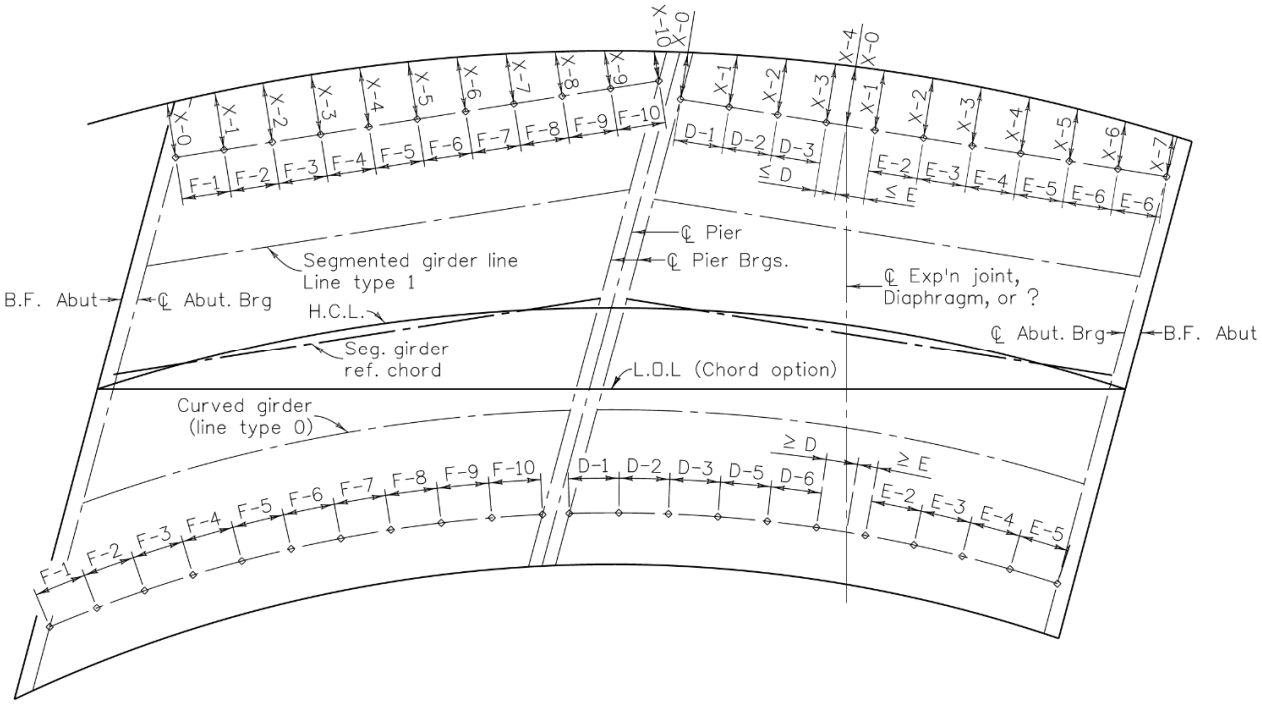


Figure no. 9 D, E, and F Points Description

Description (cols 29-38)

Use a unique description for each bent line

1. Ten characters maximum
2. Be aware of “stick figure” limitations

Selective Intersections (col. 43)

A bent line with a unique character (A-Z or 1-9) in this field will intersect only with girder lines (record 5) having the same character in the second position of the X-type field (column 53)

A bent line with a 0 in this field will only be intersected by girder lines having any digit (0-9) in the second X-type field (column 53)

A bent line with the character “*” in this field will not intersect any girder

DL (Dead Load) (col. 44)

Character to match character in 06/44 field of Dead Load tab

Sec. Ref. (Secondary Reference lines) (col. 45-46)

Places bent lines (such as CL bearings and pier faces) parallel to a secondary reference bent line.

Designate a secondary reference line with any character (0-9 or A-Z) in the first position in the range.

Designate lines referenced to this line with the same character in the second position of the range.

Offset distance defined in distance range, line type 6 or 7.

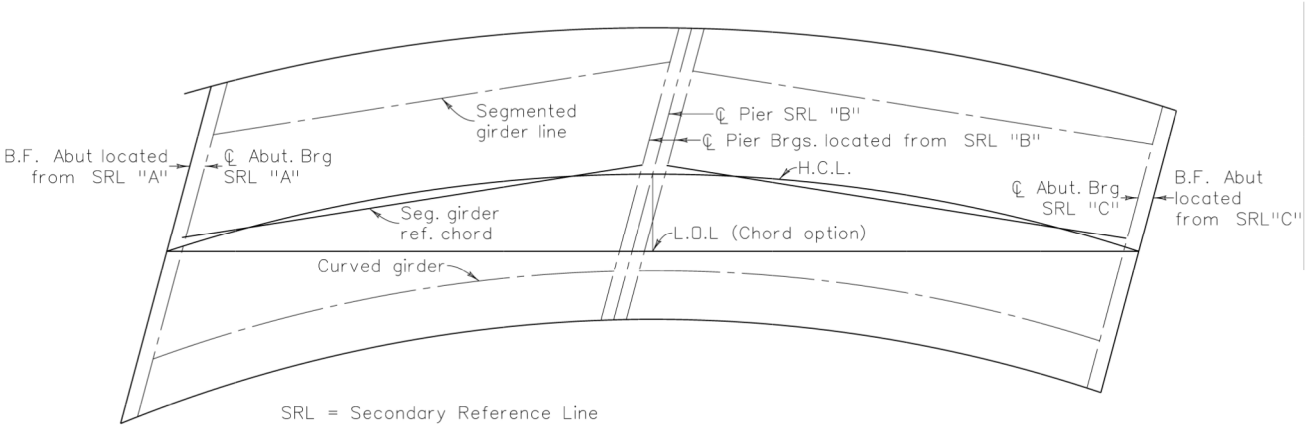


Figure no. 10 SECONDARY REFERENCE LINES

Options (cols 39-42)

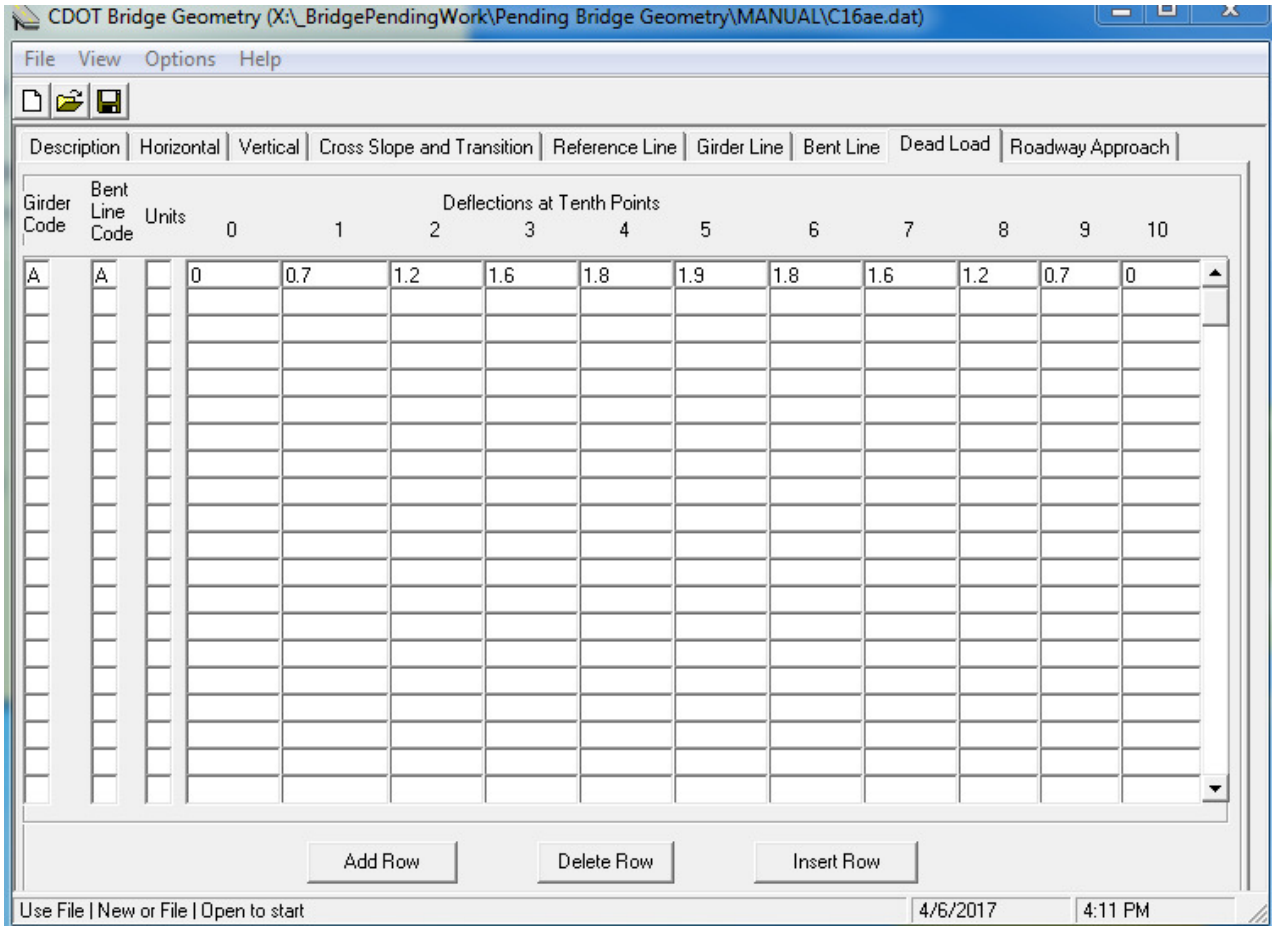
Pick to select the first option, Ctrl+pick for more, or to clear one; more than one option may be highlighted for an individual bent line.

1. Break girder lines; select all bent lines where segmented girder lines are to be broken.
2. Flared offset: select the two bent lines to define the girder line flares.
3. Chord layout: select two bent lines to define the chord layout line.
4. Suppress listing has no effect at this time; it was originally used for a speedial paste-up format

8. DEAD LOAD TAB

Dead Load tab (07 RECORDS) (see DEAD LOAD DEFLECTION form)

This tab provides dead load deflection data



Tab No 8 Record Type 07 Dead Load

In addition to finished elevations, the program calculates and prints elevations adjusted for dead load deflection if Dead Load (07) records are included in the data set. The adjusted elevation (printed under column heading “ELEV+DL” with significant digits dropped) is to represent the elevation to set concrete forms so that, after deflecting, the top of deck will attain the finished elevation. Deflection values for adjusted elevations are coded in Dead Load (07) records.

Deflection values may be specified at tenth points with a single Dead Load (07) record. If more than tenth points are needed, the initial Dead Load (07) record (with Girder Code, Bent Line Code, and Units fields (cols. 3-5) properly coded) may be followed by an arbitrary number of continuation Dead Load (07) records coded with Girder code, Bent Line Code, and Units fields (cols 3-5) all blank. This sequence of initial and continuation Dead Load records may be repeated for any number of spans or any number of girder lines.

For example: If it is desired to specify values at quarter points in the span, one would code two Dead Load (07) records: the initial record having a value specified in the 5 field (cols 45-50,) for

the fifth 20th point) and a value specified in the 10 field (cols 75-80,) for the midpoint or tenth 20th point); the continuation record having a value specified in the 5 field (cols 45-50,) for the fifteenth 20th point).

An initial record and nine continuation records allow values to be specified at hundredth points. The generalized case: n-1 continuation records allow values to be specified at 10 nth points.

Girder Code (Field 05/54) (col 3)

When all girder lines are to have the same deflection values applied, leave this field (and 05 records, col 54) blank. When different girder lines require different deflection values (whether due to different girder lengths, different girder designs, or significant weight of formwork and reinforcing steel for screed rails), an alphabetic character in col 3 means that these deflection values are to be applied to all girder lines (05 records) having the same character in col 54.

More than one initial Dead Load (07) record may have the same character in col 3 only if they have different characters in col 4.

Bent Line Code (Field 06/44) (col 4)

Each initial 07 record must have a non-blank character in this field. If this same character is found in col 44 of a 06 record (bent line) with non-blank Fractional Points field, cols 22-28, the specified deflection values will be applied to all intermediate and intersection points in the span. The terminal bent for the span is defined by the next 06 record with a non-blank Fractional Points field (see 06 record, “Fractional Points” discussion for segmented girder lines).

More than one initial 07 record may have the same character in col 4 only if they have different characters in col 3.

Units (col 5)

If deflection values are in inches, leave this field blank. Code an F in this field to indicate that deflections are specified in feet . 07 records may be mixed feet with inches, but all continuation records must have the same unit of measure as specified on the corresponding initial record.

Deflection at Tenth Points (cols 15-80)

Deflection values must always be specified for the 0 and 10 fields (i.e., the 0 field, cols 15-20 of the initial record and the 10 field, cols 75-80 of the last continuation record). Blank entries in these two fields are assumed to specify zero deflection (the typical deflection at a bearing point); default is the same as specifying zero. The intermediate fields 1 to 9 (and intermediate 0 and 10 fields when continuation records are used) may have values specified or be left blank; default means unspecified. Hence, if the span of fractional points determined by corresponding 06 records (see “Bent Line Data,” cols 22-28) begins or ends at a point other than a bearing line (splice point, for example), be certain to specify a non-zero deflection at that end (0 or 10 field).

Positive values mean downward deflection; negative values mean upward.

Inputs into the GUI require an *explicit* decimal point. Inputs into the *.dat file have an implicit decimal point between the third and fourth digit of each range.

The number or location of deflection values given on Dead Load (07) records have no necessary relation to number or type of fractional points selected on the corresponding 06 record. The deflection given in the 0 field is to be applied at the bent line beginning the span of fractional points and the deflection given in the 10 field is to be applied at the bent line ending the span.

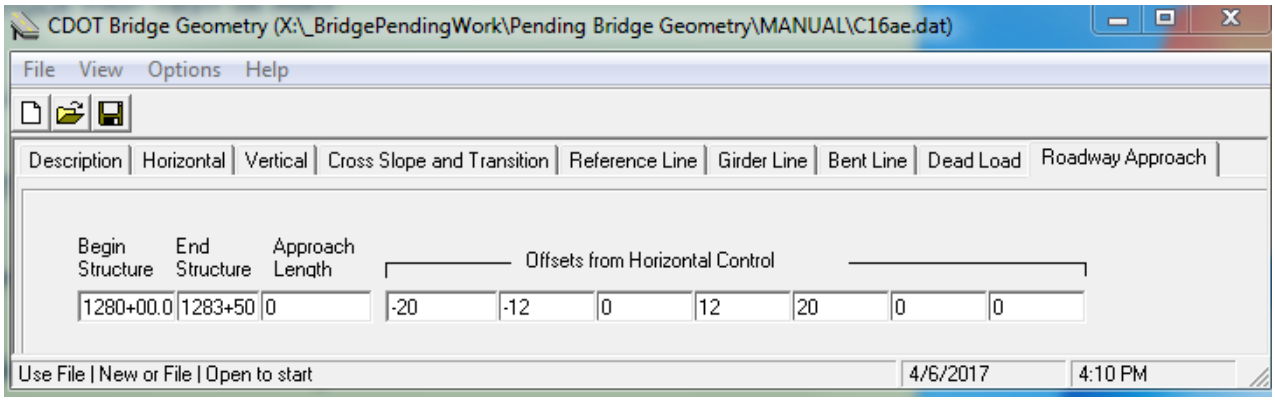
Given deflection values are never applied directly to an elevation; instead the program will first fit a polynomial curve to the points given in a span and then calculate deflections (for adjusted elevations) from the fitted curve. For this purpose, a “least squares” curve fitting, method (polynomial of degree no greater than six) is employed by mapping the scatter points into the interval from 1.0 to 2.0. Coefficients of the polynomial are then converted to inches on the interval from 0.0 to 1.0 and printed along with polynomial deflection values at tenth points. See Chapter 4, “Dead Load Deflection Data.”

A measure of control over the degree of polynomial to be fit may be provided by restricting the number of deflection values given. For an “n”th degree polynomial, give only n-l intermediate values; in particular, if a linear curve fit is desired, give deflection values only at the two end points (0 and 10 fields).

9. ROADWAY APPROACHES TAB

08 RECORD (refer: "ROADWAY APPROACHES" Form)

This tab provides data for Roadway Approaches



Tab No. 9 Record type 08 Roadway Approach

The program calculates and prints finished grade elevations at 10 foot stations for 150 feet of roadway approaches before and after the structure if Roadway Approaches (08) record is included in the data set. Stations beyond limits of valid elevation and cross-slope data (04 record, cols 59-80) are not printed. Particularly in the case of a severe skew, it is recommended that approaches should lap well onto the deck of the structure.

BEGIN STRUCTURE (cols 3-9)

Code a station at least 10 feet ahead of the beginning of the structure (usually back face of abutment). Elevations on the roadway approach will begin 150 feet back of this station. If this field is blank, no approach elevations at this end will be printed.

END STRUCTURE (cols 10-16)

Code a station at least 10 feet back of the ending of the structure (usually back face of abutment). Elevations on the roadway approach will end 150 feet ahead of this station. If this field is blank, no approach elevations at this end will be printed.

APPROACH LENGTH (cols 17-24)

If more than 150 feet of approach is needed, code the desired approach length in feet in this field. Maximum length is 910 feet.

OFFSETS FROM HORIZONTAL CONTROL (cols 25-80)

Code up to seven offset distances for lines where approach elevations are to be calculated. These offset lines should be where roadway grade stakes ("blue-tops") are being run; i.e., edge of shoulder, edge of travel lane, lane lines, profile line, etc. (Dimensions can usually be found on the roadway typical section). Offset values will be sorted by the program; input fields are order independent.

Chapter 4 Output Results

After each CDOT banner in the *.lis geometry output file is a one line banner composed of the "structure identification" (taken from the Structure Number field of the Description tab (cols 3 12 of first 00 record), program name (and version), date and time of run, and page number. Beginning on page one, six left justified headings label the input data from Description, Horizontal, Vertical, Cross Slope and Transition, and Reference Line tabs (00 04 records): "Description," "Horizontal Alignment Data," "Vertical Alignment Data," "Table of Roadway Cross Slopes," "Limits of Valid Elevation and Cross Slope Data," and "Layout Line Data." Following this information, selected input data from Girder Line (05), Bent Line (06) and Dead Load Deflection (07) records are echoed (interspersed with appropriate warning messages).

If 05 (Girder Line) record, col 21 (terminal offset) is used for a girder line of line type (col 3) other than 3 (flared) or 4 (offset varies with super), a nonfatal error message (indicating that cols 13 21 (Terminal Offset) have been ignored) will be printed: COL "3 CONFLICTS WITH COL 21". See Chapter 3, 05 (Girder Lines) records, cols 4 21.

Various warning messages describe nonfatal error conditions involving girder lines with incorrectly coded X type Fractional Points field (05 record, cols 52 53). Each message describes the condition encountered and the action taken by the program: col 52 or col 53 (X- Type Points) of the indicated girder line is ignored. A bent line that does not intersect both the horizontal control line and the layout line will cause a nonfatal error message with the result that the indicated bent line is disrecorded.

1. DESCRIPTION

A direct listing of all Description tab (00) records is printed under this heading.

2. HORIZONTAL ALIGNMENT DATA

If no horizontal curve data were given on the Horizontal tab (01 record), the comment HORIZONTAL TANGENT will be printed. Otherwise, input and calculated curve data (for comparison with line sheets) will be printed: stations at critical points (PC, TS, TSC, SC, PI, SCS, etc.), tangent lengths (T), spiral lengths (LS), spiral deflection angles (SA) in degrees, minutes and seconds, length of circular curve (LC), total deflection angle (DELTA), and radius of curve (RADIUS).

If a station equation has been given Horizontal tab, (01 record, cols 59 80), it will be echoed under this heading. The following conditions will cause a nonfatal error message to be printed: "AMBIGUOUS OR NONEXISTENT STATION USED"

a. if an ambiguous station is used (when equation is overlapping)
b. if a nonexistent station is used (when equation is non-overlapping,) or
c. if equation numbers are not used consistently (See Chapter 3, 01 record.)

For an equation that occurs at the TS (PC) or ST (PT) of a horizontal curve (tolerance of 0.03 feet), the program will make an adjustment to put the equation precisely at the critical point. (An adjustment to the station of the PI may be used to negate this effect.)

If a non-zero profile offset has been given [Horizontal tab, Profile Offset range (01 record, cols 44 51)], it will be echoed immediately below horizontal curve data.

3. VERTICAL ALIGNMENT DATA

Calculated vertical curve data are printed under this heading for comparison with line sheets. Grades between PI's, station and elevation at PC, PI and PT and tangent elevation at PI are formatted to show crest or sag condition.

If a PI is found to have an associated change in grades but a zero length vertical curve (and transition vertical curves are not inhibited), a nonfatal error message will be printed: PI AT STATION ...+... HAS BEEN ASSIGNED CURVE LENGTH =... FEET. See Chapter 3, 03 record, col 56.

PARABOLIC CROWN DATA

For crown type P, crown width and height and shoulder slopes are echoed under this heading.

4. TABLE OF ROADWAY CROSS SLOPES

For crown types A, B and C the printed table provides all information used by the program in calculating finished elevations from profile grade elevations. When the station and offset of a point have been determined, the elevation of the pivot point at that station is calculated from vertical alignment data (profile grade elevation), pivot offset and nominal cross slope. Next the table is consulted to find final (finished grade) cross slopes at that station. Then the elevation of the given point is calculated from pivot point elevation, pivot and profile offsets, final cross slopes and elevation shift.

For type 4 girder lines (offset varies with super), since the final offset cannot be determined without first determining the cross slope, an iterative procedure is invoked which adjusts station and offset, calculates a new cross slope, then adjusts station and offset again, etc.

To obtain smooth profiles along girder lines (“smooth” in the sense that elevation is a continuously differentiable function of line length), the program will insert a transition vertical curve (typically one half station in length) at every station where there is a break in the rate of change of cross slope. An entry in the table does not mean that final cross slopes at the given station are those specified; on the contrary, final cross slopes are generally not those specified. The entry means that at the given station the cross slope changes at a nonlinear rate and a transition vertical curve (centered at the given station) has been provided.

The “VC LENGTH” column gives the length of the transition vertical curve in feet at horizontal control. Curve length will be greater (or less) than given length when outside (inside) of horizontal control in a region of the horizontal curve.

The note “U,” appearing to the right of curve length column, indicates that cross slopes were specified with an optional superelevation override 03 record.

At any point where the rate of change of cross slope changes from increasing to decreasing (or from decreasing to increasing), a relative maximum (minimum) cross slope is attained at some point in the transition vertical curve. When this condition is encountered, the program prints a line

in the table (informative only, not a true table entry) giving the station at which the relative maximum or minimum is attained and the final (finished grade) cross slopes at that station.

A table entry that is found to represent the linear variation between its two neighboring entries is deleted from the table since the transition vertical curve would be flat. Hence when using optional 03 records, it is possible that no table entry will be shown for a station specified on one of the override records. This does NOT mean that the 03 record is superfluous (unless Super Rate field, cols 9 12 on initial 03 record, is blank).

The algorithm used to find final cross slopes from the table is demonstrated by the following example.

Assume the fourth, fifth and sixth entries in the table are:

STATION	SLOPE LEFT	SLOPE RIGHT	VC LENGTH
. . . etc. . . .			
16+23.4000	.0600	.0600	75.0
17+63.4000	.0200	.0200	75.0
18+83.4000	.0200	.0200	75.0
. . . etc. . . .			

representing the transition of a type C crown (center pivot) out from a left curve: PT at station 17+03.40, transition length = 200 feet, e = 0.0600 ft/ft, run out = 66.7 feet.

CASE 1: sta 18+48.40

Since the station is between the fifth and sixth entries and does not occur within either vertical curve (occurs after 1+788.40 and before 1+858.40), cross slopes are the straight line interpolations between fifth and sixth entries:

slope left = .020000
slope right = .007500

CASE 2: sta 17+62.10

Since the station is between the fourth and fifth entries and occurs within the latter transition vertical curve (occurs after 17+19.23 and before 17+94.23), cross slopes are the parabolic interpolations between cross slopes at 17+19.23 and cross slopes at 17+94.23 (found as in case 1):

at 17+19.23 slope left = .03125 slope right = .031250 *
at 1+794.23 slope left = .020000 slope right = .008750 *
at 1+762.10 slope left = .01839 slope right = .022092 *

* Note that these are the same as the straight line interpolations between fourth and sixth entries.

When the first entry in the table does not have nominal cross slopes (and Begin Station [04 record, cols 59 69] does not exclude the first transition vertical curve), this condition will result in a begin station entry for limits of valid elevation and cross slope data.

Similarly, if the last entry in the table does not have nominal cross slopes (and End Station [04 record, cols 70 80] does not exclude the last transition vertical curve), this condition will result in an end station entry for limits of valid elevation and cross slope data.

If transition vertical curves have not been inhibited and tabular stations are so crowded that a transition vertical curve is shorter than 20 FEET, a nonfatal error message will be printed: SHORT TRANSITION VERTICAL CURVES / GIVEN ALIGNMENT IS NOT SUITABLE. Possible remedies for this condition include: (1) combining two or more transition breaks; (2) straightening a series of complex transition breaks; or (3) coding 03 record Nominal Cross Slope field (cols 4 8) blank and controlling transitions entirely using optional 03 records. See Chapter 3, “Optional Superelevation Override.”

Offset from profile line to the pivot point is echoed below the table.

LIMITS OF VALID ELEVATION AND CROSS SLOPE DATA

When a Begin or End Station entry is found in Cross slope and transition tab, Begin station and End station (cols 59 80 of 04 record, it is echoed under this heading.

5. LAYOUT LINE DATA

Under this heading is printed a description of how the layout line is defined; girder line (05 record, col 51) and bent lines (06 record, col 41) defining a chord layout line; station, offset and X Y coordinates of reference line layout line intersection; and how the layout line crosses horizontal control (including skew). If a “chord” layout line does not cross horizontal control, the description will show how it crosses the back and ahead tangent lines. Skew of the layout line with respect to horizontal control (or back/ahead tangent lines) is measured from the tangent (not the normal) since layout line is a longitudinal (rather than transverse) line.

BENTS TO DEFINE OFFSETS FOR FLARED GIRDER LINES

When flared girder lines (05 record line type 3) are used, initial and terminal bent lines (06 records designated in col 40) are echoed under this heading.

SEGMENTED GIRDER LINE DATA

When segmented girder lines (05 record line type 1) are used, the girder line chosen for base chords (Girder Lines Parallel option) (05 record designated in col 50), bent lines where broken (Break Girder Lines option) (06 records designated in col 39), and offset option for segmented girder pattern shift (when selected by 04 record, col 29) (Layout Line tab, Offset option for Segmented Girder Line check box) are printed under this heading.

If relatively large skew angles affect the suitability of segmented girder lines, a nonfatal error message will be printed: DUE TO LARGE SKEW ANGLES, USE OF SEGMENTED GIRDERS IS MARGINALLY SUITABLE (Approx. 5 to 15 degrees) or IS NOT APPROPRIATE (over approx. 15 degrees). Besides reducing skews of bent lines, other means of alleviating this condition

include shortening the span lengths, flaring the exterior girders, or moving the girder line for base chords further toward the outside of the horizontal curve.

For segmented girder lines, two intersection points are printed for each bent line where segmented girder lines are broken (06 record designated in col 39, except first and last). The first of these two intersection points is where the segment in the previous span intersects the bent line; the second is where the segment in the next span intersects the bent line.

6. DEAD LOAD DEFLECTION DATA

For each 07 record (Dead load tab) (or set of initial and continuation 07 records), the program prints an initial line (describing cols 3, 4), (Girder code, Bent line code), coefficients of the polynomial (fitted curve), and deflection values at tenth points (in inches and in feet). The initial line gives a bent line description (cols 29 38) from a 06 record (Bent Line tab) found to have a character in col 44 (DL) which matches col 4 of the 07 record. If no matching character was found, UNKNOWN is printed. The initial line shows the number of 07 records in the set (greater than one if continuation records are used) and also gives the character in col 3 (to be matched with 05 9 Girder Line records, col 54).

The polynomial coefficients, printed in a column to the right, are labeled A4 through A0 and represent the curve

$$A4 * Y^4 + A3 * Y^3 + A2 * Y^2 + A1 * Y + A0$$

for Y on the closed interval from 0 to 1. If either end point has a zero deflection value, the coefficients are those of a reduced polynomial which must be expanded by the corresponding factor to find the curve which was fit to the input deflection values. If the left end point is zero, the polynomial must be expanded by a factor of Y; if the right end point is zero, the polynomial must be expanded by a factor of (1 – Y); and if both end points are zero (the typical case when the span goes from bearing to bearing), the polynomial must be expanded by a factor of (Y – Y2).

The expanded polynomial (representing deflection values in inches as a function of the proportionate span length) is used by the program so that deflections at any intermediate point (whether intersection or fractional point) may be calculated without interpolation. From the larger view, the curve fitting procedure itself is an interpolation method; but a method which applies uniformly over the entire span.

Deflection values at tenth points on the span are printed in inches (top line) and in feet (bottom line). These values are calculated from the fitted curve and should always be compared with input values to be certain that the polynomial comes reasonably close to the desired dead load deflections.

For example, assume that deflection values were input in inches at quarter points (with zero values at the end points) on two 07 (Dead Load) records:

5/20 = 0.793 10/20 = 1.031 15/20 = .788

On output, deflection value at the midpoint (0.5) is shown as 1.031 inches and the coefficients are given:

A4 = 0.0 A3 = 0.0 A2 = 1.51440 A1 = -1.53720 A0 = 4.512

By inspection, the deflection at the midpoint is close enough; but the question remains: how close to the input values would the first and third quarter points be, when calculated from the fitted curve. Rather than interpolating between tenth points, the direct calculation is done by expanding the polynomial and evaluating at Y = 0.25 and Y = 0.75. The expanded polynomial becomes:

$$(1.5144*Y^2 - 1.5372*Y + 4.512) * (Y - Y^2)$$

at Y = 0.25 (4.224) * (0.1875) = 0.7920 in
at Y = 0.75 (4.211) * (0.1875) = 0.7896 in

and it is seen that the (fourth degree) polynomial curve fits the input values very accurately.

Beneath deflection values is a line giving the slope of the fitted curve at each end of the span. If the slope at the left end is less than zero or if the slope at the right end is greater than zero, the comment DEFLECTIONS SHOW SIGNIFICANT UPLIFT will be printed. This indicates a condition that should occur only for continuous (not simple span) girders.

When a girder is continuous across a bearing, the slope at the ahead end of the previous span should be compared with the slope at the back end of the next span to ensure that the two fitted curves do not form a cusp at the bearing. Printed slopes are in units of feet per span; so for spans of unequal length, each slope must be divided by the length of the span (in feet) to find slopes in feet per meter which can then be compared for equality.

If the first 07 record is found to be a continuation (rather than initial) record, a nonfatal error message will be printed: IMPROPER USE OF DEAD LOAD DEFLECTION DATA RECORDS.

When continuation records are used, the 10 field of one record and the 0 field of the next record represent the same point. Though both fields may be coded, if the values given do not agree a nonfatal error message will be printed: INCONSISTENT DEFLECTIONS GIVEN AT THE SAME POINT

AVERAGE CROSS SLOPE

When a girder line whose offset varies with superelevation (05 record line type 4) is used, the program computes an average cross slope for purposes of determining nominal offset. The stations between which the average is computed and the resulting average are printed under this heading.

**HORIZONTAL CONTROL LINE * and * LAYOUT LINE **

Beginning on the next page is a listing of each bent line and the point where the bent line crosses horizontal control, followed by a similar listing for the layout line. These listings do not include fractional points; hence, when fractional points are needed or when the line is needed on deck elevation plot file, the line must also be input as a girder line (05 record). All elevations in these listings are at finished grade. Points which are outside limits of valid elevation and cross slope

data (04 record, cols 59 80) are printed nonetheless. Information in these ten columns is essentially similar to that provided for other girder lines; see “General Girder Line,” below.

In the listing for intersections at horizontal control, an extra column, printed between elevation and X offset, indicates value found in Fractional Points field (06 record, cols 22 28) and condition of Selective Intersections field (col 43).

In general, both horizontal control and layout lines should always be run as girder lines for deck elevation sheets.

**BACK TANGENT LINE * and * AHEAD TANGENT LINE **

When reference is made to either of the two tangent lines on the horizontal curve, intersection points for each bent line are listed for the tangent line(s). Stations given here are horizontal control stations (NOT tangent stations, which may be calculated from Girder Length column). In addition to intersection points, critical points (TS, ST, PC, or PT) at beginning and end of the horizontal curve are also listed.

7. GENERAL GIRDER LINE

On succeeding pages immediately beneath the banner line and above the column headings, is a line giving:

a. the girder line description (05 record, cols 30 49) (Girder Line tab Description range)
b. the line type (col 3) (Line Type option)
c. the notation (CONT) for “continued” only if it is not the first page for the specified girder line
d. the offset from the base chord if girder line is segmented (line type 1)
e. the nominal offset from horizontal control if girder line offset varies with super (line type 4)
f. the elevation shift (cols 22 29) (Elevation Shift column) in feet above or below finished grade (at normal to cross slope of deck if line type 4, vertical otherwise)

Beneath this are headings for eleven columns of information describing each intersection point or fractional point on the indicated girder line.

BENT LINE

This column gives either the bent line description (06 record, cols 29 38) (Bent Line tab, Description range) if the point is an intersection point, or a fractional point designation in the form F n, D n, E n or X n.

STATION and OFFSET

These columns give the coordinates of the point with respect to the surveyor's station and offset from the horizontal control line.

ELEVATION

This column gives finished (deck) elevations (in feet above sea level), which differ from finished grade elevations by the elevation shift (05 record, cols 22 29).

ELEV+DL

If 07 records (Dead Load tab) are used, this column gives the elevation (with significant digits dropped) adjusted for dead load deflection.

OFFSET (X) and ORDINATE (Y)

These columns give the coordinates of the point with respect to a coordinate system determined by the reference line and the layout line (see Chapter 3, 04 record). These coordinates are in the horizontal plane and, together with the elevation, make a three dimensional Cartesian system useful in finding distances between points by the Euclidean norm.

BENT LENGTH

At intersection points, this column gives the horizontal length (measured along the bent line) from the point of intersection of the bent line with the Y axis to the point of intersection of the bent line with the girder line. Positive lengths are right of the Y axis; negative lengths are left of the Y axis. At X type fractional points, this column gives the horizontal offset of the point from the corresponding fractional point on the exterior girder. (See Chapter 3, 05 records, cols 52 53.)

SKEW

At intersection points, this column gives the skew (in degrees, minutes and seconds) of the bent line with respect to the girder line. Negative skew is to the left; positive skew is to the right.

GIRDER LENGTH

For girder lines of type 0 and type 2 (parallel), this column gives the horizontal length (measured along the girder line) from the point of intersection of the girder line with the reference line to the designated point (whether intersection or fractional point). For type 1 (segmented) girder lines, girder line lengths are measured independently on each line segment from the initial bent line where segmented girder lines are broken (06 record, col 39) (Bent Line tab Girder Line Broken option). For type 3 (flared) girder lines, girder line lengths are measured from the initial bent line defining offsets for flared girder lines (06 record, col 40) (Flared Girder Line option). For type 4 girder lines (offset varies with super), girder line lengths are measured from the reference line along the corresponding parallel line at the nominal offset.

Positive lengths are ahead of the reference or initial bent line; negative lengths are back. If the girder line is curved (line type 0 or 4), this length is an arc length.

CROSS-SLOPE

This column gives the roadway cross slope at the station of the designated point when the slope is continuous. For crown types A and B cross slopes at the profile line are printed in absolute value (with “+/-” sign). For crown type C cross slopes are typically discontinuous at the profile line (due to the sign convention). For crown type P, cross slopes in the parabolic section are instantaneous values; cross slopes are typically discontinuous only at the edge of the parabolic section.

ROADWAY APPROACHES

When 08 record is used, station, offset, elevation and cross slope are printed for each station on the roadway approaches. All elevations are at finished grade. Cross slope is blank where discontinuous (see "General Girder Line," Cross Slope, above). Portions of approaches that extend beyond limits of valid elevation and cross slope data (04 record, cols 59 80) are deleted.

When the Approach Length field (08 record, cols 17 24) is used, the program will sometimes extend the approaches (in the direction that laps further onto the structure) by 5 or 10 feet. This is done to make the number of stations (where approach elevations are output) a multiple of four.

PROJECT COORDINATE FILES

The *.pcf files as the same as *.lis files, but with the following additions:

A cover sheet is printed giving basis information as well as the date and time of the run, the Northing offset, the Easting offset, and the bearing of the Layout line in degrees, minutes, and seconds.

In the body of the file two columns are added: the first column giving the Northing co-ordinate (the north-south location), and the Easting co-ordinate (the east-west location) of the given point.

ELEVATION AND ROADWAY APPROACHES

With the Project Co-ordinate file (*.pcf) run successfully, it shall be edited to strip extraneous information, reformatted, and inserted into Proper Elevation sheets for the structure plan set.

This may be done using any available editor; however, tools available in the "TOM'S TOOLS" ("PFE32.EXE", "Header Strip.kbm", "Find Cont,kbm", and "New Count.kbm") folder in "BRIDGE COMMON" work well.

With formatting completed the file shall be cut up and placed on the plan sheets, either as a picture or as text.

If pasted as text, the file will be placed using the Microstation text settings. In any case the font shall be monospaced ("MONOSPAC821BT" is the preferred font), 0.07 high, 0.056 wide to preserve column spacing. Other fonts may require adjustment of text width. A text style "07_ENG-80-BridgeGeo" has been added to facilitate this.

For more information, see Chapter 14 "BRIDGE DECK ELEVATIONS" in the Bridge Detailing Manual.

Work sheets "B-100-2" and "B-100-3" are available if desired.

Appendix A - Fatal Error Messages

Fatal errors have different effects according to their severity. Any fatal error will inhibit the printing of output files and will limit output to no more than one girder line. Some errors will prevent printing of even one girder line; some will prevent printing of horizontal control and layout lines. Errors associated with horizontal or vertical alignment data will abort the run immediately. "Card" in error heading refers to record number in input file. (See Chapter 2)

Errors in alphabetical order are:

1. **BENT LINES NOT LOCATED BECAUSE SECONDARY REFERENCE LINE WAS NOT FOUND**

Indicates improper use of secondary reference lines. See Chapter 3, "Bent Line Data" (06 records), cols 45-46 (Secondary Reference Lines. This message may result from a combination of: 06 record with distance type 7 but no 05 record for segmented (line type 1) girder line.

2. **COL 3, 12 OR 21 OUT OF RANGE—GIRDER LINE: . . .**

See Chapter 3, "Girder Line Data" (05 records), for allowable range Column 3 (Line Type), and Columns 12 and 21 (Offset Type).

3. **COL 11 OR 21 OUT OF RANGE—BENT LINE: . . .**

See Chapter 3, "Bent Line Data" (06 records), for allowable range for Column 11 (Distance Type) or Column 21 (Skew Angle).

4. **COL 11 CONFLICTS WITH COL 21 -- BENT LINE: . . .**

If a 06 record has skew type 1 (with respect to horizontal control), then distance type must be designated 0 (along horizontal control line). (Applies only when horizontal alignment is not tangent.)

5. **COL 11 CONFLICTS WITH COL 40 -- BENT LINE: . . .**

A 06 record designated in col 40 (bent to define offsets for flared girder lines) may NOT use distance type 6 or 7 (from a secondary reference line). See Chapter 3, "Bent Line Data."

6. **COL 14 CONFLICTS WITH COL 24**

Col 14 (Station is on" scroll bar) conflicts with col 24 ("With Respect to" scroll bar). If skew of the reference line is with respect to horizontal control, then reference station **must** be on horizontal control. (Applies only when reference station is in horizontal curve).

7. COL 14, 24, 25 OR 26 OUT OF RANGE (OR LAYOUT LINE NOT FOUND ON PREV SECTION)

04 record (Layout Line tab) Col 14 ("Station is on" scroll bar), 24 ("With Respect to" scroll bar) 25 ("Default Skew Angle" Radio Buttons or 26 out of range (or layout line not found on previous section). See Chapter 3, "Reference and Layout Line Data" (04 record), for allowable range for these fields. Col 14 is considered "out of range" if it is a 3 and a fatal error in the previous section of 04-07 records resulted in an undefined layout line.

8. COL 46 CONFLICTS WITH COL 11 OR 45 -- BENT LINE: . . .

Indicates improper use of secondary reference lines. See Chapter 3, "Bent Line Data" (06 records), cols 45-46 (Secondary Reference Lines).

9. EITHER (1) 04 CARD HAS ERROR IN COL 24 OR 26

Reference Line tab, skew selection or chord option

OR (2) NOT ENOUGH 06 CARDS HAVE VALUE IN COL 41

Column 41 ("Chord Layout Line") in Options scroll bars

OR (3) NO 05 CARD HAS VALUE IN COL 51

Girder Line tab, Layout Line is Chord option

A chord layout line was requested but one of two rules was violated. If reference line is used as initial or terminal bent to define chord layout line (i.e., only one 06 record (Bent Line tab) has been designated in col 41 ("Chord Layout Line" in Options scroll bar) and if skew of reference line is with respect to layout line (skew type 2), then layout line must be a chord on horizontal control line. Only two cases permit no 06 records designated as initial or terminal bent to define chord layout line, viz.: (1) 05 record designated in col 5l ("Layout Line is a Chord" in Options) is a girder line of type 3 (flared), or (2) 05 record designated in col 51 is a girder line of type 0 (parallel to horizontal control) AND horizontal alignment is tangent (i.e., no curve data given on 01 record). See (Chapter 3, "Reference and Layout Line Data" (04 record).

10. ESTIMATED NUMBER OF POINTS EXCEEDS DEFAULT MAXIMUM

See Chapter 3, "Reference and Layout Line Data" (04 record), Extended Print Capability, col 33.

11. FATAL ERROR—02 CARD

In the absence of a more detailed diagnostic, this indicates insufficient or redundant data on 02 record. (Vertical tab) See Chapter 3, "Vertical Alignment Data."

12. FATAL ERROR—INTERSECTION OF REFERENCE LINE WITH HORIZONTAL CONTROL OR WITH LAYOUT LINE OR WITH TANGENT LINE IS ILL-CONDITIONED

The reference line must intersect both horizontal control and layout line. It must intersect back or ahead tangent only if a 06 record has distance type 2 or 3. (Back or Ahead tangent) This message indicates that the point of intersection could not be found (as, e.g., reference line being parallel to layout line).

13. FATAL ERROR—LAYOUT LINE IS RECURSIVELY DEFINED

Generally results from using a bent line to locate a "chord" layout line when the location of the bent line itself depends on the layout line.

14. FATAL ERROR—NO n CARD FOUND

Where n = 00, 02, 03, 04, 05 or 06; the indicated record type was not found due to records out of sequence or **required record missing.**

15. THE FOLLOWING LINES WEWE NOT FOUND

The program found a record out of sequence (see Chapter 2, "File Organization") or an invalid Record Type field, cols 1-2. Comment records with record type 99 will not be listed.

16. GIRDER LINE TYPE 4 MAY BE USED ONLY WITH CROWN TYPE A OR B:

See Chapter 3, "Girder Line Data" (05 records), line type 4.and "Cross Slope and Transition Data" (Crown Type).

17. HORIZ CIRCULAR CURVE NOT LONG ENOUGH TO PREVENT SUPER TRANSITIONS FROM LAPPING

Alignment End of transition in was found to be more than one ahead of beginning of transition out. and Generally indicates an error in coding 03 record (Cross Slope and Transition tab,) cols 21-50 (Transition In and Transition Out ranges) for a simple curve. (See Chapter 3, "Crown Superelevation Data.") May also be caused by incorrect delta, or radius given on 01 record. (See Chapter 3, "Horizontal Data.")

18. IMPROPER USE OF OPTIONAL 03 CARDS

Stations on optional superelevation override records were found to be in conflict or too close together.

19. INVALID PARABOLIC CROWN WIDTH

A parabolic crown must be given a non-zero crown width (03 record, cols 57-65). This error may also be due to incorrect crown type (col 3). See Chapter 3, "Crown and Superelevation Data."

20. INVALID STATION EQUATION

Equation number of back station was found to be greater than equation number of ahead station. See Chapter 3, "Horizontal Alignment Data" (01 record Equation number of back station was found to be greater than equation number of ahead station. See Chapter 3, "Horizontal Alignment Data" (01 record).

21. INVALID TRANSITION LENGTH FOR SIMPLE CURVE

A superelevated horizontal curve that does not have spiral transition at one end (or both ends) must be given a non-zero transition length for superelevation on 03 record (cols 26-30 or 41-45) (Transition In and transition Out ranges.)

22. NOT ENOUGH 06 CARDS HAVE PUNCH IN COL 39

Not enough “Break Girders Lines” designated in Options Range scroll bars. When segmented girder lines are used, at least two bent lines (06 records) must be designated in col 39 (segmented girder lines to be broken). See Chapter 3, “Girder Line Data” (05 records), line type 1.

23. NOT ENOUGH 06 CARDS HAVE PUNCH IN COL 40

Not enough “Flared Girder Offsets” designated in Options Range scroll bar. line was requested but no bent line (06 record) was designated in col 40 (bent to define offsets for flared girder lines). See Chapter 3, “Girder Line Data” (05 records), line type 3.

24. RADIUS OF CURVE OR DELTA ANGLE OUT OF RANGE

See Chapter 3, **“**Horizontal Alignment Data” (01 record), for allowable range for radius of curve and delta.

25. SPIRAL LENGTH OUT OF RANGE

Spiral lengths must (each) be less than π times radius of curve.

26. SPIRALS LAP

Sum of the two spiral angles was found to be (significantly) greater than the given delta.

27. VERTICAL CURVES LAP

PT of first vertical curve was found to have station (significantly) ahead of PC of second vertical curve.

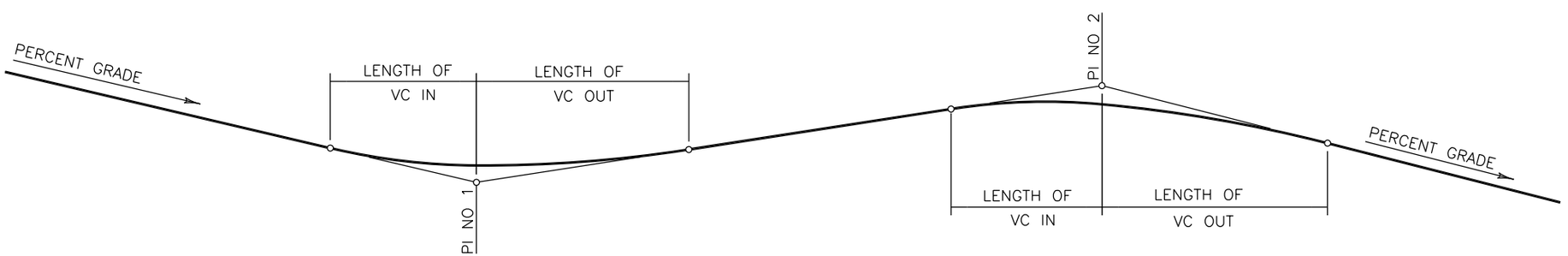
00–02 IDENTIFICATION AND ALIGNMENT FORM

00–02ID_ALG.DGN
E.H.H. 06/2010

CARD TYPE	STRUCTURE ID	DESCRIPTION PROJECT NUMBER, DESIGNER, DETAILER, LOCATION, REMARKS, ETC.
	1 2 3 4 5 6 7 8 9 10 11 12	13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80
0,0		
0,0		
0,0		
0,0		
0,0		
0,0		
0,0		

HORIZONTAL ALIGNMENT

CARD TYPE	△ L or R	△ DEG	△ MIN	△ SEC	PI STATION	D_c DEG	D_c MIN	D_c SEC	SPIRAL LENGTHS L_S IN	SPIRAL LENGTHS L_S OUT	PROFILE OFFSET (+RIGHT/–LEFT)	RADIUS	STATION EQUATION BACK STATION	STATION EQUATION AHEAD STATION
	1 2	3	4 5 6	7 8	9 10 11 12 13 14 15 16 17 18 19 20 21 22 23	24 25	26 27	28 29 30 31	32 33 34 35 36 37	38 39 40 41 42 43	44 45 46 47 48 49 50 51	52 53 54 55 56 57 58	59 60 61 62 63 64 65 66 67 68 69	70 71 72 73 74 75 76 77 78 79 80
0,1			.		+ .			.	.	.	.		+ .	+ .



VERTICAL ALIGNMENT

CARD TYPE	PERCENT GRADE	VERTICAL CURVE NO 1 LENGTH OF VC IN	VERTICAL CURVE NO 1 STATION OF PI	VERTICAL CURVE NO 1 ELEVATION OF PI	VERTICAL CURVE NO 1 LENGTH OF VC OUT	VERTICAL CURVE NO 1 LENGTH OF VC IN	VERTICAL CURVE NO 1 STATION OF PI	VERTICAL CURVE NO 1 ELEVATION OF PI	VERTICAL CURVE NO 1 LENGTH OF VC OUT	PERCENT GRADE
	1 2 3 4 5 6 7 8 9 10 11	12 13 14 15 16 17	18 19 20 21 22 23 24 25 26	27 28 29 30 31 32 33 34 35	36 37 38 39 40 41	42 43 44 45 46	47 48 49 50 51 52 53 54 55 56	57 58 59 60 61 62 63 64 65	66 67 68 69 70	71 72 73 74 75 76 77 78 79 80
0,2	.	.	+ .	.	.	.	+ .	.	.	.

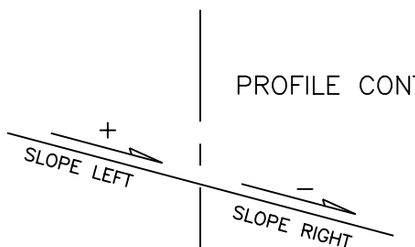
03-04 SUPERELEVATION AND LAYOUT DATA FORM

03-04SUP_LAY.DGN
E.H.H. 05/2000

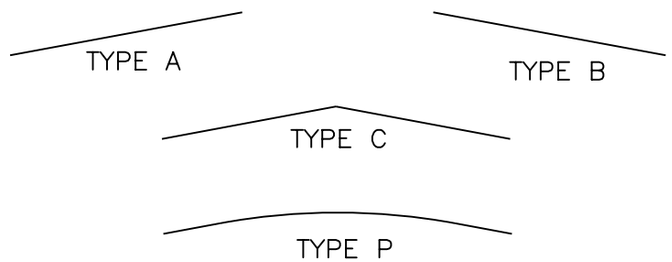
CARD TYPE	CROWN TYPE	CROSS SLOPE AND TRANSITION DATA										PARABOLIC CROWN DATA			
		NOMINAL CROSS–SLOPE	SUPER RATE (e)	PIVOT OFFSET FROM PROFILE LINE (+RIGHT/–LEFT)	TRANSITION IN: RUN–OUT	TRANSITION IN: TRANSITION LENGTH FOR SIMPLE CURVE	TRANSITION IN: PERCENT OF TRANSITION OUTSIDE SIMPLE CURVE	TRANSITION OUT: RUN–OUT	TRANSITION OUT: TRANSITION LENGTH FOR SIMPLE CURVE	TRANSITION OUT: PERCENT OF TRANSITION OUTSIDE SIMPLE CURVE	MAX. LENGTH OF TRANS VC	WIDTH (FEET)	HEIGHT (INCHES)	SLOPE LEFT (FT/FT)	SLOPE RIGHT (FT/FT)
1 2	3	4 5 6 7 8	9 10 11 12	13 14 15 16 17 18 19 20	21 22 23 24 25	26 27 28 29 30	31 32 33 34 35	36 37 38 39 40	41 42 43 44 45	46 47 48 49 50	51 52 53	57 58 59 60 61 62 63 64 65	66 67 68 69 70	71 72 73 74 75	76 77 78 79 80
0 3		. :		.	.	.	.	.	.	.	.	.	.	.	.

OPTIONAL SUPERELEVATION OVERRIDE

CARD TYPE	STATION	SLOPE LEFT (FT/FT)	SLOPE RIGHT (FT/FT)		
1 2	3 4 5 6 7 8 9 10 11	12 13 14 15 16	17 18 19 20 21	22 23 24	25
0 3	+ .	.	.	.	
0 3	+ .	.	.	.	
0 3	+ .	.	.	.	
0 3	+ .	.	.	.	
0 3	+ .	.	.	.	
0 3	+ .	.	.	.	



CROSS–SLOPE
SIGN CONVENTION
(SECTION LOOKING AHEAD STATION)



CROWN TYPES
(COLUMN 3)

REFERENCE LINE DATA

CARD TYPE	REFERENCE STATION		SKEW: L OR R	SKEW: DEG	SKEW: MIN	SKEW: SEC		*		1 *	2 *	3 *		4 *	5 *	6 *		TRANSFORM CONSTANT FOR LAYOUT COORDINATES: X	TRANSFORM CONSTANT FOR LAYOUT COORDINATES: Y	LIMITS OF VALID ELEVATION AND CROSS SLOPE DATA: BEGIN STATION	LIMITS OF VALID ELEVATION AND CROSS SLOPE DATA: END STATION
1 2	3 4 5 6 7 8 9 10 11 12 13	14	15	16 17	18 19	20 21 22 23	24	25	26	27	28	29	30	31	32	33	34 35 36 37 38 39 40	41 42 43 44 45 46 47 48 49	50 51 52 53 54 55 56 57 58	59 60 61 62 63 64 65 66 67 68 69	70 71 72 73 74 75 76 77 78 79 80
0 4	+ .					.												.	.	+ .	+ .

STATION IS ON: 0) HORIZONTAL CONTROL
1) BACK TANGENT
2) AHEAD TANGENT
3) SAME REFERENCE AND LAYOUT LINES AS PREVIOUS SECTION
(ONLY * FIELDS MUST BE SPECIFIED)

SKEW IS WITH RESPECT TO: 1) HORIZONTAL CONTROL
2) LAYOUT LINE
3) BACK TANGENT
4) AHEAD TANGENT

DEFAULT SKEW ANGLE FOR BENT LINES:
0) PARALLEL TO REFERENCE LINE
1) SAME SKEW (TO HORIZ. CONTROL) AS REFERENCE LINE

LAYOUT LINE IS 1) BACK TANGENT
2) CHORD
3) AHEAD TANGENT

REVERSE LAYOUT LINE (0 INCR/NOT
(1DEC/REVERSED
(2 DECR/NOT
(3 INCR/REVERSED

SELECT OPTIONS:

1. SEGMENTED GIRDER LINES TO BE BROKEN AT REFERENCE LINE (COL 27)
2. SUPRESS LISTING (COL 28)
3. OFFSET OPTION FOR SEGMENTED GIRDER PATTERN SHIFT (COL 29)
4. REQUEST X-O POINTS (COL 30)
5. ADJUSTED ELEVATIONS ON TRANSLUCENT (COL 32)
6. EXTEND PRINT CAPABILITY (COL 33)

05 GIRDER LINE DATA FORM

05GIRLINE.DGN
E.H.H. 11/2015

GIRDER LINE DATA

CARD TYPE	1	OFFSET DISTANCE (+RIGHT/−LEFT) INITIAL	2	OFFSET DISTANCE (+RIGHT/−LEFT) TERMINAL	2	ELEVATION SHIFT (+ABOVE/-BELOW)	DESCRIPTION	3	4	5	6	7	8	9	
1 2	3	4 5 6 7 8 9 10 11	12	13 14 15 16 17 18 19 20	21	22 23 24 25 26 27 28 29	30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49	50	51	52 53	54	55	56	57	58 59
05															
05															
05															
05															
05															
05															
05															
05															
05															
05															
05															
05															
05															
05															
05															
05															
05															
05															
05															
05															
05															
05															
05															
05															
05															
05															

GIRDER LINE DATA RECORDS

1. LINE TYPE (COL 3)
   0) PARALLEL TO HORIZ CONTROL
   1) SEGMENTED GIRDER LINE
   2) PARALLEL TO LAYOUT LINE
   3) FLARED GIRDER LINE
   4) OFFSET VARIES WITH SUPER

2. OFFSET TYPE
   FOR A LINE TYPE 0, 2, 0R 3 (COL 12 OR 21)
   1) ALONG A BENT LINE FROM LAYOUT LINE
   2) ALONG A NORMAL FROM LAYOUT LINE
   3) ALONG A BENT LINE FROM HORIZONTAL CONTROL
   4) ALONG A NORMAL FROM HORIZONTAL CONTROL

   FOR A LINE TYPE 1 (COL 12)
   5) NORMAL OFFSET FROM BASE CHORD

   FOR LINE TYPE 4 (COL 12)
   1) FROM HORIZ CONTROL AT NOMINAL C/S
   2) FROM HORIZ CONTROL AT LEVEL C/S
   3) FROM PIVOT POINT AT NOMINAL C/S
   4) FROM PIVOT POINT AT LEVEL C/S

3. SEGMENTED GIRDER LINES ARE PARALLEL TO TO CHORDS ON THIS LINE (LINE TYPE 0 ONLY) (COL 50)

4. LAYOUT LINE IS A CHORD ON THIS LINE (LINE TYPE 0 OR 3 ONLY) (COL 51)

5. X-TYPE FRACTIONAL POINTS (COLS 52-53)
   DESIGNATE THE EXTERIOR GIRDER WITH A CHARACTER IN COL 52

   DESIGNATE THE OUTSIDE LINE(S) WITH THE CORRESPONDING CHARACTER IN COL 53

   FRACTIONAL POINTS ON THE OUTSIDE LINE WILL BE LOCATED ON NORMALS FROM THE FRACTIONAL POINTS ON THE EXTERIOR GIRDER

   SELECTIVE INTERSECTIONS (COL 53)
   A GIRDER LINE WITH ANY CHARACTER (A-Z OR 1-9) IN COL. 53 WILL INTERSECT WITH A BENT LINE (06 RECORD) HAVING THE SAME CHARACTER IN COL. 43.

   A GIRDER LINE WITH ANY DIGIT (1-9) IN COL. 53 WILL INTERSECT WITH A BENT LINE (06 RECORD) HAVING THE DIGIT ZERO (0) IN COL. 43.

6. CHARACTER TO MATCH 07 RECORD COL 3 FOR DEAD LOAD DEFLECTIONS (COL 54)

7. REQUEST CAMBER CUTTING SCHEDULE (COL 55)

8. LINE OF CONSTANT OFFSET FOR TYPE 4 GIRDER LINES (LINE TYPE 0 ONLY) (COL 56)

9. SUPRESS LISTING (COL 57)

06 BENT LINE DATA FORM

06BENLINE.DGN
E.H.H. 05/2000

BENT LINE DATA

CARD TYPE	DISTANCE (FEET) (+AHEAD/-BACK)	1	SKEW L OR R	SKEW DEG	SKEW MIN	SKEW SEC	2	FRACTIONAL POINTS	DESCRIPTION	3	4	5	6	7	8	9	
1 2	3 4 5 6 7 8 9 10	11	12	13 14	15 16	17 18 19 20	21	22 23 24 25 26 27 28	29 30 31 32 33 34 35 36 37 38	39	40	41	42	43	44	45 46	47 48 49 50
06																	
06																	
06																	
06																	
06																	
06																	
06																	
06																	
06																	
06																	
06																	
06																	
06																	
06																	
06																	
06																	
06																	
06																	
06																	
06																	
06																	
06																	
06																	
06																	
06																	

BENT LINE DATA RECORDS
(80 MAX. PER SECTION)

1. DISTANCE TYPE (COL 11)
   DISTANCE IS FROM REFERENCE LINE ALONG:
   0) HORIZONTAL CONTROL LINE
   1) LAYOUT LINE
   2) BACK TANGENT
   3) AHEAD TANGENT
   4) NORMAL TO REFERENCE LINE

   DISTANCE IS FROM BENT LINE REFERENCED BY COL 46:
   6) NORMAL OFFSET
   7) SEGMENTED CHORD LENGTH

   (MAY NOT USE COLS 40 OR 41
   MUST HAVE DEFAULT SKEW)

2. SKEW TYPE (COL 21)
   SKEW IS WITH RESPECT TO:
   0) DEFAULT
   1) HORIZONTAL CONTROL LINE
   2) LAYOUT LINE
   3) BACK TANGENT
   4) AHEAD TANGENT

3. SEGMENTED GIRDER LINE TO BE BROKEN AT THIS BENT LINE (COL 39)

4. BENT LINE OFFSETS FOR FLARED GIRDER LINES (COL 40)

5. INITIAL OR TERMINAL BENT TO DEFINE CHORD LAYOUT LINE (COL 41)

6. SUPPRESS LISTING (COL 42)

7. SELECTIVE INTERSECTIONS (COL 43)
   A BENT LINE WITH A CHARACTER (A-Z OR 1-9)IN THIS COL WILL BE INTERSECTED ONLY WITH GIRDER LINE (05 RECORD) HAVING THE SAME CHARACTER IN COL 53

   A BENT LINE WITH THE DIGIT ZERO IN THIS COL WILL BE INTERSECTED ONLY WITH GIRDER LINES HAVING ANY DIGIT (1-9) IN COL 53

   A BENT LINE WITH THE CHARACTER * IN THIS COL WILL NOT INTERSECT ANY GIRDER LINE

8. CHARACTER TO MATCH 07 RECORD COL 4 FOR DEAD LOAD DEFLECTIONS (COL 44)

9. SECONDARY REFERENCE LINES (COLS 45-46)

   INDICATE A SECONDARY REFERENCE LINE WITH A CHARACTER IN COL 45

   BENT LINES REFERENCED BY DISTANCE TYPE 6 OR 7 MUST HAVE THIS CHARACTER IN COL 46

07–08 DEAD LOAD DEFLECTIONS AND ROADWAY APPROACHES FORM

07-08DLD_APP.DGN
E.H.H. 11/16/2000

DEAD LOAD DEFLECTION DATA

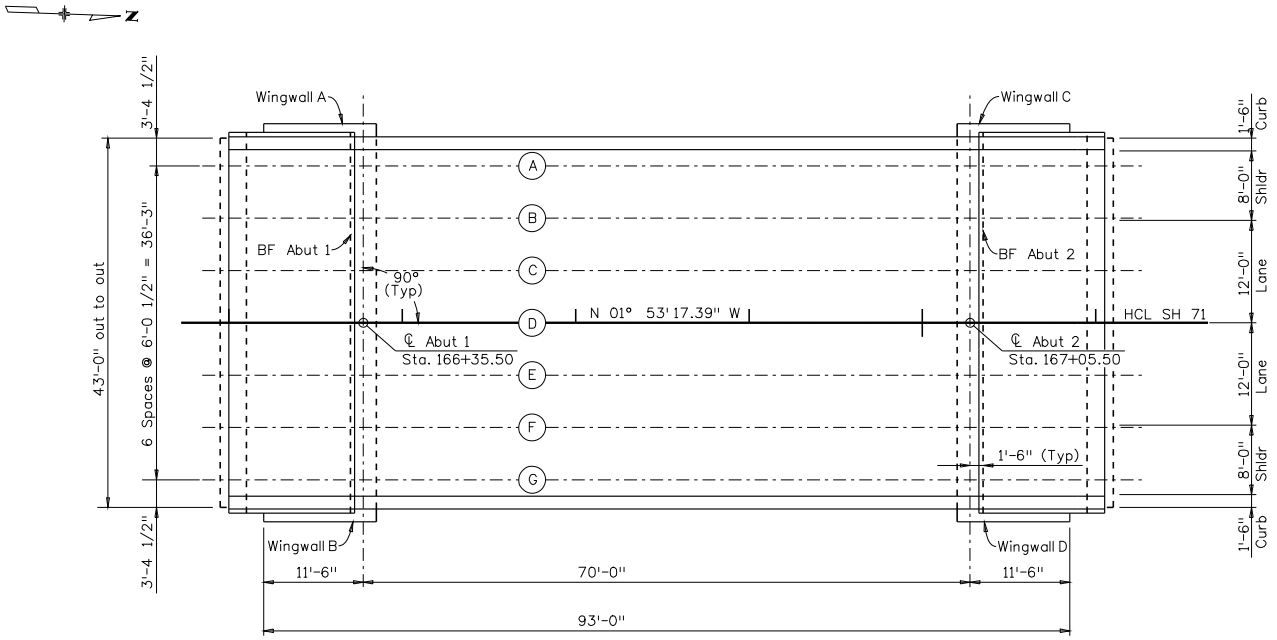
CARD TYPE	05/54	06/44	F (FEET)		DEFLECTIONS AT TENTH POINTS (+DOWNWARD -UPWARD)										
					0 (BRG)	1	2	3	4	5	6	7	8	9	10 (BRG)
1 2	3	4	5	6 7 8 9 10 11 12 13 14	15 16 17 18 19 20	21 22 23 24 25 26	27 28 29 30 31 32	33 34 35 36 37 38	39 40 41 42 43 44	45 46 47 48 49 50	51 52 53 54 55 56	57 58 59 60 61 62	63 64 65 66 67 68	69 70 71 72 73 74	75 76 77 78 79 80
0,7															
0,7															
0,7															
0,7															
0,7															
0,7															
0,7															
0,7															
0,7															
0,7															
0,7															
0,7															
0,7															
0,7															
0,7															
0,7															
0,7															

ROADWAY APPROACHES

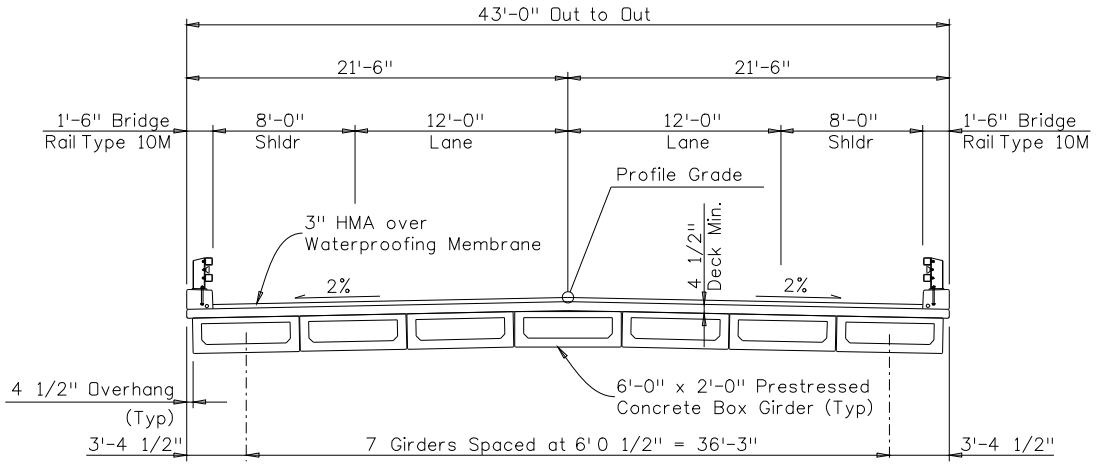
CARD TYPE	BEGIN STRUCTURE	END STRUCTURE	APPROACH LENGTH (150 DEF)	OFFSETS FROM HORIZONTAL CONTROL (+RIGHT/-LEFT) TO EDGE OF SHOULDER, EDGES OF TRAVEL LANES, PROFILE LINE, PIVOT POINT, ETC.						
1 2	3 4 5 6 7 8 9	10 11 12 13 14 15 16	17 18 19 20 21 22 23 24	25 26 27 28 29 30 31 32	33 34 35 36 37 38 39 40	41 42 43 44 45 46 47 48	49 50 51 52 53 54 55 56	57 58 59 60 61 62 63 64	65 66 67 68 69 70 71 72	73 74 75 76 77 78 79 80
0,8										

Appendix C – Examples

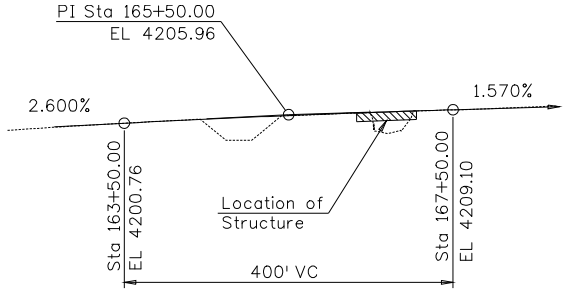
Example 1 - Simple span bridge on a straight horizontal alignment



PLAN VIEW

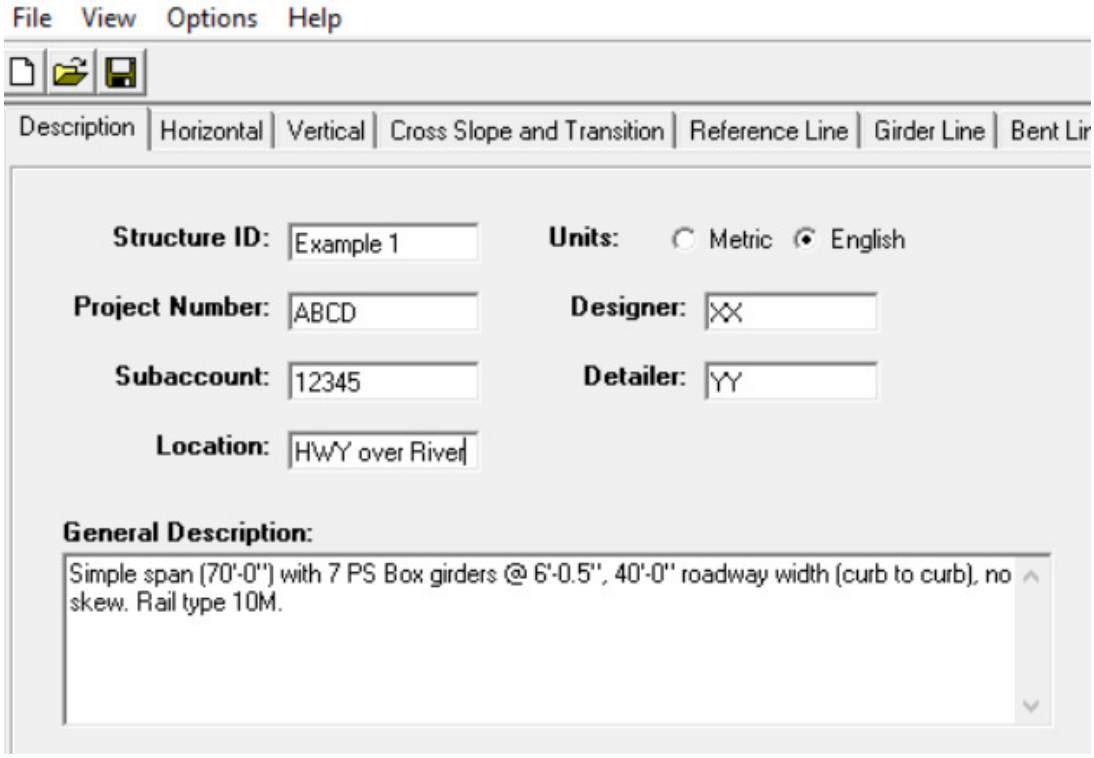


TYPICAL SECTION

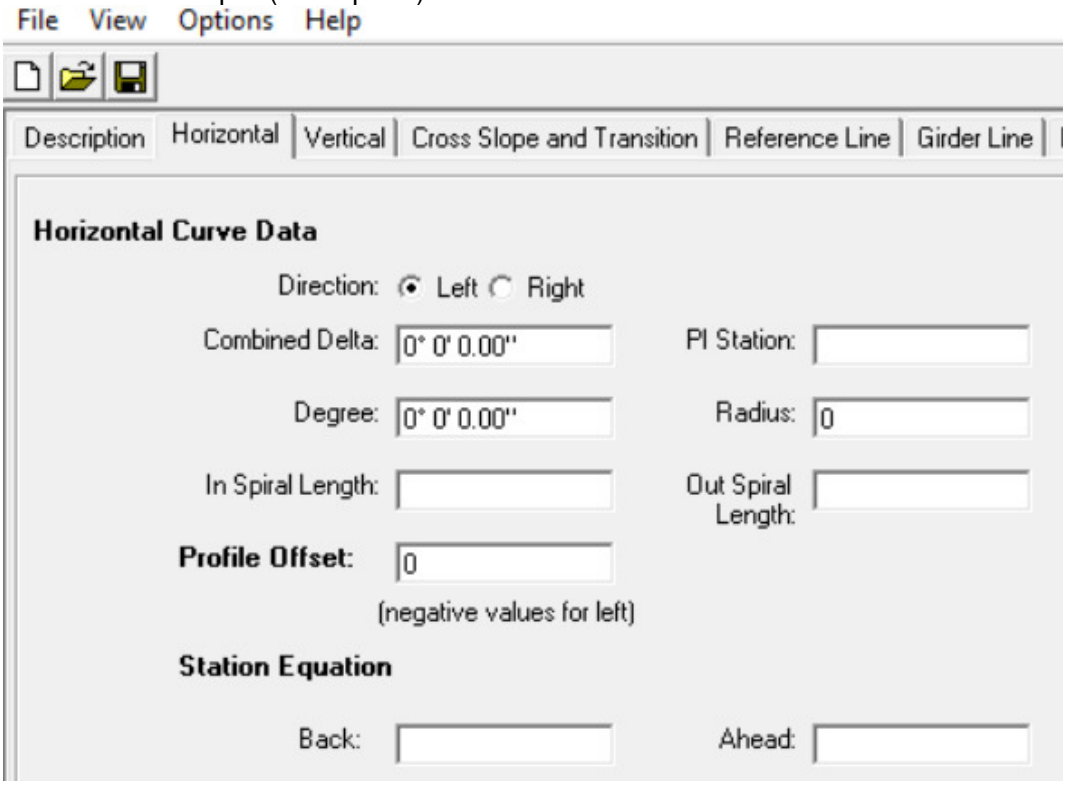


PROFILE GRADE

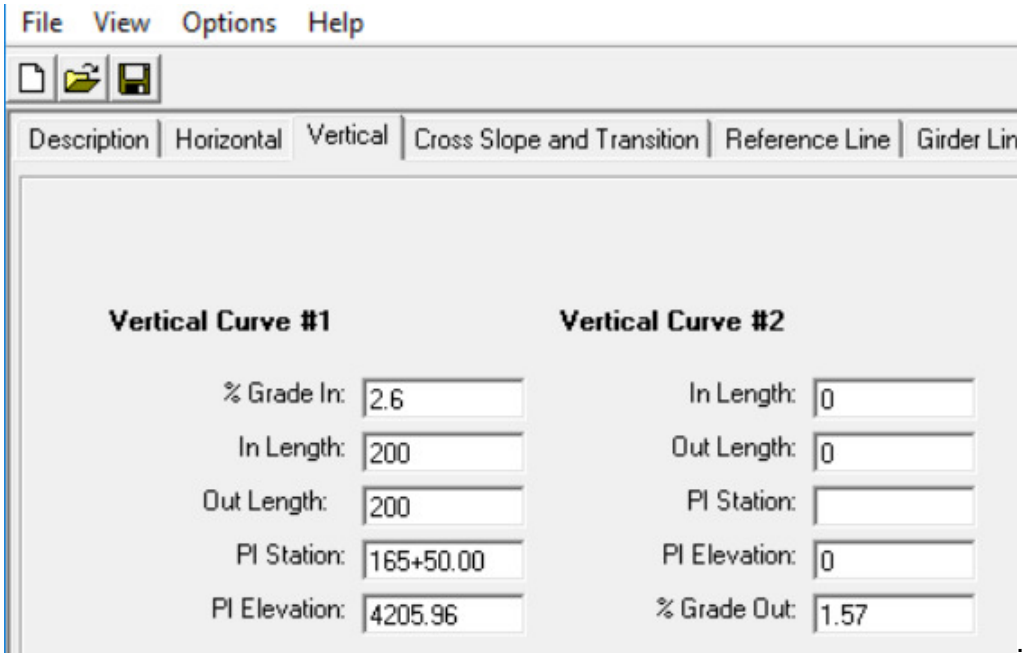
1. Description Tab Input (Example 1)



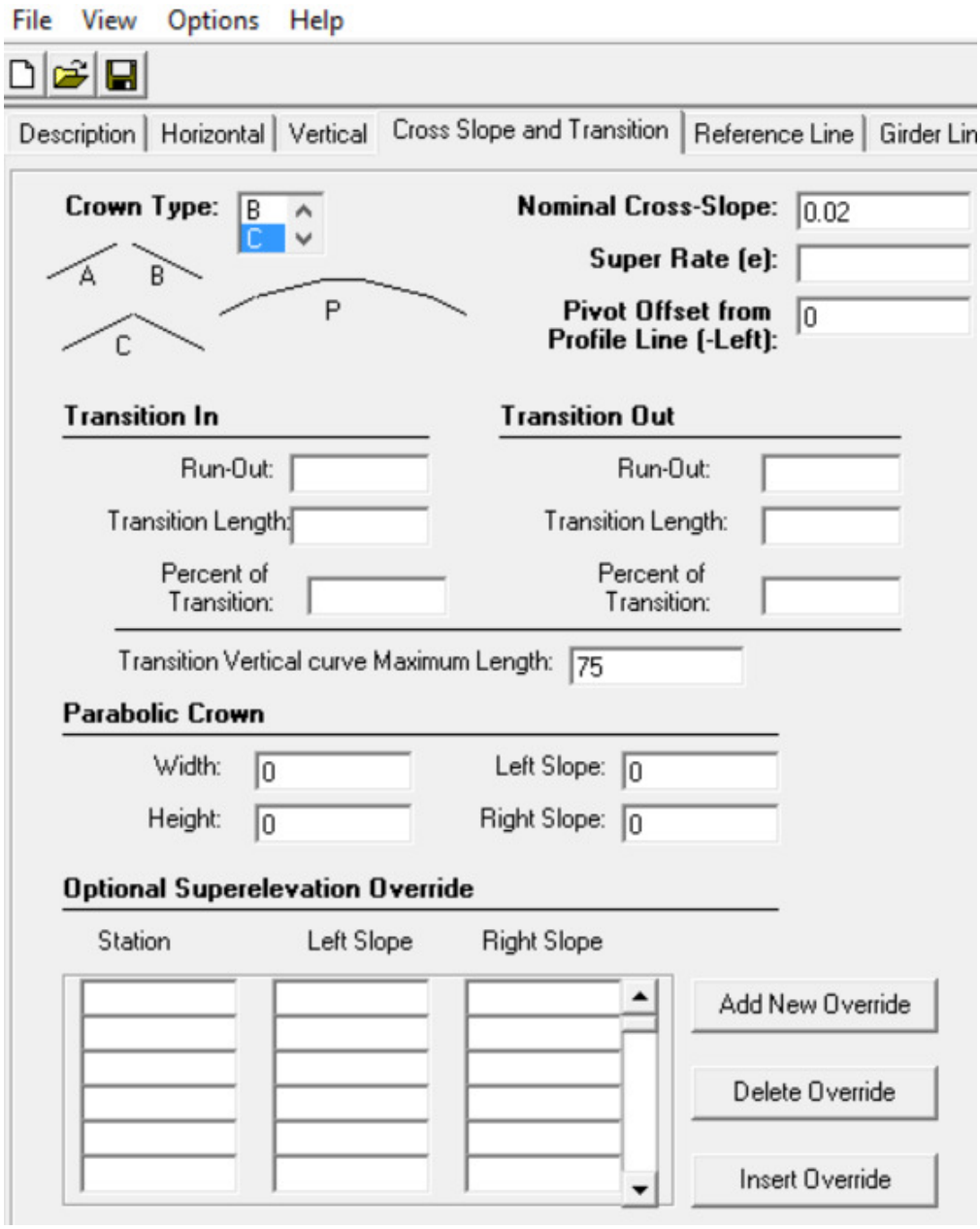
2. Horizontal Tab Input (Example 1)



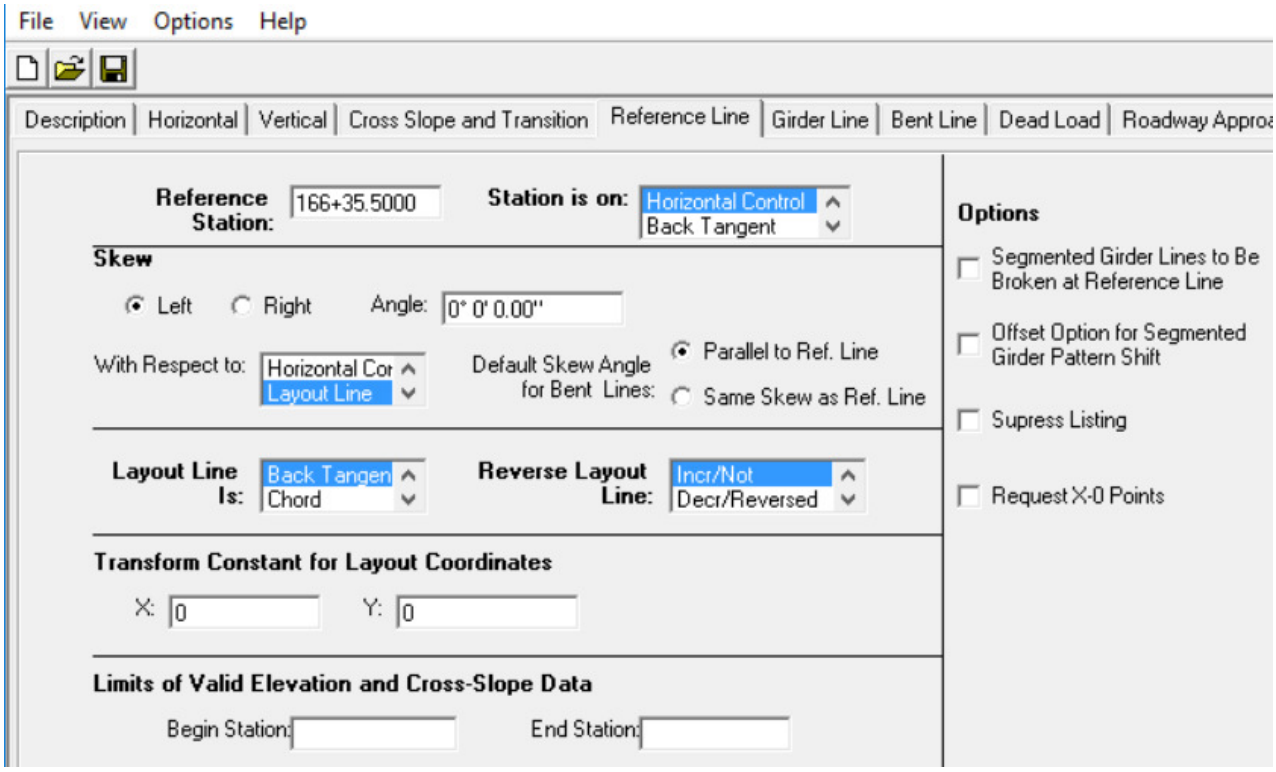
3. Vertical Tab Input (Example 1)



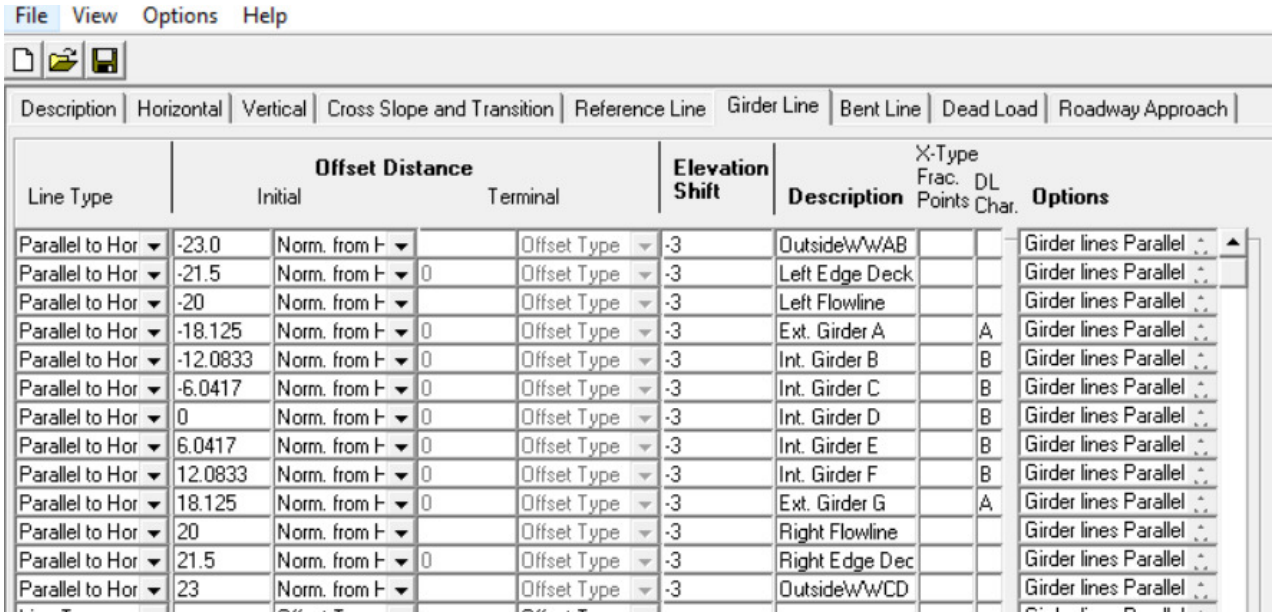
4. Cross Slope and Transition Tab Input (Example 1)



5. Reference Line Tab Input (Example 1)

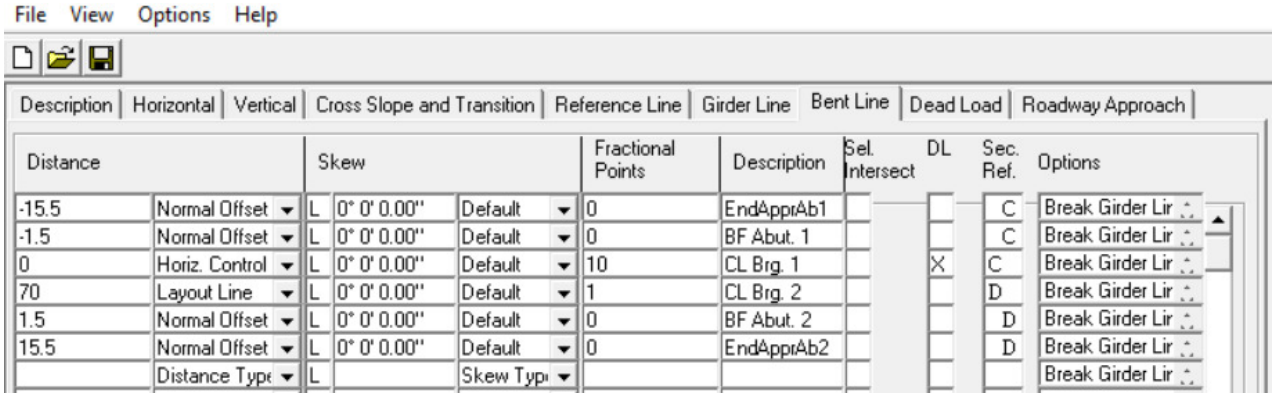


6. Girder Line Tab Input (Example 1)

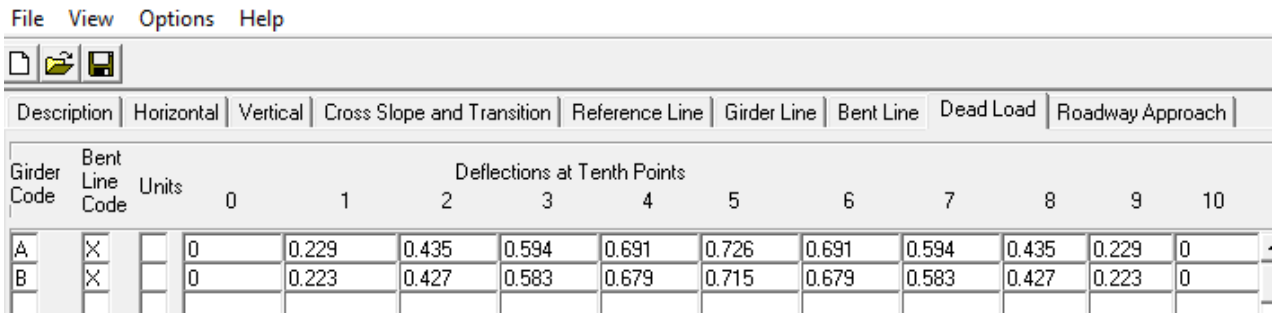


Line Type	Offset Distance Initial		Terminal		Elevation Shift	Description	X-Type Frac. Points	DL Char.	Options
Parallel to Hor	-23.0	Norm. from H		Offset Type	-3	OutsideWWAB			Girder lines Parallel
Parallel to Hor	-21.5	Norm. from H	0	Offset Type	-3	Left Edge Deck			Girder lines Parallel
Parallel to Hor	-20	Norm. from H		Offset Type	-3	Left Flowline			Girder lines Parallel
Parallel to Hor	-18.125	Norm. from H	0	Offset Type	-3	Ext. Girder A		A	Girder lines Parallel
Parallel to Hor	-12.0833	Norm. from H	0	Offset Type	-3	Int. Girder B		B	Girder lines Parallel
Parallel to Hor	-6.0417	Norm. from H	0	Offset Type	-3	Int. Girder C		B	Girder lines Parallel
Parallel to Hor	0	Norm. from H	0	Offset Type	-3	Int. Girder D		B	Girder lines Parallel
Parallel to Hor	6.0417	Norm. from H	0	Offset Type	-3	Int. Girder E		B	Girder lines Parallel
Parallel to Hor	12.0833	Norm. from H	0	Offset Type	-3	Int. Girder F		B	Girder lines Parallel
Parallel to Hor	18.125	Norm. from H	0	Offset Type	-3	Ext. Girder G		A	Girder lines Parallel
Parallel to Hor	20	Norm. from H		Offset Type	-3	Right Flowline			Girder lines Parallel
Parallel to Hor	21.5	Norm. from H	0	Offset Type	-3	Right Edge Dec			Girder lines Parallel
Parallel to Hor	23	Norm. from H		Offset Type	-3	OutsideWWCD			Girder lines Parallel

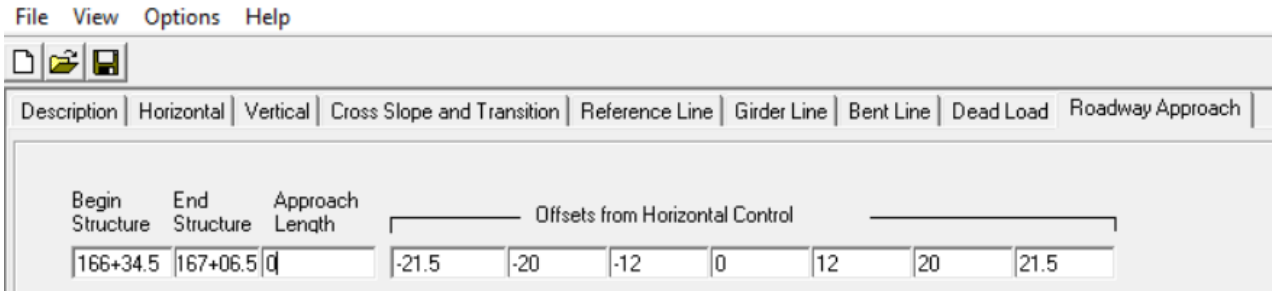
7. Bent Line Tab Input (Example 1)



8. Dead Load Tab Input (Example 1)



9. Roadway Approach Tab Input (Example 1)

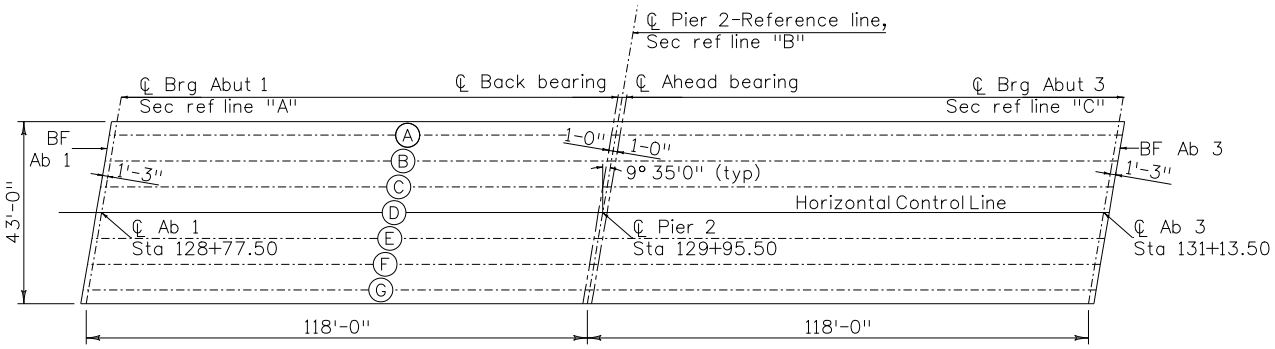


Input file (EX1.dat)

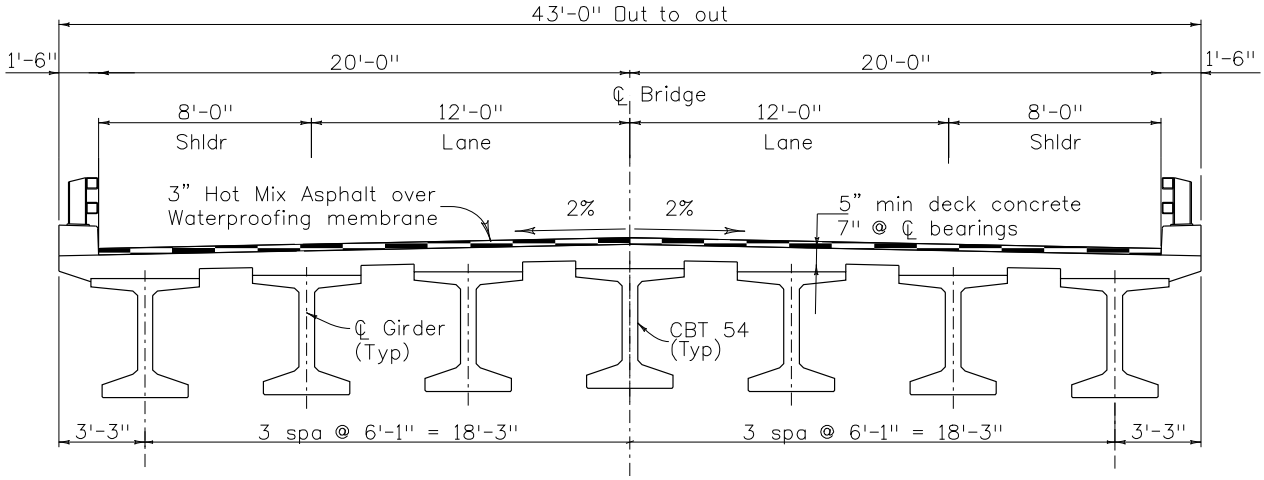
```
00Example 1
00 Units: feet;
00 Project: ABCD; Subaccount: 12345;
00 Designer: XX; Detailer: YY;
00 Location: HWY over River;
00Simple span (70'-0") with 7 PS Box girders @ 6'-0.5", 40'-0" roadway width (curb to curb), no skew. Rail type 10M.

01L  0 0 000            0 0 000               00000   0.00
02  2600000 20000  1655000 42059600 20000   000             00000   000  1570000
03C00200       00000                            750       00000 00000000000000
04  1663550000L 0 0 000201   0              00000    00000
050 -2300004   00000   -30000OutsideWWAB
050 -2150004   00000   -30000Left Edge Deck
050 -2000004   00000   -30000Left Flowline
050 -1812504   00000   -30000Ext. Girder A           A
050 -1208334   00000   -30000Int. Girder B           B
050  -604174   00000   -30000Int. Girder C           B
050   000004   00000   -30000Int. Girder D           B
050   604174   00000   -30000Int. Girder E           B
050  1208334   00000   -30000Int. Girder F           B
050  1812504   00000   -30000Ext. Girder G           A
050  2000004   00000   -30000Right Flowline
050  2150004   00000   -30000Right Edge Deck
050  2300004   00000   -30000OutsideWWCD
06 -1550006L 0 0 0000  0    EndApprAb1       C
06  -150006L 0 0 0000  0    BF Abut. 1       C
06   000000L 0 0 0000 10    CL Brg. 1      XC
06  7000001L 0 0 0000  1    CL Brg. 2       D
06   150006L 0 0 0000  0    BF Abut. 2       D
06  1550006L 0 0 0000  0    EndApprAb2       D
07AX                 0229  0435  0594  0691  0726  0691  0594  0435  0229
07BX                 0223  0427  0583  0679  0715  0679  0583  0427  0223
08  16635  16707      00 -215000 -200000 -120000   00000  120000  200000  215000
```

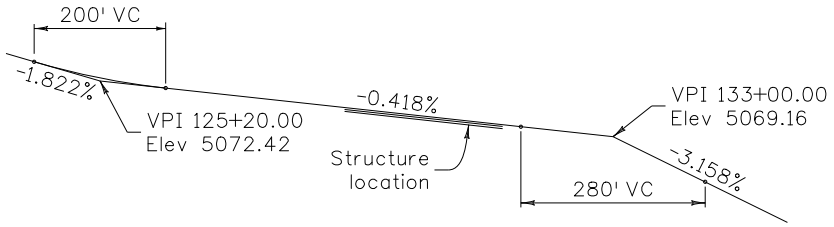
Example 2 - 2-Span skewed bridge on a straight horizontal alignment



PLAN VIEW

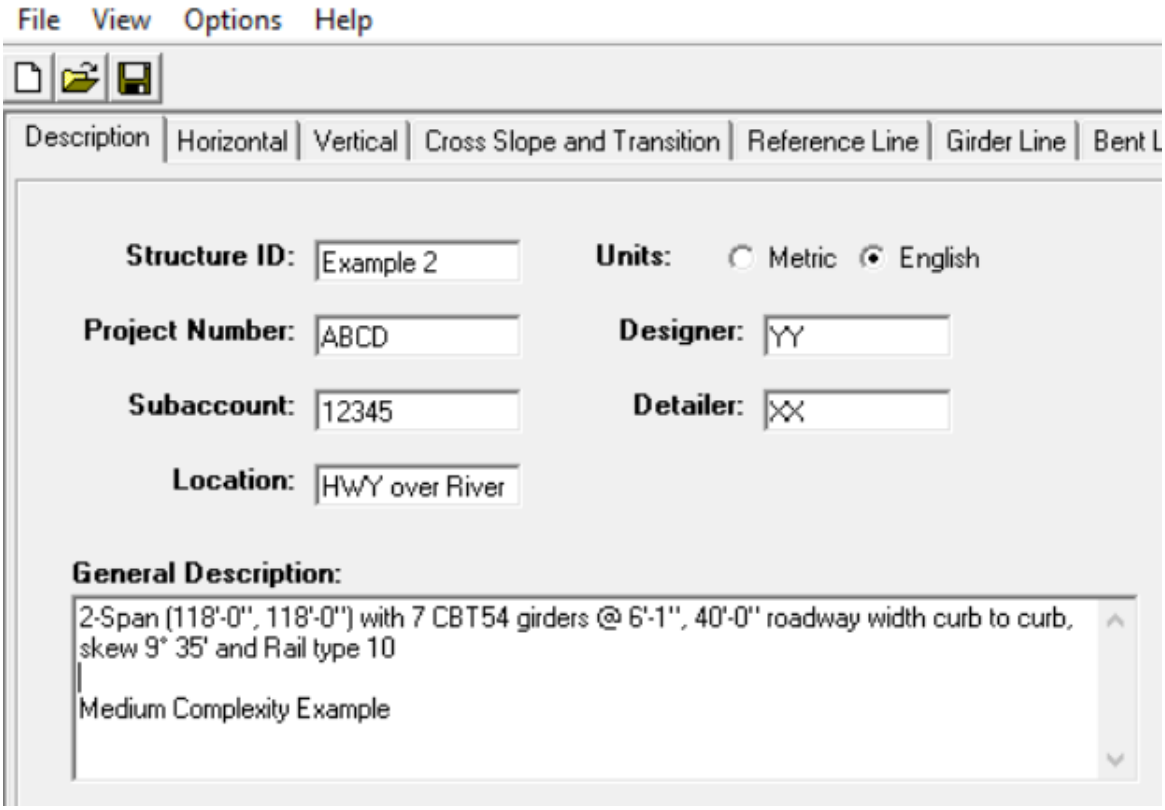


TYPICAL SECTION

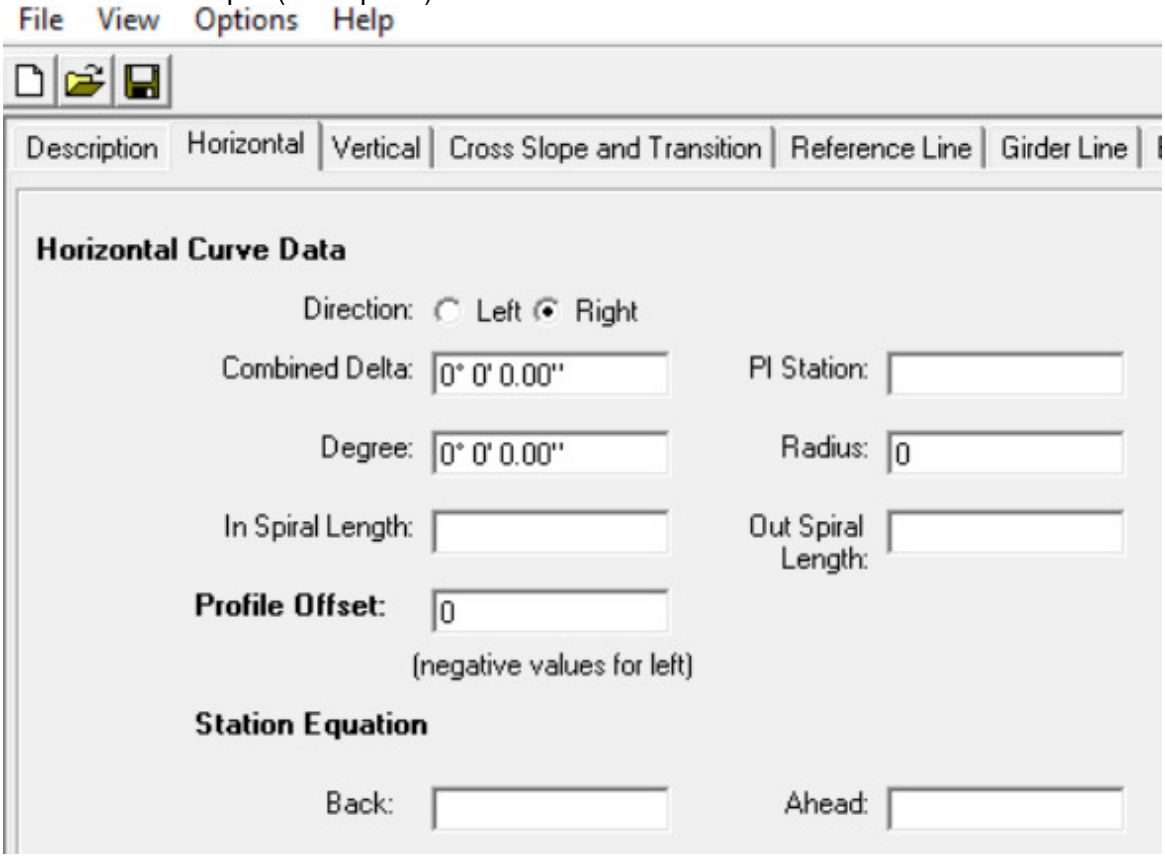


PROFILE GRADE

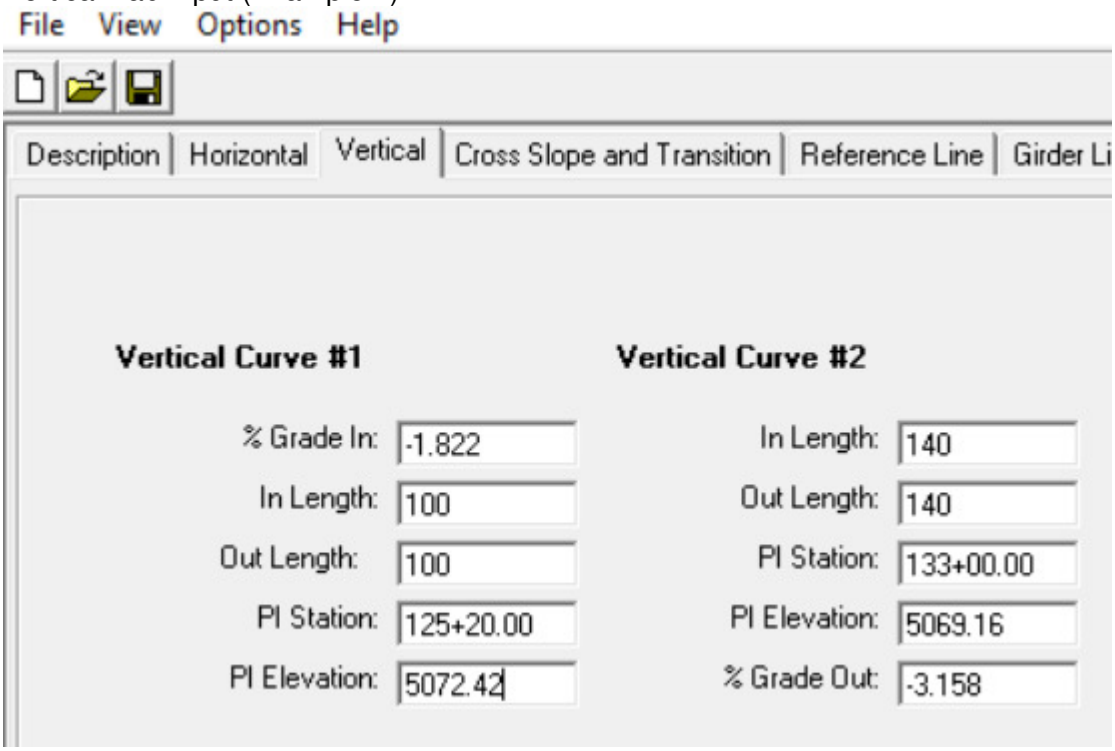
1. Description Tab Input (Example 2)



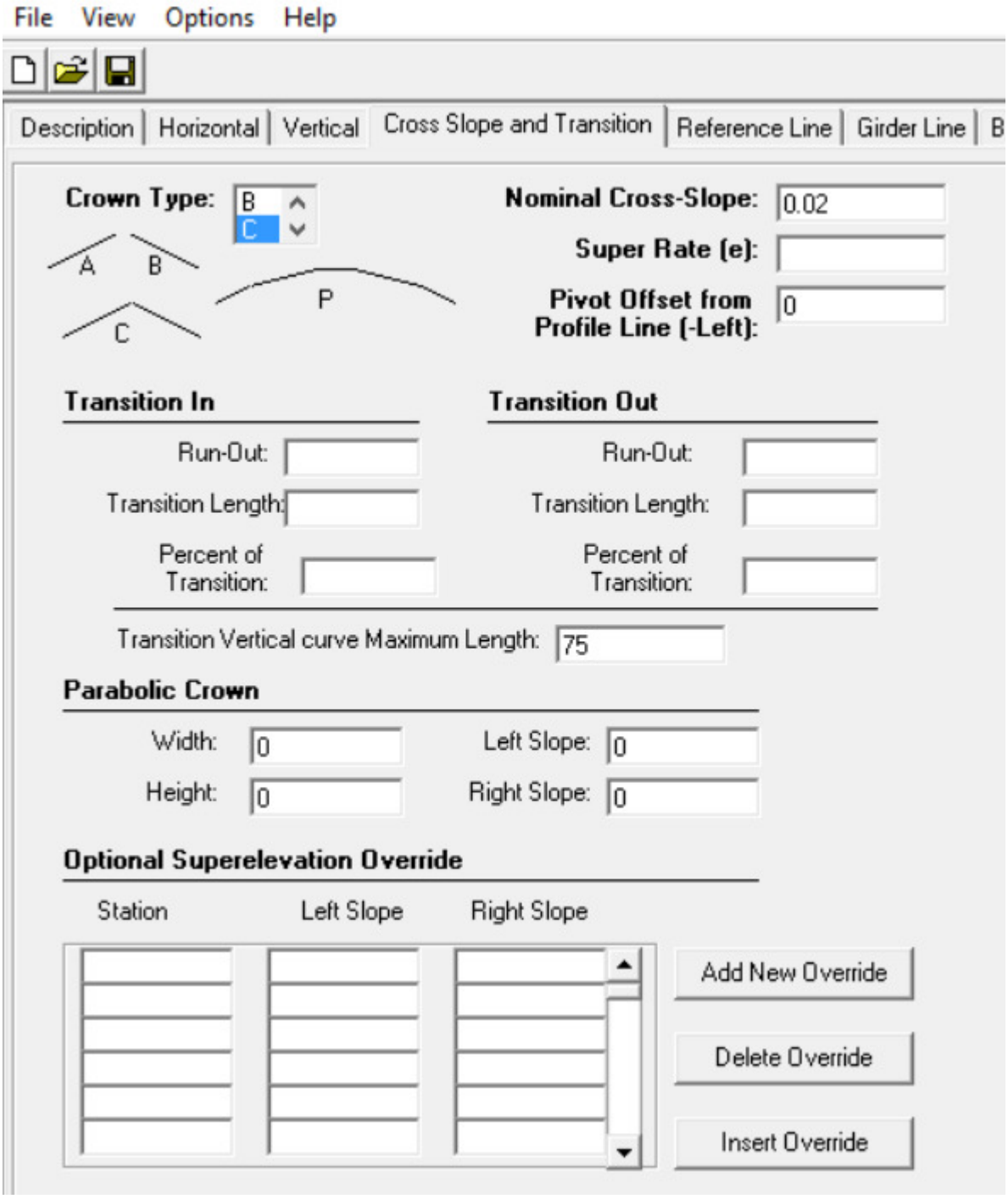
2. Horizontal Tab Input (Example 2)



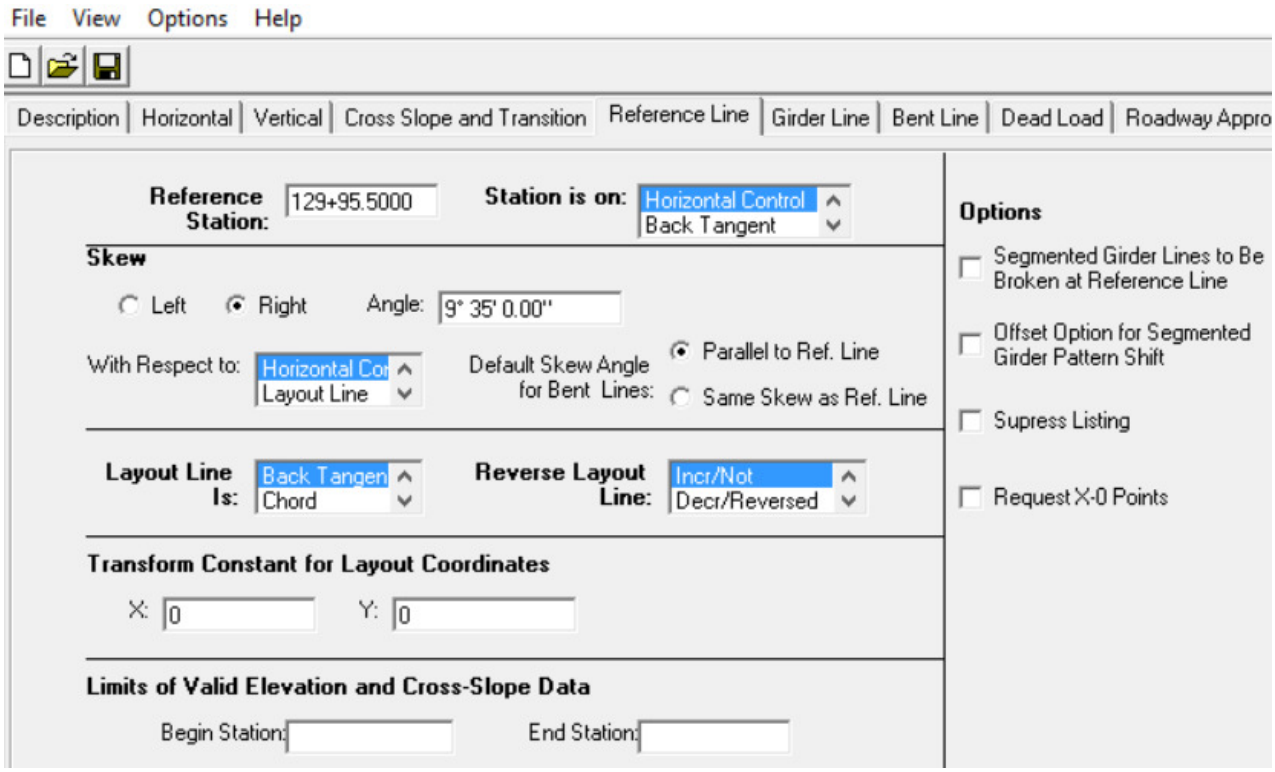
3. Vertical Tab Input (Example 2)



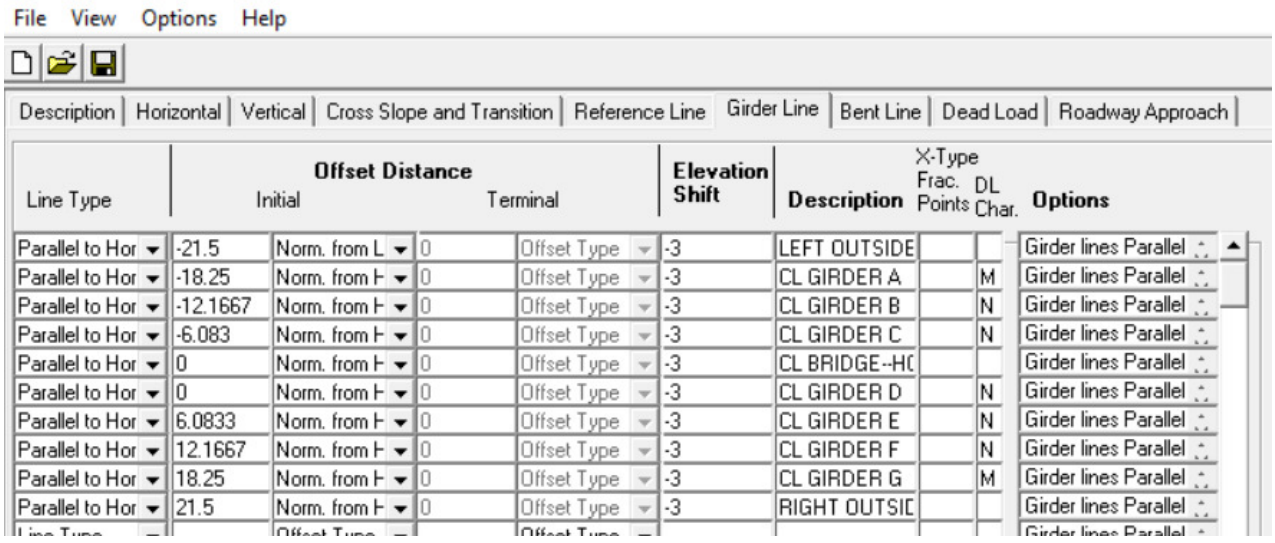
4. Cross Slope and Transition Tab Input (Example 2)



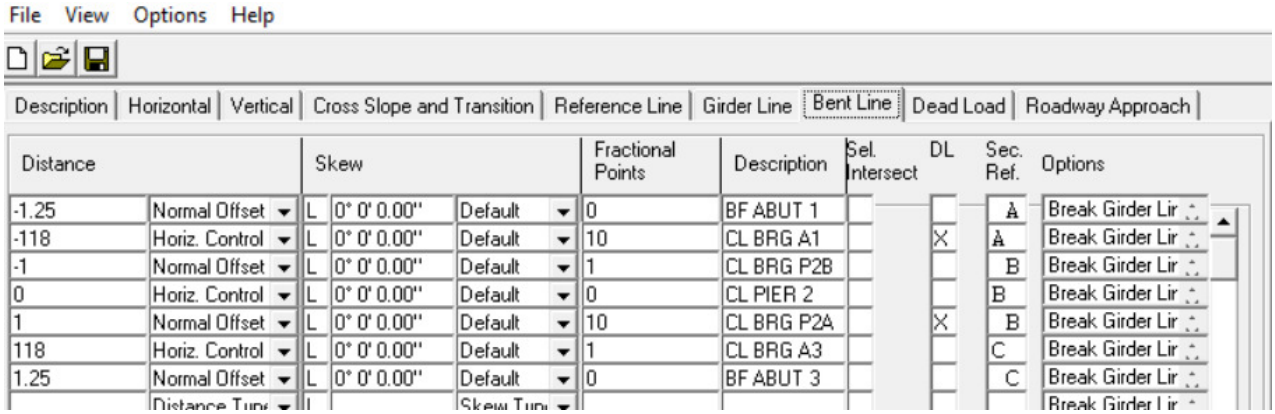
5. Reference Line Tab Input (Example 2)



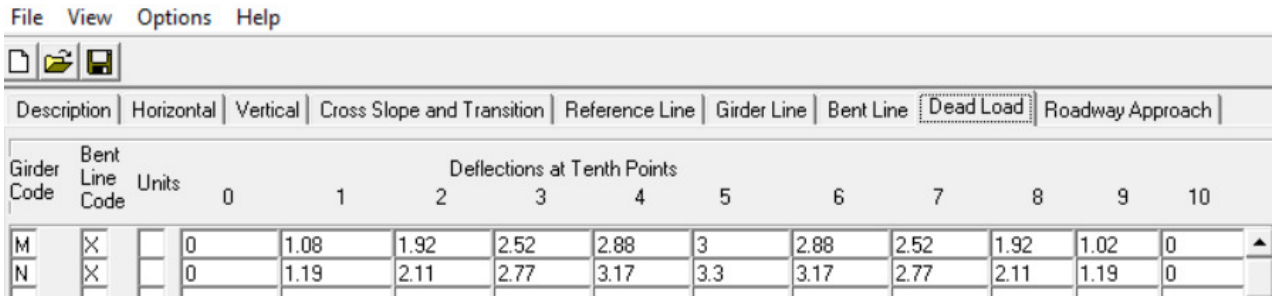
6. Girder Line Tab Input (Example 2)



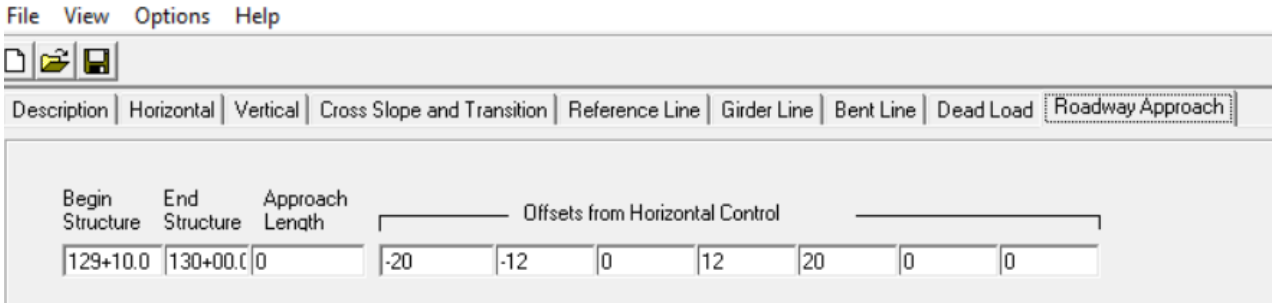
7. Bent Line Tab Input (Example 2)



8. Dead Load Tab Input (Example 2)



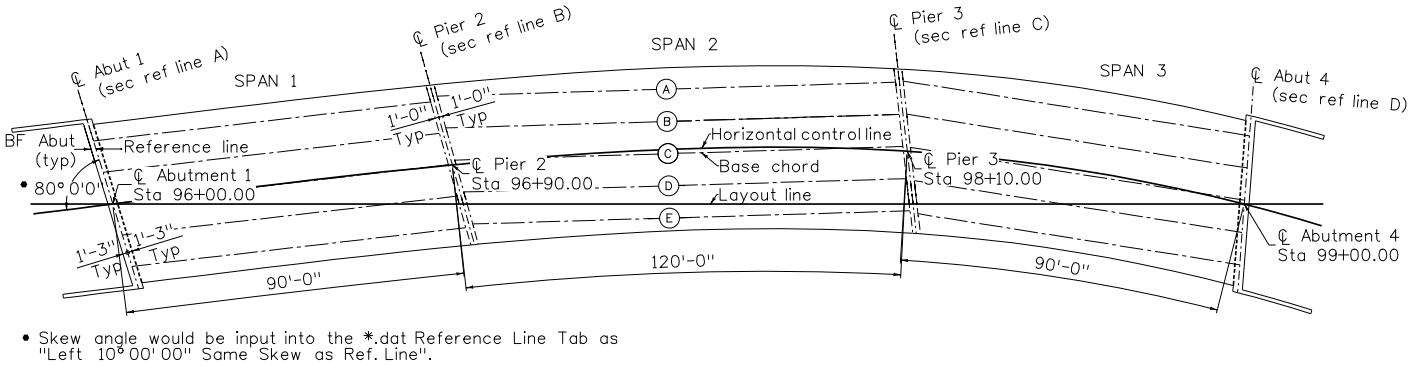
9. Roadway Approach Tab Input (Example 2)



Input file (EX2.dat)

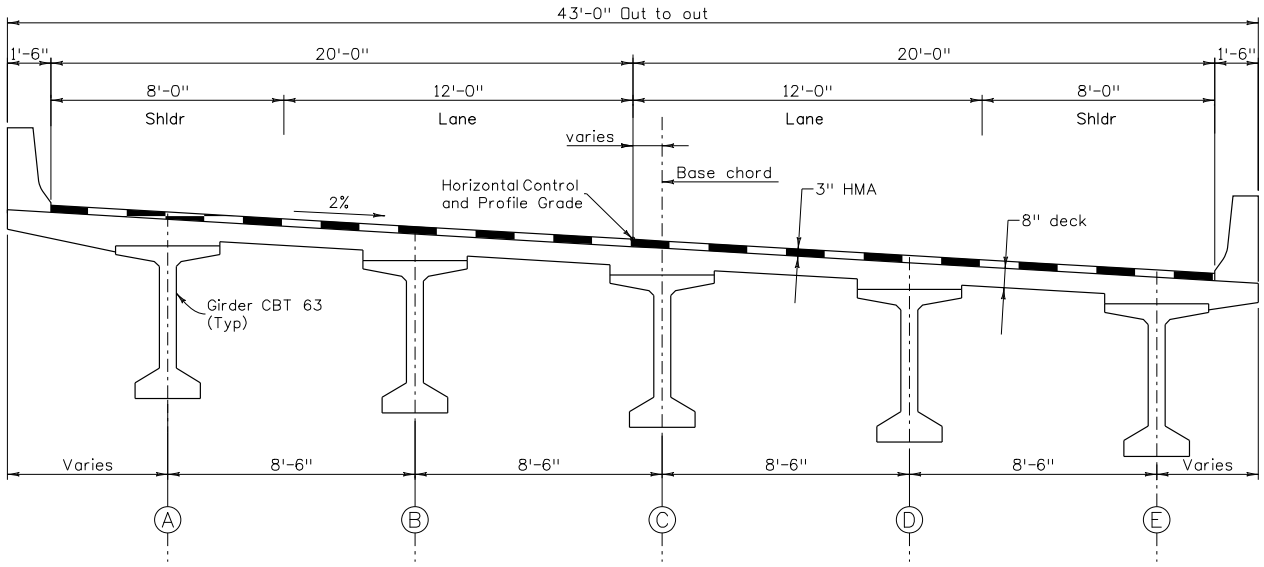
```
00Example 2
00 Units: feet;
00 Project: ABCD; Subaccount: 12345;
00 Designer: YY; Detailer: XX;
00 Location: HWY over River;
002-Span (118'-0", 118'-0") with 7 CBT54 girders @ 6'-1", 40'-0" roadway width curb to curb, skew 9° 35' and Rail type 10
00
00Medium Complexity Example
01R  0 0 000            0 0 000               00000   0.00
02 -1822000 10000  1252000 50724200 10000 14000  1330000 50691600 14000 -3158000
03C00200       00000                          750       00000 00000000000000
04  1299550000R 935 000101   0              00000    00000
050 -2150002   00000   -30000LEFT OUTSIDE
050 -1825004   00000   -30000CL GIRDER A             M
050 -1216674   00000   -30000CL GIRDER B             N
050  -608304   00000   -30000CL GIRDER C             N
050   000004   00000   -30000CL BRIDGE--HCL
050   000004   00000   -30000CL GIRDER D             N
050   608334   00000   -30000CL GIRDER E             N
050  1216674   00000   -30000CL GIRDER F             N
050  1825004   00000   -30000CL GIRDER G             M
050  2150004   00000   -30000RIGHT OUTSIDE
06  -125006L 0 0 0000  0    BF ABUT 1        A
06-11800000L 0 0 0000 10    CL BRG A1      XA
06  -100006L 0 0 0000  1    CL BRG P2B       B
06   000000L 0 0 0000  0    CL PIER 2       B
06   100006L 0 0 0000 10    CL BRG P2A     X B
06 11800000L 0 0 0000  1    CL BRG A3        C
06   125006L 0 0 0000  0    BF ABUT 3        C
07MX            0000  1080  1920  2520  2880  3000  2880  2520  1920  1020  0000
07NX            0000  1190  2110  2770  3170  3300  3170  2770  2110  1190  0000
08  12910  13000      00 -200000 -120000   00000  120000  200000   00000   00000
```

Example 3 - 3-Span skewed segmental bridge on a spiral horizontal alignment with superelevation

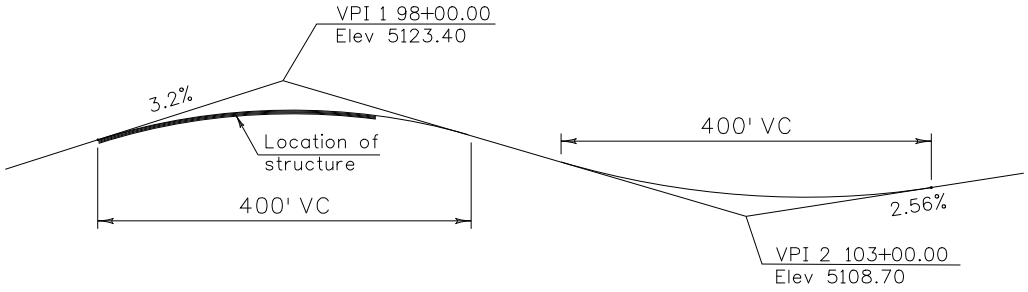


• Skew angle would be input into the *.dat Reference Line Tab as "Left 10° 00' 00" Same Skew as Ref. Line".

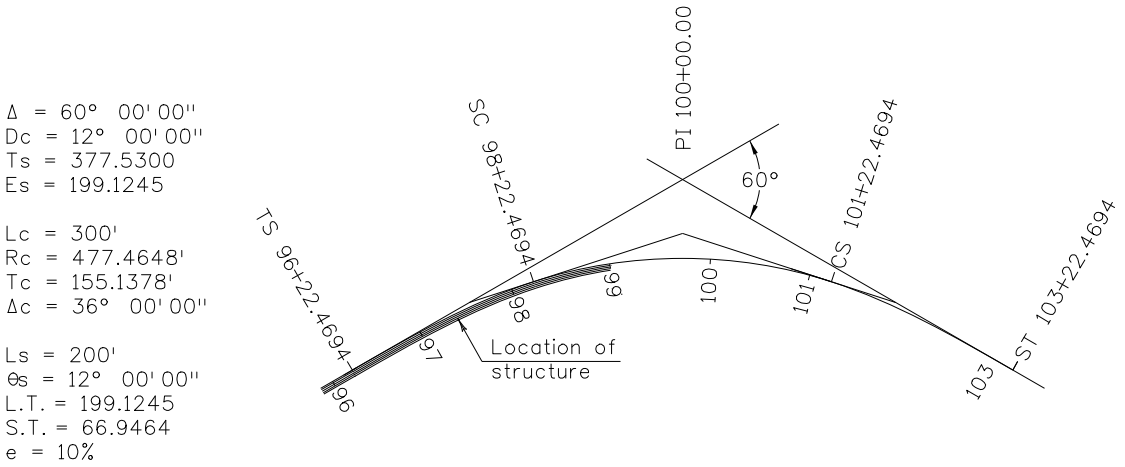
PLAN VIEW



TYPICAL SECTION

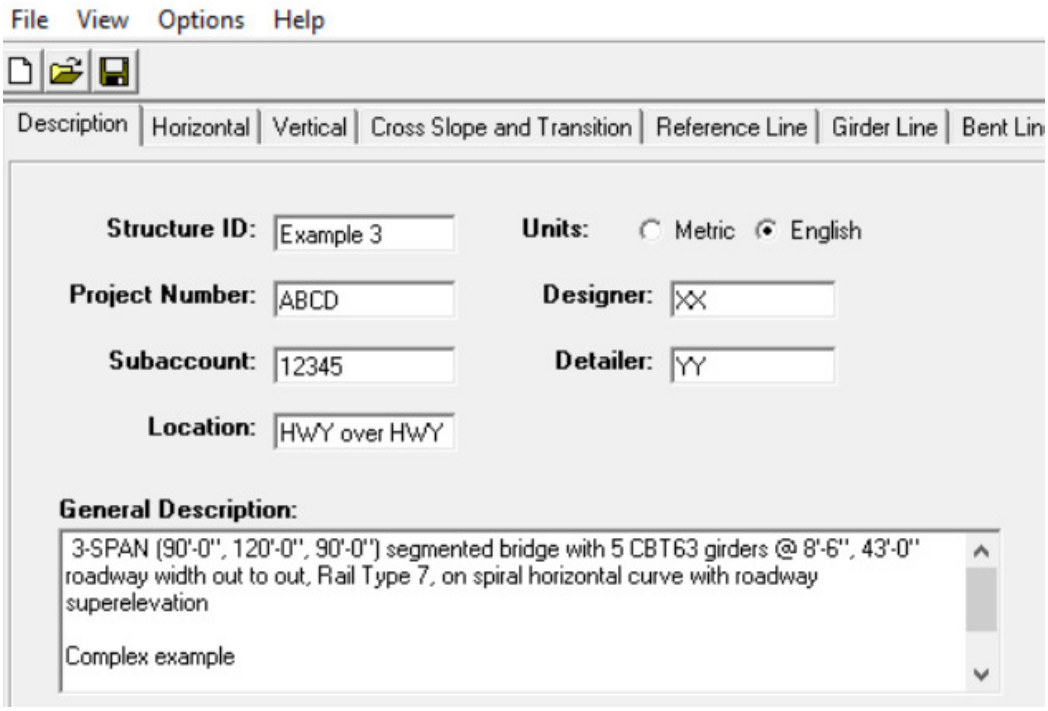


VERTICAL PROFILE GRADE

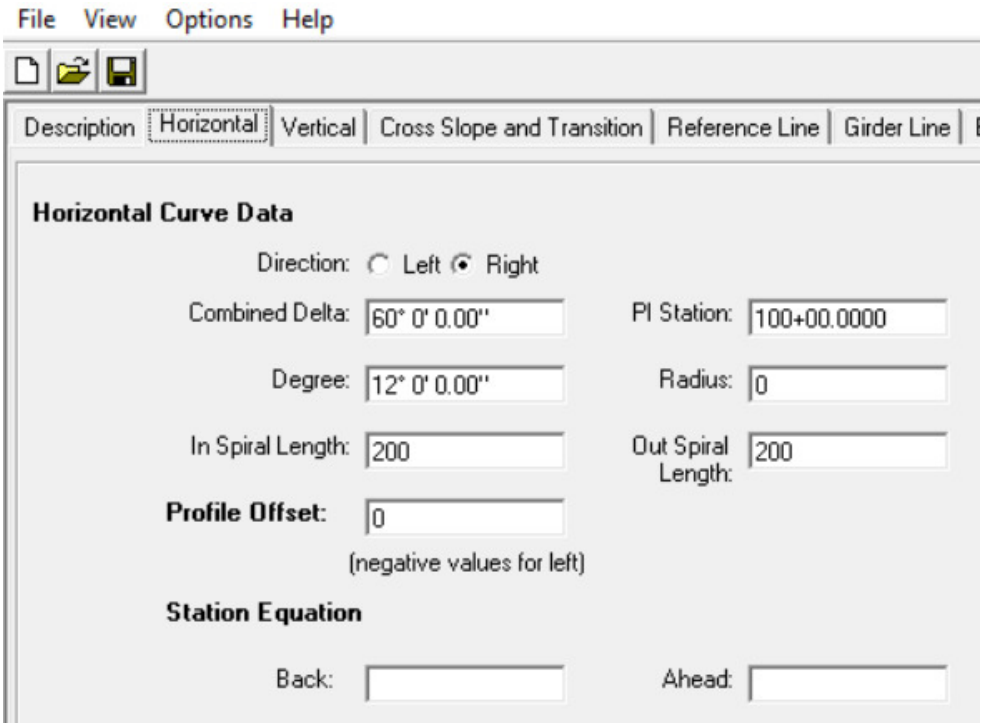


HORIZONTAL CURVE

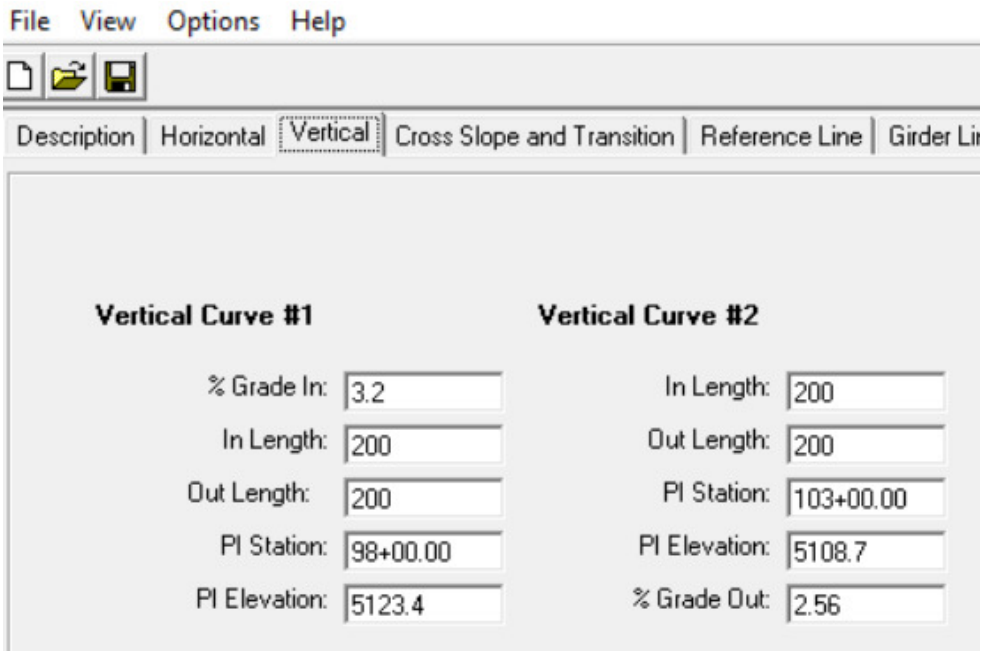
1. Description Tab Input (Example 3)



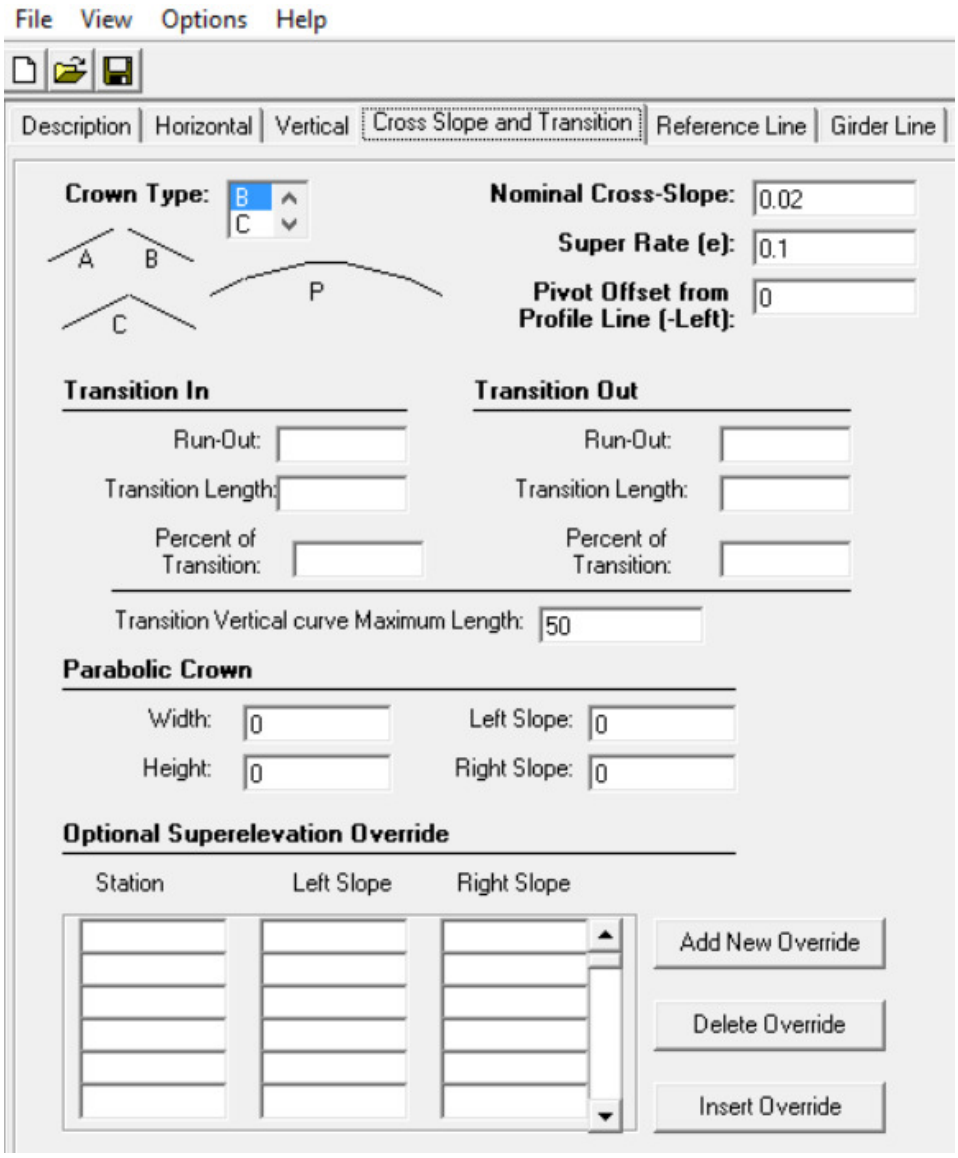
2. Horizontal Tab Input (Example 3)



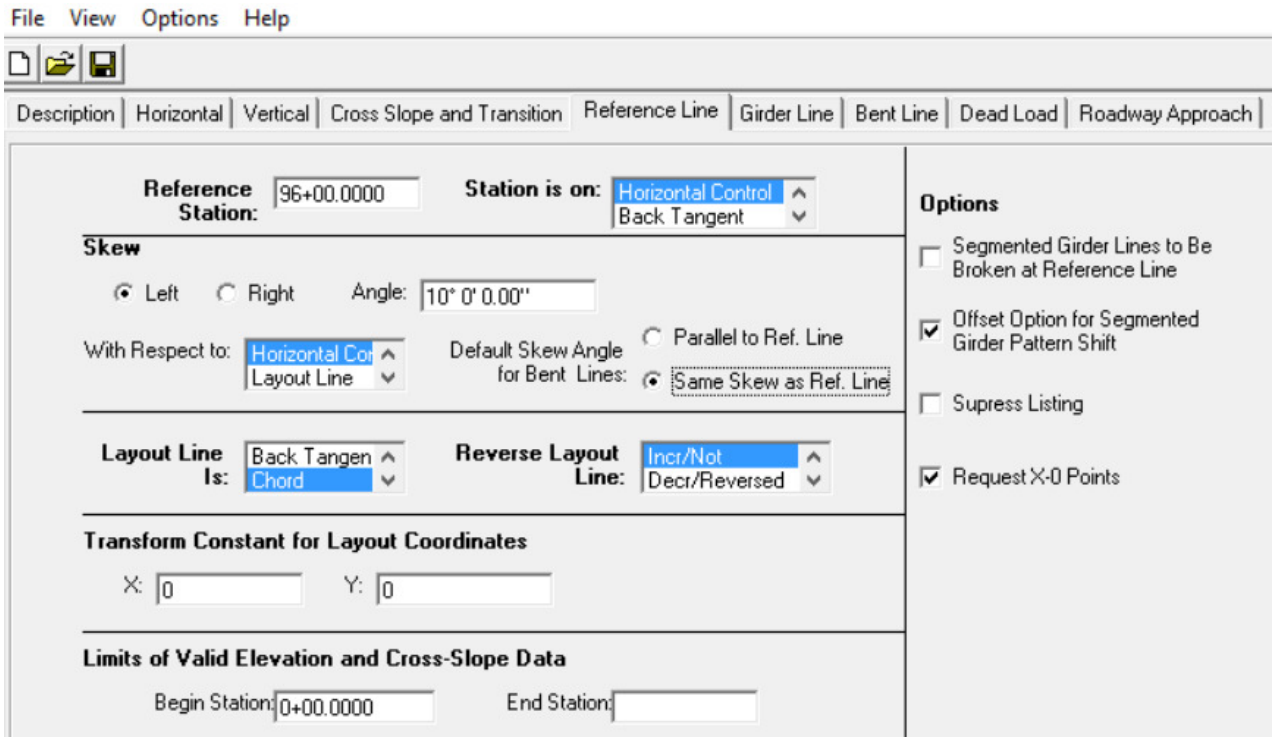
3. Vertical Tab Input (Example 3)



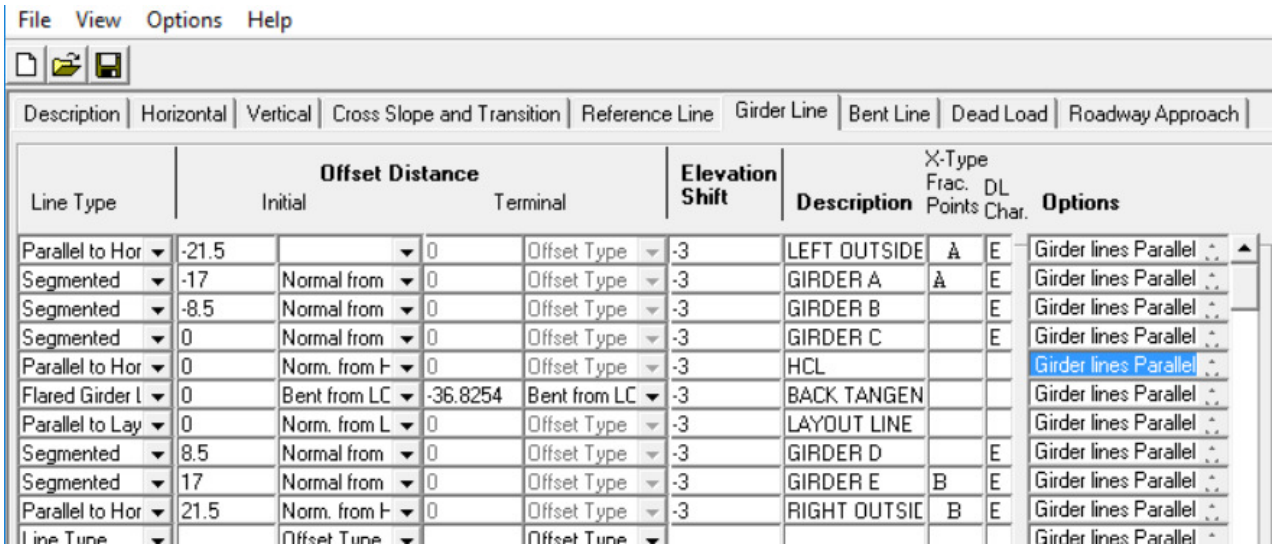
4. Cross Slope and Transition Tab Input (Example 3)



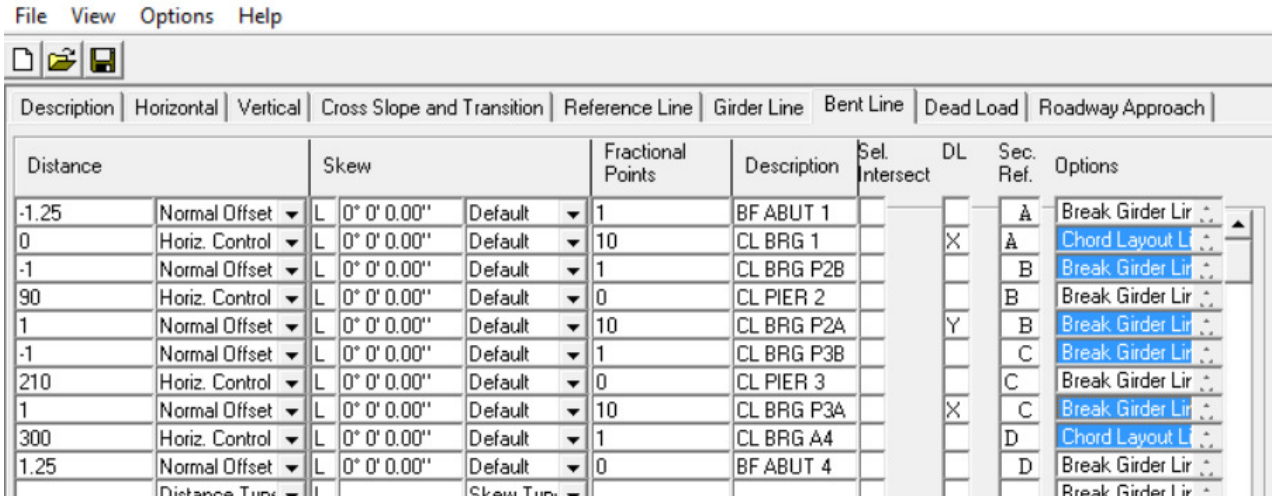
5. Reference Line Tab Input (Example 3)



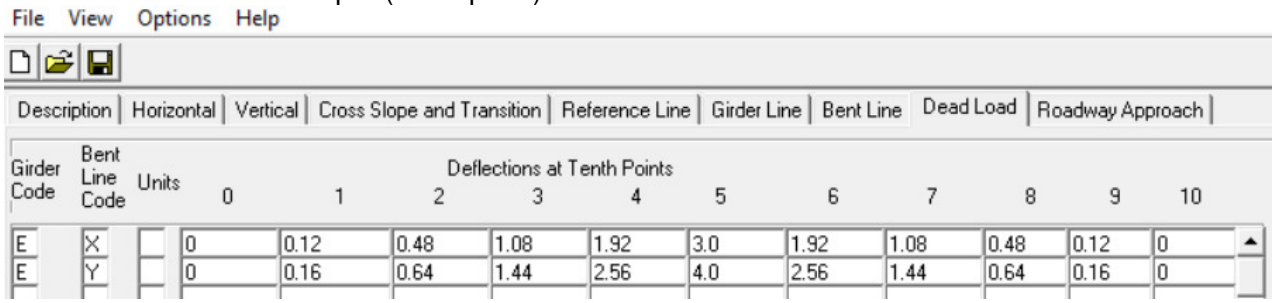
6. Girder Line Tab Input (Example 3)



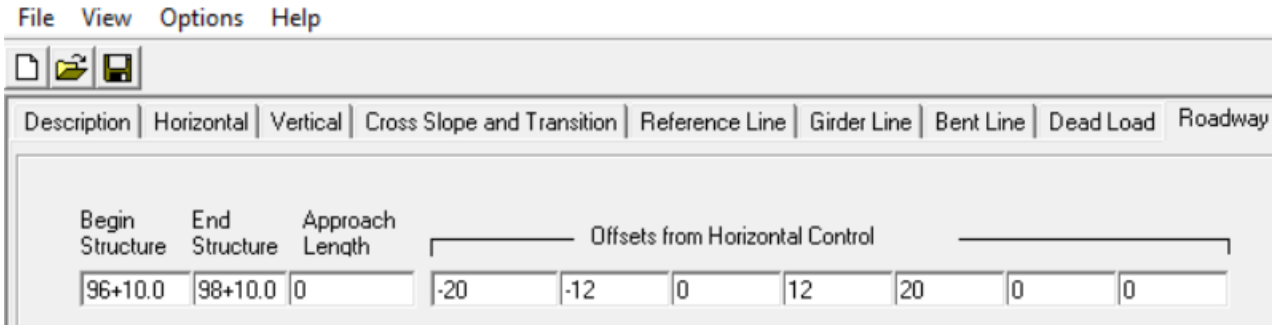
7. Bent Line Tab Input (Example 3)



8. Dead Load Tab Input (Example 3)



9. Roadway Approach Tab Input (Example 3)



Input file (EX3.dat)

```
00Example 3
00 Units: feet;
00 Project: ABCD; Subaccount: 12345;
00 Designer: XX; Detailer: YY;
00 Location: HWY over HWY;
00 3-SPAN (90'-0", 120'-0", 90'-0") segmented bridge with 5 CBT63 girders @ 8'-6", 43'-0" roadway width out to out,
Rail Type 7, on spiral horizontal curve with roadway superelevation
00
00Complex example
00
01R 60 0 000  10000000012 0 000 20000 20000   00000   0.00
02  3200000 20000   980000 51234000 20000 20000  1030000 51087000 20000  2560000
03B002001000   00000                              500       00000 00000000000000
04   960000000L10 0 000112  X0X             00000    00000      00000
050 -2150004   00000   -30000LEFT OUTSIDE           AE
051 -1700005   00000   -30000GIRDER A              A E
051  -850005   00000   -30000GIRDER B                E
051   000005   00000   -30000GIRDER C                E
050   000004   00000   -30000HCL                 X
053   000001 -3682541  -30000BACK TANGENT
052   000002   00000   -30000LAYOUT LINE
051   850005   00000   -30000GIRDER D                E
051  1700005   00000   -30000GIRDER E              B E
050  2150004   00000   -30000RIGHT OUTSIDE          BE
06  -125006L 0 0 0000  1    BF ABUT 1        A
06   000000L 0 0 0000 10    CL BRG 1  XXX  XA
06  -100006L 0 0 0000  1    CL BRG P2BX      B
06  9000000L 0 0 0000  0    CL PIER 2       B
06   100006L 0 0 0000 10    CL BRG P2AX    Y B
06  -100006L 0 0 0000  1    CL BRG P3BX      C
06 21000000L 0 0 0000  0    CL PIER 3       C
06   100006L 0 0 0000 10    CL BRG P3AX    X C
06 30000000L 0 0 0000  1    CL BRG A4 XXX   D
06   125006L 0 0 0000  0    BF ABUT 4        D
07EX            0000  0120  0480  1080  1920  3000  1920  1080  0480  0120  0000
07EY            0000  0160  0640  1440  2560  4000  2560  1440  0640  0160  0000
08   9610   9810      00 -200000 -120000   00000  120000  200000   00000   00000
```

Appendix D – Basic Roadway Geometry Information

USE OF CARTESIAN SYSTEMS

The following summarizes some of the basic formulas for Cartesian coordinate systems.

For implicitly distinct points:
P(1) represented by coordinates (X_1, Y_1)
P(2) represented by coordinates (X_2, Y_2)
P(3) represented by coordinates (X_3, Y_3) etc.

P(1), P(2) and P(3) lie on the same line (are colinear) if

$$Y_3 = Y_2 + \frac{(X_3 - X_2)(Y_1 - Y_2)}{(X_1 - X_2)} \quad \text{OR} \quad X_3 = X_2 + \frac{(Y_3 - Y_2)(X_1 - X_2)}{(Y_1 - Y_2)}$$

$$\text{OR} \quad \det \begin{vmatrix} X_1 & Y_1 & 1 \\ X_2 & Y_2 & 1 \\ X_3 & Y_3 & 1 \end{vmatrix} = 0$$

Distance from P(1) to P(2) (in the horizontal plane)

$$\sqrt{(X_2 - X_1)^2 + (Y_2 - Y_1)^2}$$

The Euclidean norm (including difference in elevation)

$$\sqrt{(X_2 - X_1)^2 + (Y_2 - Y_1)^2 + (\text{Elev.}_2 - \text{Elev.}_1)^2}$$

Line through P(1) and P(2) is parallel to line through P(3) and P(4) if

$$(X_1 - X_2)(Y_3 - Y_4) = (X_3 - X_4)(Y_1 - Y_2)$$

Line through P(1) and P(2) is perpendicular to line through P(3) and P(4) if:

$$(X_1 - X_2)(X_3 - X_4) = (Y_1 - Y_2)(Y_4 - Y_3)$$

Area of triangle with vertices P(1), P(2) and P(3)

$$\left|(X_1 Y_2 + X_2 Y_3 + X_3 Y_1 - X_1 Y_3 - X_2 Y_1 - X_3 Y_2)\right| / 2$$

$$\left|((X_1 - X_2)(Y_3 - Y_2) - (X_3 - X_2)(Y_1 - Y_2))\right| / 2$$

Area of quadrilateral with sequential vertices P(1), P(2), P(3) and P(4)

$$\left|((X_1 Y_2 + X_2 Y_3 + X_3 Y_4 + X_4 Y_1 - X_1 Y_4 - X_2 Y_1 - X_3 Y_2 - X_4 Y_1))\right| / 2$$

Distance of P(3) from the line through P(1) and P(2) is equal to twice the area of triangle P(1), P(2), P(3) divided by distance from P(1) to P(2)

$$\frac{\left|((X_1 - X_2)(Y_3 - Y_2) - (X_3 - X_2)(Y_1 - Y_2))\right|}{\sqrt{(X_2 - X_1)^2 + (Y_2 - Y_1)^2}}$$

Transit at P(0), the angle turned from the line (parallel to Y-axis) to sight P(1) is given by

$$\theta = \text{Arctan} \frac{X_1 - X_0}{Y_1 - Y_0}$$

The angle turned from sight on P(1) to sight P(2) is given by

$$\theta = \text{Arctan} \frac{(Y_1 - Y_0)(X_2 - X_0) - (X_1 - X_0)(Y_2 - Y_0)}{(X_1 - X_0)(X_2 - X_0) + (Y_1 - Y_0)(Y_2 - Y_0)}$$

If $\tan(\theta)$ is > 0, θ may be either to the right $0° < \theta < 90°$ or to the left $-180° < \theta < -90°$.

If $\tan(\theta)$ is < 0, θ may be either to the left $-90° < \theta < 0°$ or the right $90° < \theta < 180°$.

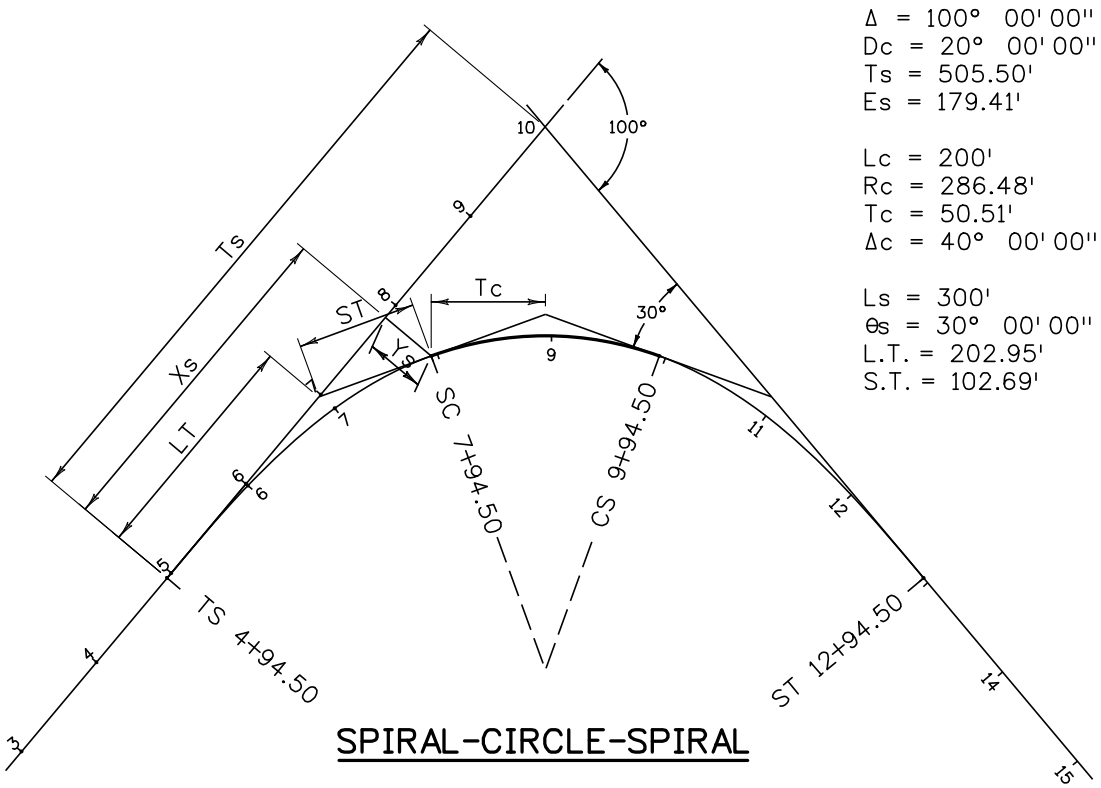
PI Point of intersection of tangents
TS Tangent to spiral point
SC Spiral to circle point
CS Circle to spiral point
ST Spiral to tangent point

Δ = Total deflection angle of curve
θ_s = Deflection angle of spiral
Ts = Distance from ST to PI
Es = External distance from PI to center of circular portion of curve
Ls = Length of spiral
Lt = Distance from ST or TS to PI of spiral
St = Distance from PI of spiral to SC or CS
Dc = Degree of curve of circular portion
Tc = Distance from S.C. or C.S. to P.I of circular portion
Lc = Arc length of circular portion S.C. to C.S.
Rc = Radius of circular Portion

$D = \frac{L}{L_s} \times D_c$; Relationship between Dc and the curvature of the spiral

$\theta_s = \frac{L_s}{200} \times D_c$; Relationship between θ_s, Ls, and Dc

$\theta = \frac{L^2}{L_s^2} \times \theta_s$; Angle at any length (L) along spiral with respect to Ls and θ



TS Point of change from tangent to spiral
ST Point of change from spiral to tangent
SC Point of change from spiral to circle
CS Point of change from circle to spiral
l Spiral arc length from TS to any point
l_s total length of spiral from TS to SC
θ Central angle of spiral arc l
θ_s Central angle of spiral arc ls, called "spiral angle"
D Degree of curve of the spiral at any point
R Radius of curve of the spiral at any point
D_c Degree of of curve of the shifted circle to which the spiral becomes tangent at the SC
R_c The radius of the circle
L.T. Long tangent distance of spiral only
S.T. Short tangent distance of spiral only
p Offset distance from the tangent of P.C. of circular curve produced
k Distance from T.S.to point on tangent opposite the P.C. of the circular curve produced
x,y Coordinates at any point on the spiral
x_s,y_s Coordinates at the S.C. or C.S.

$D = \frac{L}{L_s} \times D_c$; Relationship between Dc and the curvature of the spiral

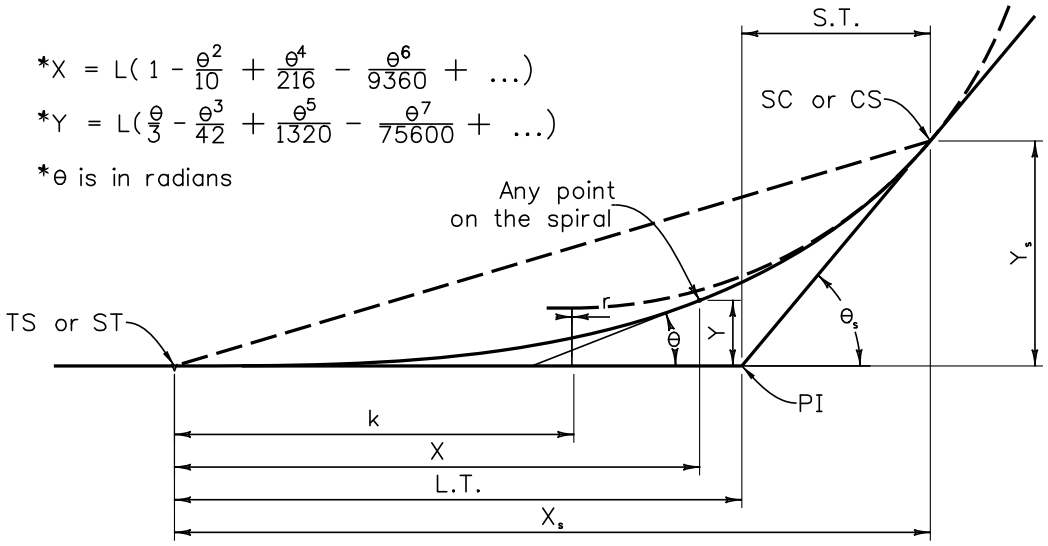
$\theta_s = \frac{L_s}{200} \times D_c$; Relationship between θs, Ls, and Dc

$\theta = \frac{L^2}{L_s^2} \times \theta_s$; Angle at any length (L) along spiral with respect to Ls and θ

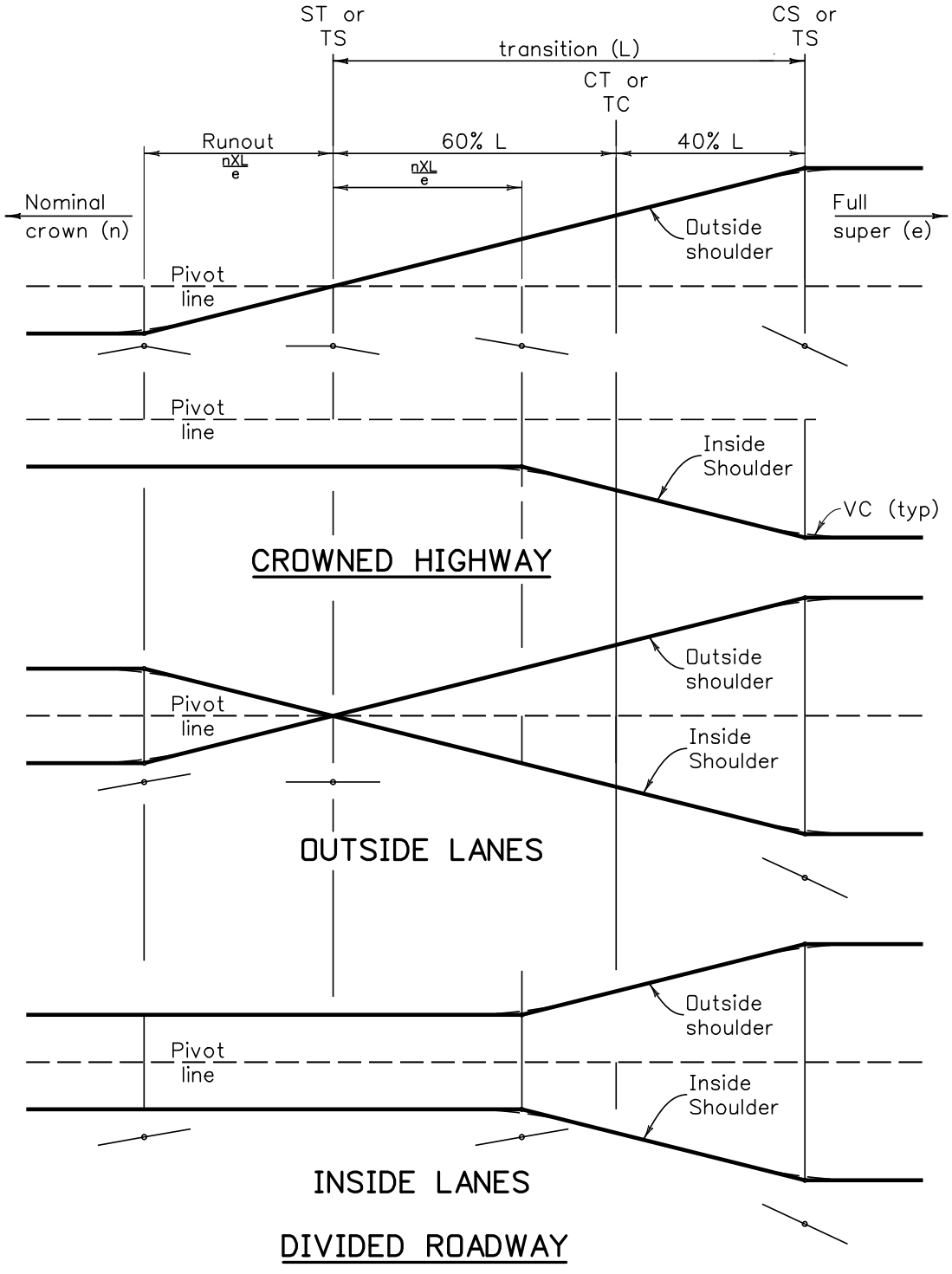
$*X = L\left(1 - \frac{\theta^2}{10} + \frac{\theta^4}{216} - \frac{\theta^6}{9360} + \ldots\right)$

$*Y = L\left(\frac{\theta}{3} - \frac{\theta^3}{42} + \frac{\theta^5}{1320} - \frac{\theta^7}{75600} + \ldots\right)$

*θ is in radians



SPIRAL EXAMPLE



SUPERELEVATION DIAGRAMS

Appendix E – Auxiliary Applications

1. PROJECT COORDINATES APPLICATION

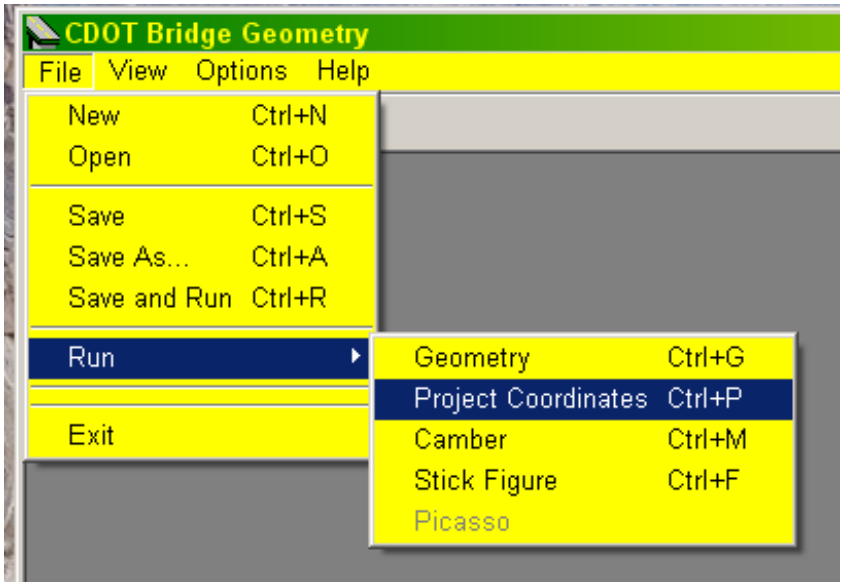
This application shall be run for all projects to provide coordinates on the deck elevation drawing sheets.

The Bridge Geometry program needs to be run first to produce a .lis file. Do not edit this .lis file prior to running Project Coordinates application.

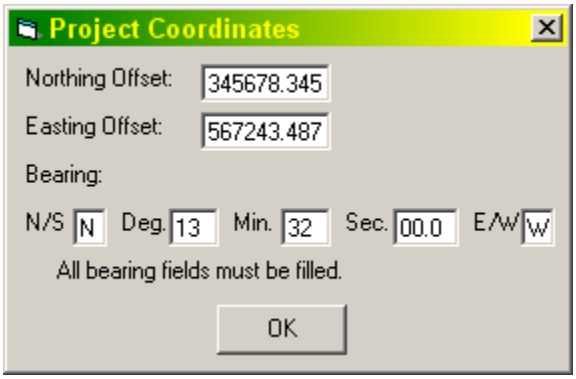
File names and folder names in the path must follow the MSDOS convention: no more than 12 characters including the dot and the file extension, which limits the file name to eight characters. Spaces and most ASCII characters (#, $, ^, *, <, etc.) will not work with the MSDOS file names, but underlines (A_B) will work. The Windows desktop is a temporary workable location for files.

To use the application, the State Plane Coordinates of the intersection of the Layout line and the Reference line in the Bridge Geometry must be determined, as well as the bearing of the Layout line. Coordinates may be determined mathematically from a COGO output obtained from the region, graphically from the roadway line sheets, or by graphically inputting the pertinent data into a CAD drawing. The bearing may be determined using the same general method.

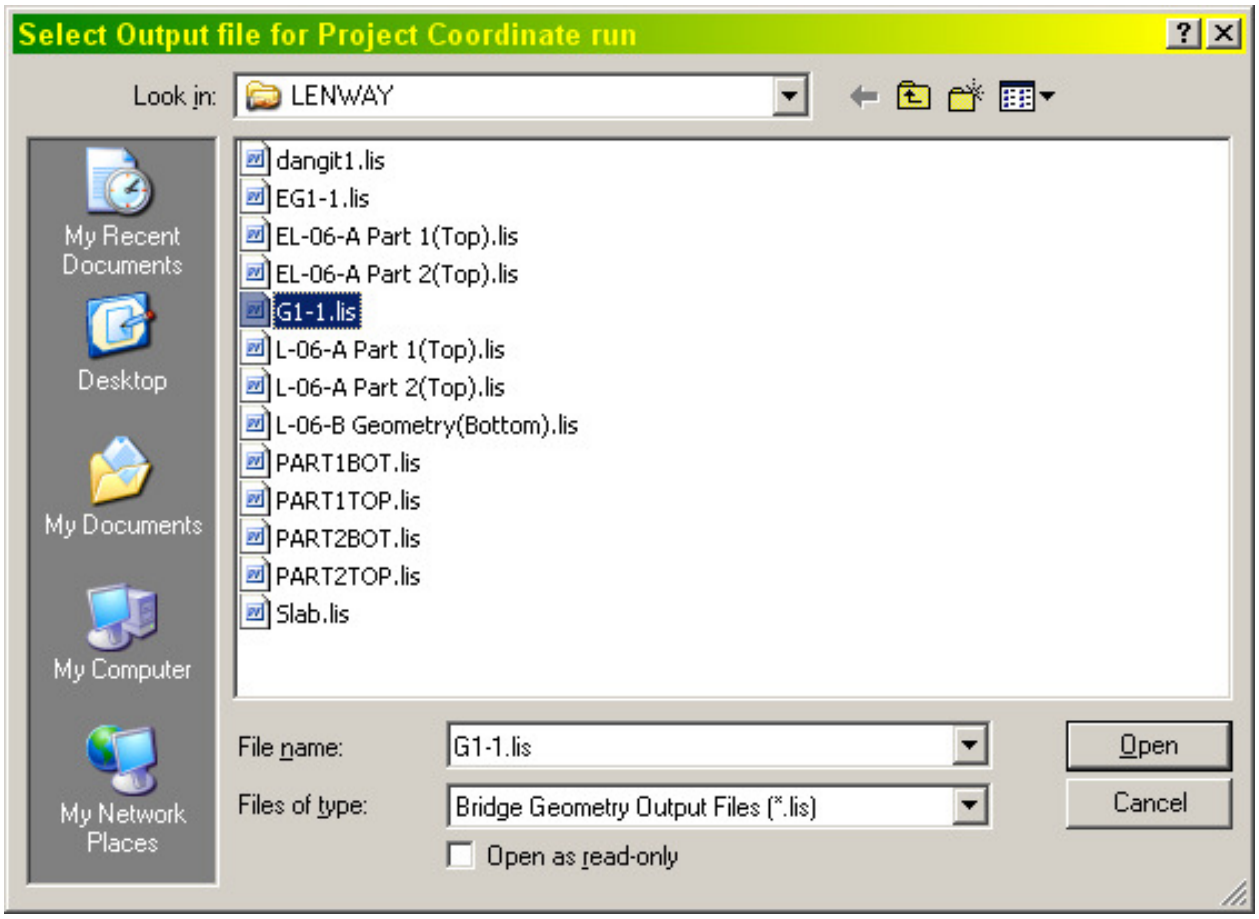
To run the application, go to the Bridge Geometry input window, click on File, then Run, then Project Coordinates.



In the Project Coordinates window enter the Northing and Easting coordinates, and the bearing of the layout line. Use explicit decimal points in the Northing and Easting, and in the seconds portion of the bearing. All fields must be filled. Click OK.



In the Select Output file, select the desired *.lis file, and click on Open. The *.pcf file will appear in the same folder with the same file name, but with the *.PCF suffix.



2. CAMBER APPLICATION

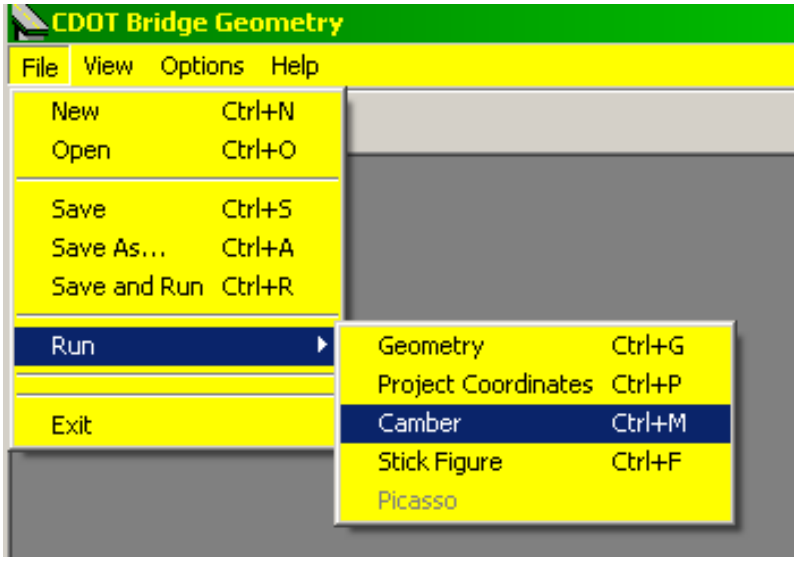
This application is for developing camber cutting and blocking information for steel bridges for fabrication shop use only.

File names and folder names in the folder path must follow the MSDOS convention: no more than 12 characters including the dot and the file extension, which limits the file name to eight characters. Spaces and most ASCII characters (#, $, ^, *, <, etc.) will not work with the MSDOS file names, but underlines (A_B) will work. The Windows desktop is a temporary workable location for files.

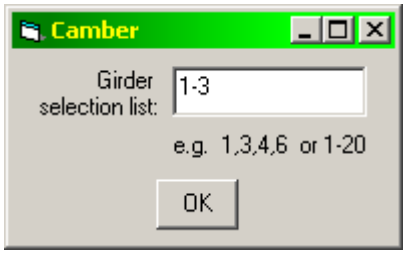
First, run Bridge Geometry.

- Code girder lines with girder names containing “GIR” and the number for the girder such as CL GIRDER or GIR 3. The camber utility will not run with the alpha girder designations; they should be edited into the camber output
- Code abutment lines as CL ABUT and the number
- Code splices as CL SPL and the number
- Run Bridge Geometry with total dead load deflection at 10th or 20th points.

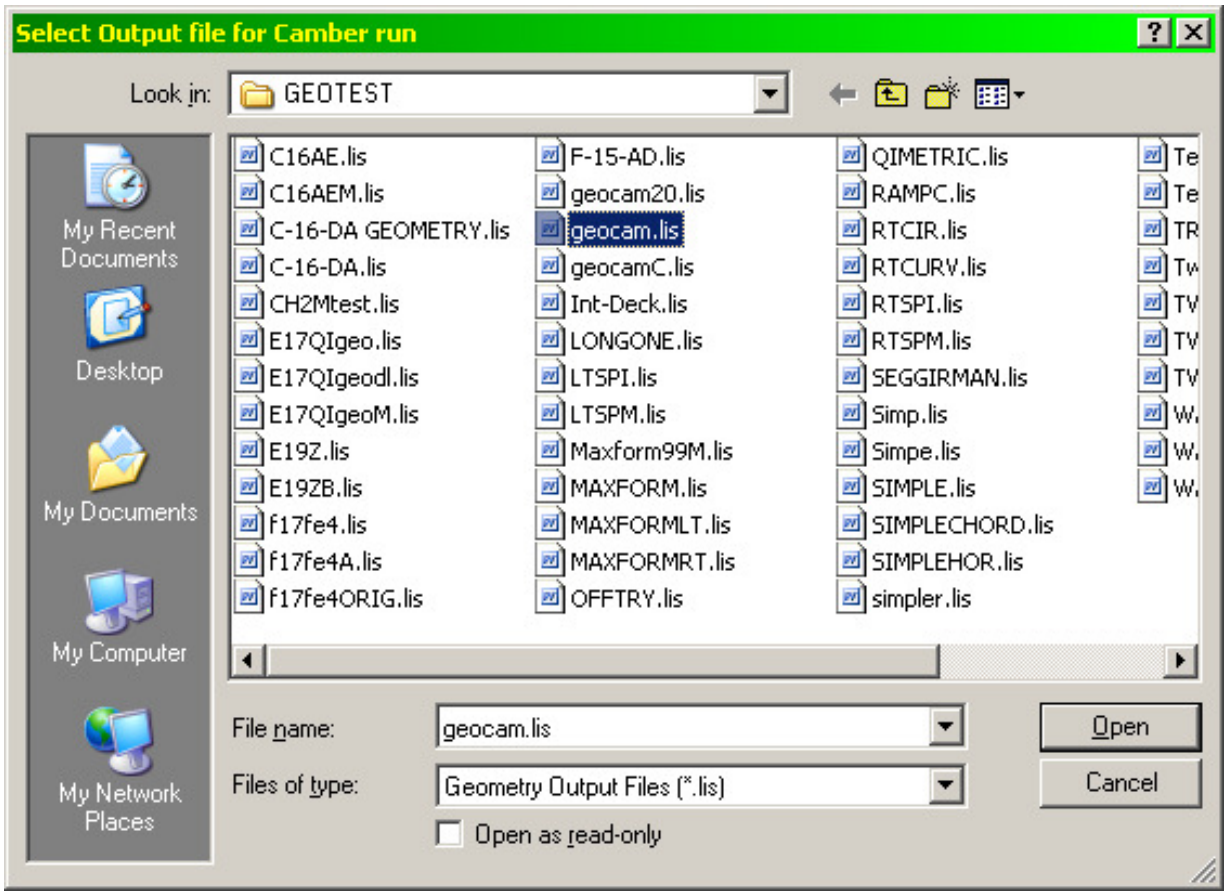
Then, run Camber by selecting “File”, “Run” and then “Camber” from the Bridge Geometry Menu



Input girders desired for Camber run (there is no prompt for available girder numbers).



Select the *.lis geometry file from the geometry run. The camber output file will have the same name as the input file with a .out suffix. There will be no message that the program has finished.



3. STICK FIGURE APPLICATION

This application is for creating a 3-dimensional wireframe model from a Bridge Geometry run. It may be used to see if everything looks "right", i.e. a graphical approach to check input. It may be also used as a layout guide for superstructure and bent layouts.

File names and folder names in the folder path must follow the MSDOS convention: no more than 12 characters including the dot and the file extension, which limits the file name to eight characters. Spaces and most ASCII characters (#, $, ^, *, <, etc.) will not work with the MSDOS file names, but underlines (A_B) will work. As an alternative, the *.lis may be copied to the Windows desktop as a temporary workable location for files.

Step 1- Run Bridge Geometry.

In order for the longitudinal lines and bent lines to be produced by the Stick Figure application, the Bridge Geometry input file will have to contain certain codes, as shown below:

- Longitudinal lines shall CONTAIN the following codes as enclosed by quotes

Command Name	*Codes*
Outside line	"RIGHT OUT"
	"LEFT OUT"
Girder line	"GIR"
Curb line	"RIGHT CURB"
	"LEFT CURB"
Control line	"CONT"
	"CTRL"
Center line bearing	"CL BRG"
Center line bottom (girder, etc.)	"CL BOTT"
Centerline Expansion device	"CL EXPN"

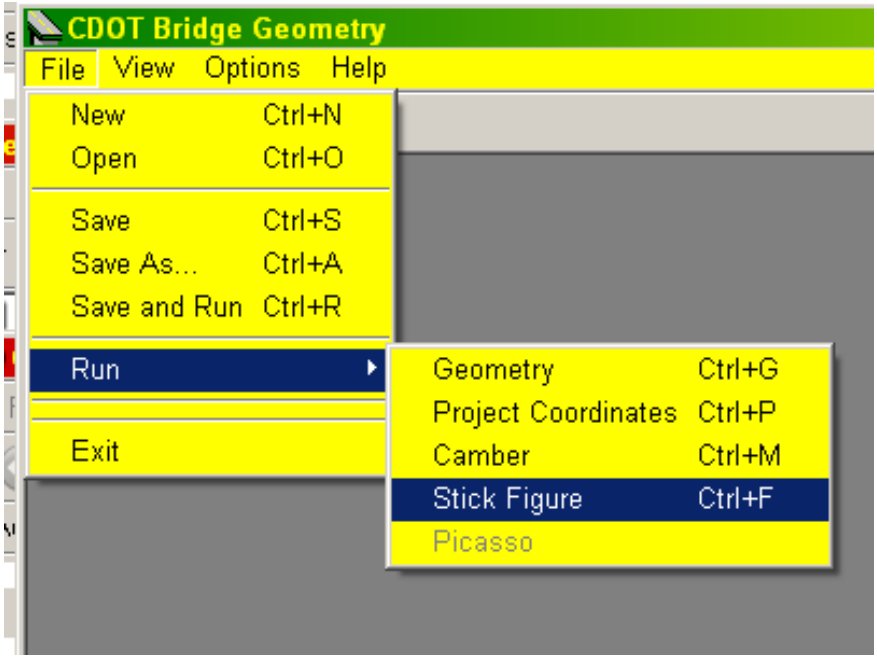
- Bent lines shall BEGIN with the following codes as enclosed by quotes.

Common name	*Codes*
Intermediate points	"F", "D", "E", "X"
Splice points	"SP"
Center lines	
Abutment	"CL ABUT"
Bearing	"CL BRG"
Pier	"CL PIER"
Diaphragm	"CL DIA"

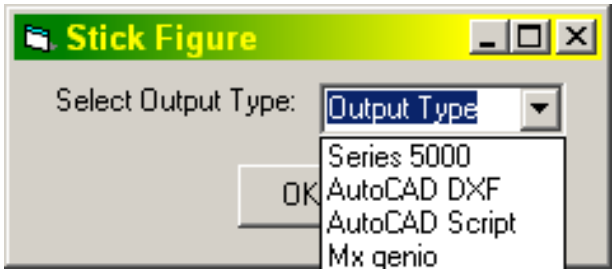
Temp bent line	“CL TEMP”
Wing walls	“WW”
Retaining walls	“RET”
Flange	“FLANGE”
End	“END”
Back Face Abutment	“BF ABUT”

Note that Stick Figure runs in the MS-DOS format, which means that files and folders are limited to 12 characters, with no spaces or special characters.

Step 2 - Run Stick Figure by selecting “File”, “Run” and then “Stick Figure” from the Bridge Geometry Menu

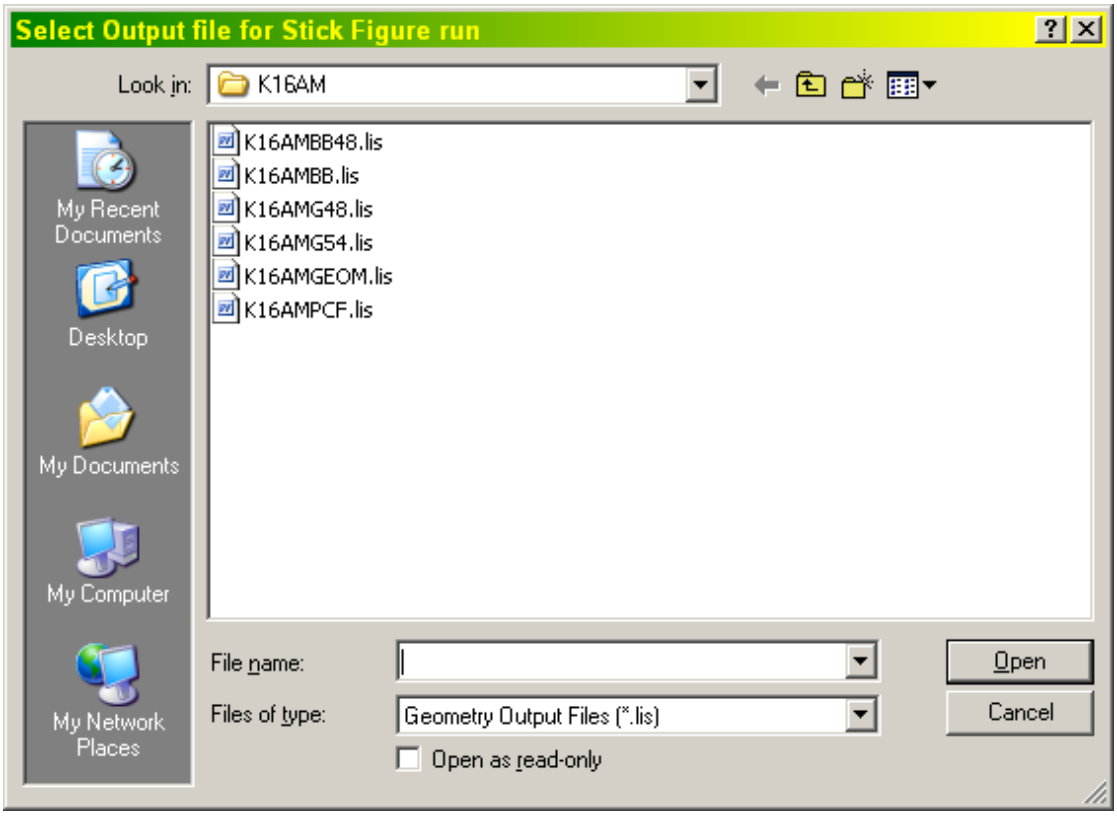


This will result in a few output choices; while AutoCAD Script is preferred for AutoCAD, AutoCAD DXF will also work. AutoCAD DXF is the only choice for MicroStation. The other two choices were formats for applications long departed.



After making the selection, click “OK”.

This results in a list of available *.lis files.



Choose the one of interest and click on “Open“. This creates a file in the same directory and the same name, but with a .DXF or .SCR file extension. There will be no confirmation that the job is finished.

Step 3 - Place in a graphics file

For MicroStation, double-click on the DXF file. This results in a graphics file with the same filename and the .DXF extension. Save this with a .DGN extension For AutoCAD simply drag and drop the .DXF or . SCR file into a blank AutoCAD screen, and save to a desired filename.