CHAPTER 12

BRIDGE GEOMETRY COMMANDS

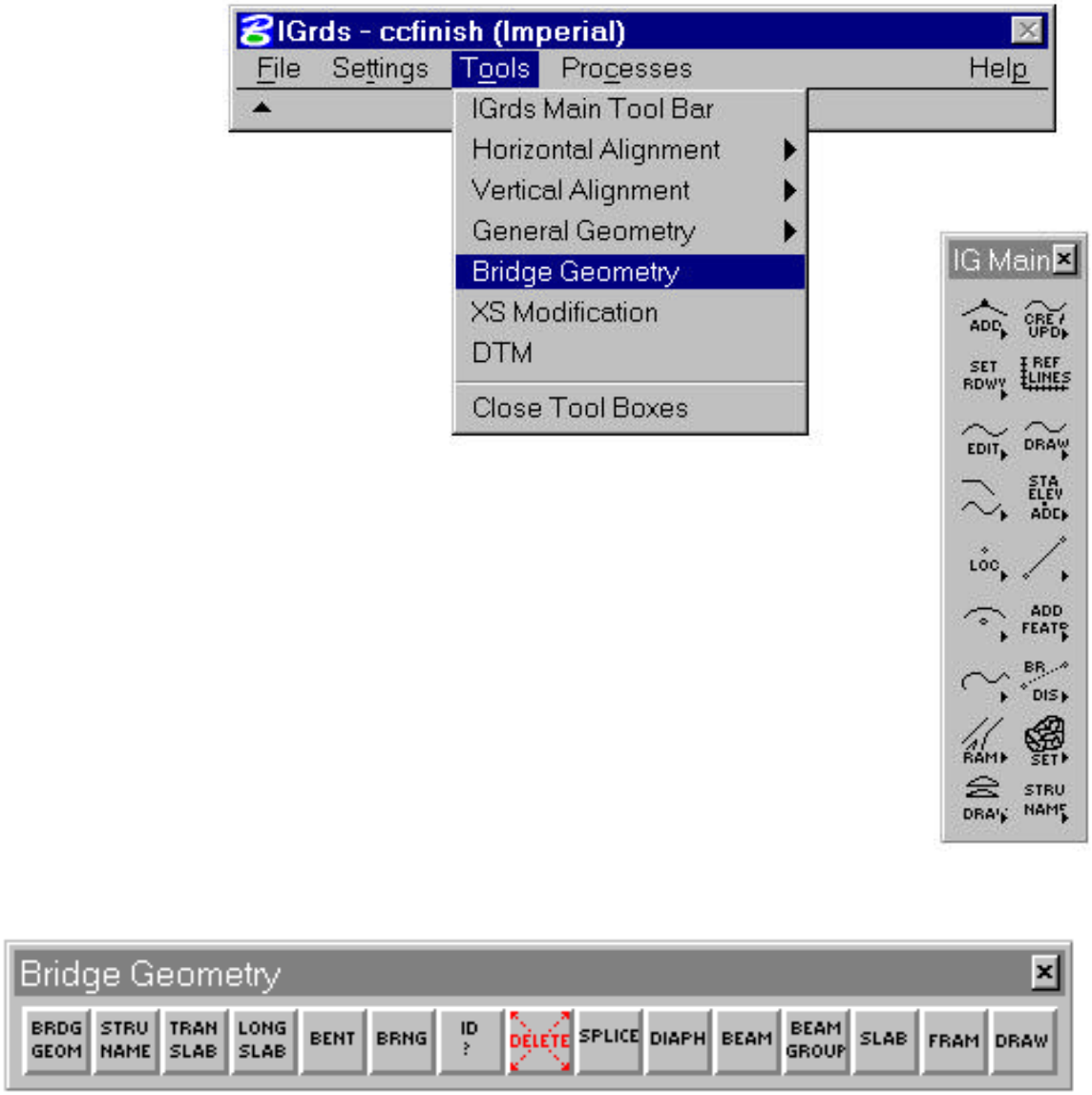


Figure 12-1
Bridge Geometry Commands Palette

BRIDGE GEOMETRY

Introduction

The IGrds Bridge Geometry commands are used to define plan view bridge elements and to compute and display various dimensional aspects of the structure based on these elements. The Bridge Geometry commands work interchangeably with other IGrds commands and with MicroStation.

The Bridge Geometry commands allow the designer to:

1. Define the plan view elements of structures.

2. Compute the dimensional aspects of the bridge frame and slab.

3. Compute the vertical and horizontal blocking data for continuous beams.

4. Display plan view elements of the structure in graphic files.

5. Compute bridge construction grades.

6. Compute vertical clearance between structures and lower roadways or between the top of a roadway's beams and its own bottom of slab.

7. Store the plan view elements and dimensional aspects for the project.

Bridge Geometry data is stored in a special file format which is subdivided by individual structure. Up to 17 structures may be stored. Each structure is stored by name and is associated with its elements and the specific alignment which defines its stationing centerline and stationing. Three groups of commands are discussed in the following stations.

The NAME command which establishes files for storing data for individual structures supports all three groups of commands. It also establishes structure alignment, stationing, structure type, and loading for the structure.

Bridge Geometry Element Commands

The geometry elements that are defined using Bridge Geometry commands and used for computations are illustrated on Figure 12-2 and described below:

PSLB (parallel slab line) - defines lines that are the outside edges of the slab and slab break lines.

TSLB (transverse slab line) - defines straight lines which are used to locate the ends of the slab.

BENT (bent line) - defines straight lines which represent the centerline of bents or other supporting members for the structure.

BRNG (bearing seat) - locates the bearing seats and beam ends relative to the Bent Lines.

DIAF (diaphragm line) - defines straight lines which indicate the location of diaphragm members between beams.

SPLC (splice line) - defines straight lines which indicate the location of beam splices in continuous units.

BEAM (beam line) - defines beam lines which are used in various ways to locate actual beams in the structure.

BGRP (beam line group) - defines groups of parallel or concentric beam lines.

Previously stored elements can be used in defining new elements. The same is true of general geometry elements which have been previously defined by other IGrds subsections. These general elements include:

Horizontal Alignments
Vertical Alignments
Roadway Surface Definition
- Templates
- Superelevation
- Widening
- Ridge Line Modification

General Geometry Elements
- Points
- Lines
- Arcs
- Chains

General Geometry Elements may also be stored in the process of executing some commands.

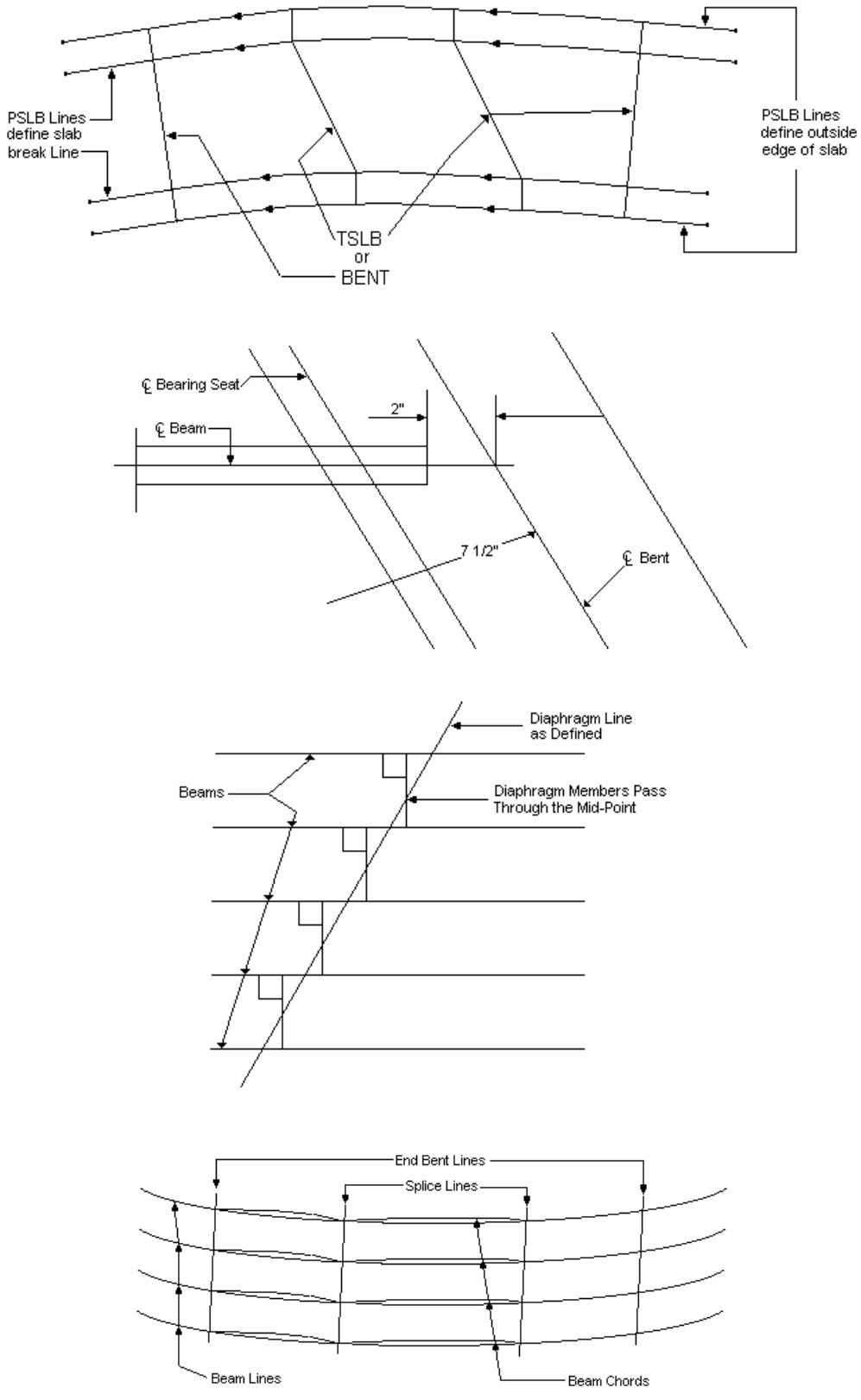


Figure 12-2
Bridge Geometry Elements

Bridge Geometry Computation Commands

The set of computation commands produce reports and graphics based on the elements discussed above and user specifications. The computation commands are:

SLAB (slab) - intersects two PSLB Lines with two TSLB or bent lines to define the boundaries of the slab and plots the slab (optional). It also defines the interior and overhang slab depths.

SLEL (slab elevations) - produces a tabulation of surface elevations and bottom of slab elevations along the boundaries of the slab.

RLIN (radial line) - constructs a line which passes through a slab corner and intersects the opposite side of the slab (this is helpful for slab detailing).

FOPT (frame option) - request computation of the bridge frame layout. This command intersects bent and splice lines with the beam lines to define the actual location of the beams. Bearing seat locations and diaphragm intersections are computed on chords between successive bents and splices. An option is available for curved continuous beams. Various reports are generated along with an optional plan view plot.

BMGD (beam grade) - produces a tabulation of surface elevations, bottom of slab elevations, and bottom-of-slab elevations plus deflection along the centerline of each beam.

VCLR (vertical clearance) - computes vertical clearances between the structure and a lower roadway and may be used to determine the required haunch between the beams and slab of its own roadway.

Support Commands

The following functions and commands support the Bridge Geometry command.

Parameters - Setting

Identify/Delete Bridge Geometry Element

Bridge File Capacity

The Bridge Geometry file provides for storing data for a maximum of 17 structures. Separate sets of independent bridge commands are defined for each NAME command. There are fixed limits on some of these commands as indicated below.

1. The following commands must be assigned a storage number.

Command	Storage Number Limits*
BENT	1-75
SPLC	1-20
TSLB	1-10
PSLB	1-99
BEAM) -- Beam Lines BGRP)	1-99
* These storage limits apply to each NAME command.	

2. A storage number is not assigned to the DIAF command, but a maximum of 60 entries per NAME command are allowed.

3. The BRNG command allows back, forward, or both conditions for each bent line entered.

Command Sequence

Bridge Geometry commands can be executed in the desired sequence with these qualifications:

- The appropriate structure must be active.

- Any data referenced has been previously defined.

- Some computation commands must directly follow other computational commands which they reference. The required sequence is as follows:

  SLAB
  - SLEL
  - RLIN*

  FOPT
  - BMGD
  - VCLR

  The dialog boxes for SLAB and FOPT provide the only access to the commands which must follow them.

Typical Sequence

- The horizontal and vertical alignments and the cross slopes will normally be defined before using Bridge Geometry commands. General Geometry elements may also be stored earlier, however, these computations may be intermixed with Bridge commands if they provide any reference.

- Execute Name to set up limits.

- Define TSLB
  PSLB
  BENTs

- Complete Slab Dimensions (repeat as desired) Report and Graphics.
  Slab Elevation - Report
  Slab Radial Lines - Report and Store

- Define Bearings Seat Specifications
  BEAM Lines
  SPLC Lines
  DIAF Lines
  Bearing Lines

- Compute Frame Layout
  BEAM Grades - Report
  Vertical Clearance - Report
  Horizontal Block - Report
  Vertical Block - Report

General User Notes

- The designation of "active structure" is completely independent from the IGrds setting of "active roadway". The Bridge Geometry commands do not depend upon "active roadway" setting.

- Active Structure must be set at the beginning of a session prior to executing any of the Bridge Geometry commands.

- Bents for a structure **MUST** be defined in consecutive station and number order beginning with No. 1. References to Bents by the Frame option must observe this order.

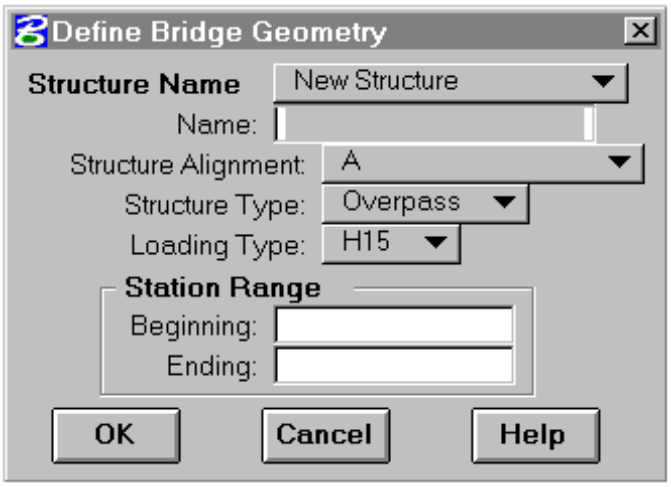
- A series of beams to be referenced by the Frame command must be located in left to right order looking "up-station" and have consecutive numbers. More than one series of beams may be defined for a structure (e.g., Beams 1-5 may be located from left to right and Beams 6-14 may be located from left to right in the same space as long as Frame commands reference 1-5 or 6-14).

- Commands which reference edge of slab should be preceded by execution of the applicable Slab command.

- Transverse elements are drawn as lines extending in each direction from the centerline regardless of how they are located.

- It is easy to inadvertently store an element over a previously stored element. The graphics will appear as one element. This condition can be ascertained using ID or Delete commands and the overstored element can be deleted.

STRUCTURE NAME COMMAND



The NAME command is used to establish the file for an individual structure and to establish general data related to the structure. As used here, individual structure refers to any set of connected simple span and/or continuous units. There may be up to 17 individual structures which are automatically assigned a number.

Data includes the number of bents, maximum beams per span, loading type, type of structure, station limits, and the structure name. Execution of the command makes the structure "active".

(See "Set Active Structure" command.)

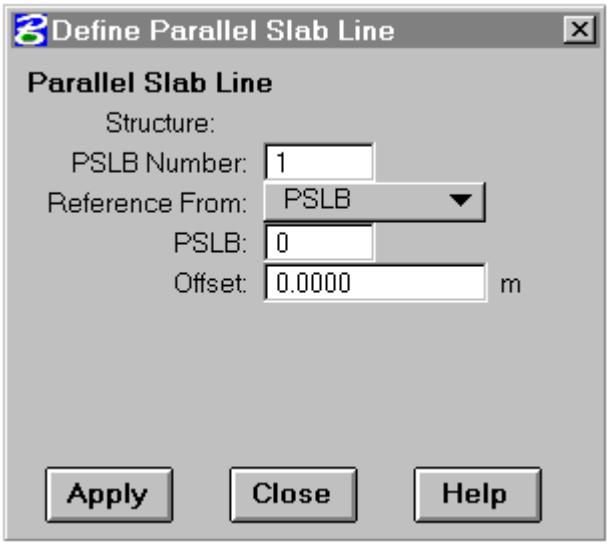
Structure Name	Select "New Structure" or any of the previously defined structures in the list. Complete all requested data for "New Structure" or revise data for other structures as applicable.
Name	The selected structure name is displayed, or a new name may be entered.
Structure Alignment	Select the desired alignment from the available list.
Structure Type	Select Type option: Bridge, Overpass, Underpass
Loading Type	Select Type option: Imperial: H15, H20, HS20 Metric: M13.5, M18, MS18
Station Range	
Beginning **Ending**	Enter/select station Enter/select station This defines the limits for which computations are to be made.

OK	Execute the command. Push when all data is defined. For "New Structure", a file is established based on data supplied and the structure is made active. For previously defined structures. Any revisions are applied and the structure is made active.
Cancel	Close the dialog with no action.
Help	Display Help for this command.

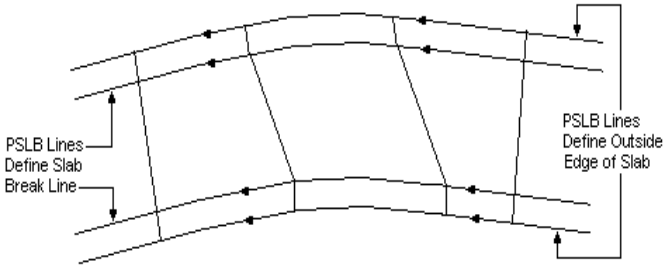
Note: Revision of data for previously defined structures may cause difficulties with elements defined prior to the revision. It may be necessary to redefine some elements.

The Structure Alignment cannot be revised after the Structure is defined. The entire structure must be deleted if this needs to be changed.

PARALLEL SLAB LINE (PSLB)



The PSLB command is used to define longitudinal lines that represent the outside edges of the slab and slab break lines. PSLB Lines may consist of from one to thirty-four straight line and/or circular elements. They are limited in extent since their end points must be defined.

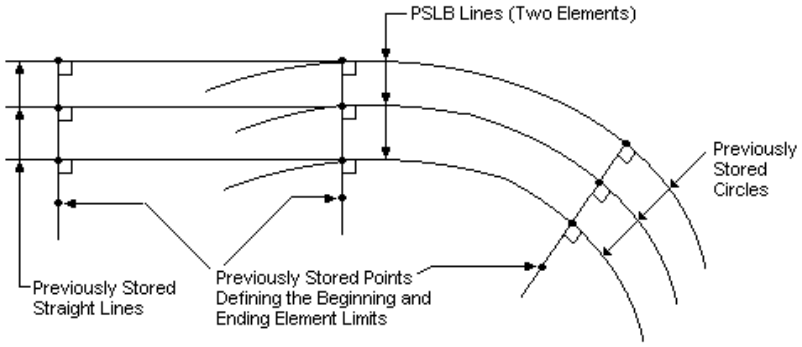


PSLB Lines may be defined by giving their offset from another PSLB Line or from any stored alignment. In this case, the direction of the PSLB Line will be the same as the direction of the PSLB Line or alignment that it is referenced from. PSLB Lines may also be defined by referring to curves which have been previously stored by other IGrds commands. The extent of the curves is indicated by giving the end points which have been previously defined by other IGrds commands. The order of curve entry determines the direction of the PSLB Line in this case. PSLB Lines defined by any of the possible methods are given a storage number between 1 and 99 for each structure. These numbers are used for future reference and the designer should be aware of the direction of the PSLB Line.

Structure	Active Structure Name is displayed.
PSLB Number	The next available number is displayed. Enter another number if desired.
Reference From	Select the desired option: PSLB Geometry Chain (Future) Alignment Other Alignment Geometry Curve
Offset	Enter Offset distance +/-.

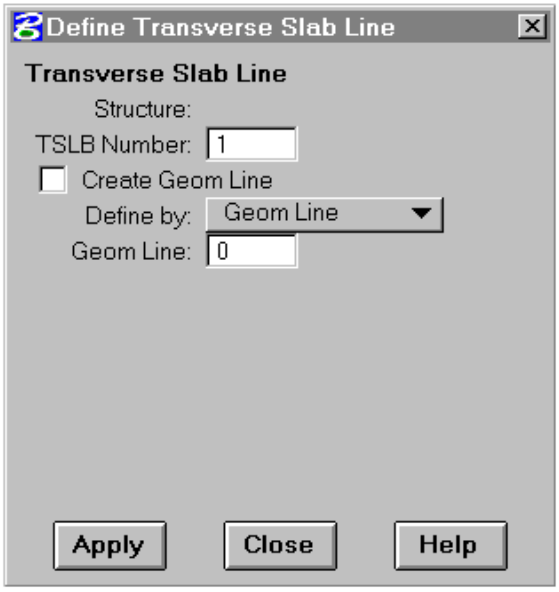
Apply	Execute the command. Push this button after all desired components have been stored.
Close	Close the dialog box.
Help	Display Help for this command.

When referencing a PSLB from one or more Geometry curves, the beginning and ending points of lines or circles should normally lie on the line or circle. These points will be used to determine the limits of the element and will be treated as shown in the figure when they do not fall on the line or circle.



Note: Several PSLB Lines may reference the same stored points for defining element limits, as shown above.

TRANSVERSE SLAB LINE (TSLB)



The TSLB command is used to define transverse slab lines to locate the ends of slabs. A TSLB Line should only be defined when the slab end does not coincide with the centerline of the bent. TSLB Lines must be assigned a storage number between one and ten for each structure. TSLB Lines may be defined by one of eight transverse line options.

Structure	Active Structure Name is displayed.
TSLB Number	The next available number is displayed. Enter another number if desired.
Create Geometry Line (Optional)	Push button to store a general geometry line coinciding with the TSLB line, if desired, and enter number for the line to be created.
Define By	Select the desired option for defining the transverse line by: Geometry Line Point & Direction

Input for the Define By options is explained on the next page.

Apply	Execute the command. Push this button after all desired components have been stored.
Close	Close the dialog box.
Help	Display Help for this command.

Define by Geometry Line.

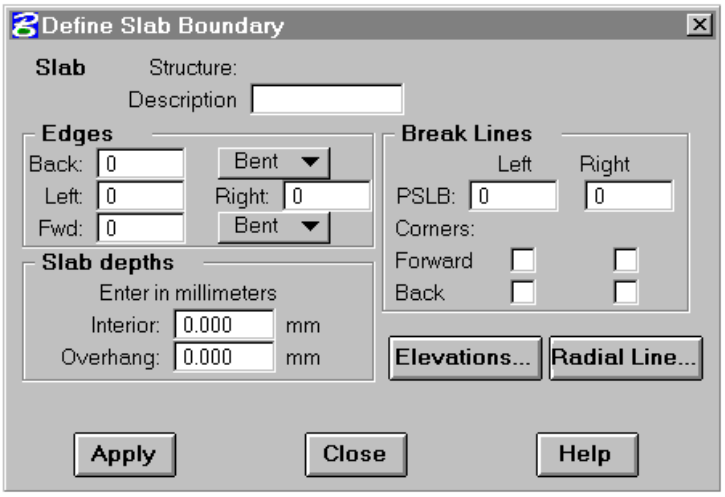
Geometry Line	Enter number or select line.

Define by Point and Direction.

Direction	Select the desired option for establishing direction. Bearing Azimuth Skew Geometry Line (for direction) Radial Enter requested data.
Station/Location	Select the desired option for establishing a point through which the line passes. Geometry Point Coordinates Station Enter requested data. (Station is the only valid selection for direction by skew or radial.)

Note: Existing geometry points can be selected graphically. Points for coordinates and stations may also be selected graphically.

SLAB (SLAB)



The SLAB command is used to define and enter into temporary storage the boundaries of a bridge slab and the interior and overhang depths. The boundaries are expressed in terms of previously defined transverse lines (BENT or TSLB Lines) and longitudinal lines (PSLB Lines). The transverse edges (back and forward) may be either straight lines or broken lines. The designer has the option to break one or both transverse edges of the slab. Broken lines are defined by entering two additional PSLB Lines. The transverse lines will intersect the two specified PSLB Lines and then extend perpendicularly or radially to intersect with the longitudinal edges (left and right). Figure 12-3 shows an example slab report and diagram that uses two additional PSLB Lines to define a break back slab. The resulting longitudinal edges are limited to ten elements on each side.

The output will include slab dimensions and the slab area. A graphic display of the slab perimeter may be generated.

The slab elevations (SLEL) and radial line (RLIN) dialog boxes are activated from the SLAB dialog box. These capabilities must be selected after the slab calculations are performed.

SLAB REPORT
SPAN 2

		SEG. NO.	SEGMENT LENGTH	SEGMENT OR CHORD BEARING	CHORD LENGTH	RADIUS	ACCUMULATED SEGMENT LENGTHS	DISTANCE TO RADIAL INTERSECT
LEFT EDGE	(PSLB 1)	1	13.5314	M 72 20 49.96 E	13.5314	0.0000	13.5314	
		2	66.2786	M 73 39 19.15 E	66.2729	-1451.5195	79.8100	18.7854
RIGHT EDGE	(PSLB 2)	1	80.2104	M 74 10 49.88 E	80.1997	-1413.2695	80.2104	59.4165

		SEG. NO.	SEGMENT LENGTH	SEGMENT BEARING	SKEW ANGLE	DISTANCE TO STATION LIKE	RADIAL DISTANCE
		1	2.0000	M 17 39 10.04 W			
BACK EDGE	(BENT 2)	2	39.0087	M 46 13 15.82 W	28 34 5.79	19.4990	36.2500
		3	2.000	M 17 26 43.43 W			
		1	2.0000	M 15 2 11.66 W			
FORWARD EDGE	(BENT 3)	2	40.2139	M 46 13 15.82 W	31 36 0.00	20.0615	36.2500
		3	2.0000	M 14 11 36.82 W			

SLAB DEPTH = 8.0000 IN. , OVERHANG DEPTH = 7.0000 IN.
SLAB AREA = 3060.3195 SQ. FT. = 340.0355 SQ. YDS.

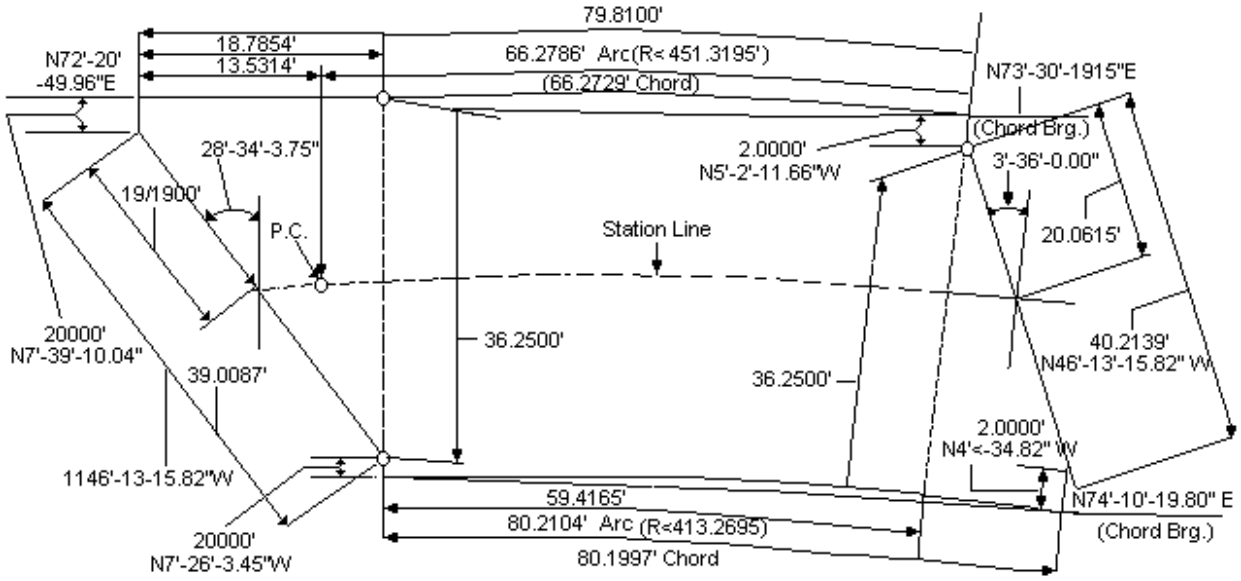
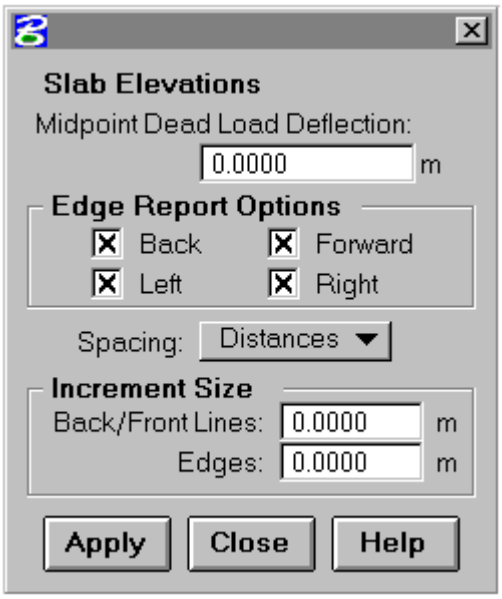


Figure 12-3

Structure	Active Structure Name is displayed.
Slab Description	Enter twenty character description.
Edges	Select the type of lines to be used for Back and Forward slab edges. TSLB BENT Enter number or select Back, Forward, Left, and Right edges.
Break Lines	Enter number or select left and right PSLB lines indicating breaklines. Push buttons to indicate break corners. Forward Left Forward Right Back Left Back Right
Slab Depths	
Interior	Enter depth.
Overhang	Enter depth.
Elevations	Push to display dialog for Slab Elevations for this slab - AFTER EXECUTING SLAB DATA
Radial Line	Push to display dialog for Radial Line for this slab - AFTER EXECUTING SLAB DATA
Apply	Execute the command. Push this button after all desired components have been stored.
Close	Close the dialog box.
Help	Display Help for this command.

SLAB ELEVATIONS (SLEL)



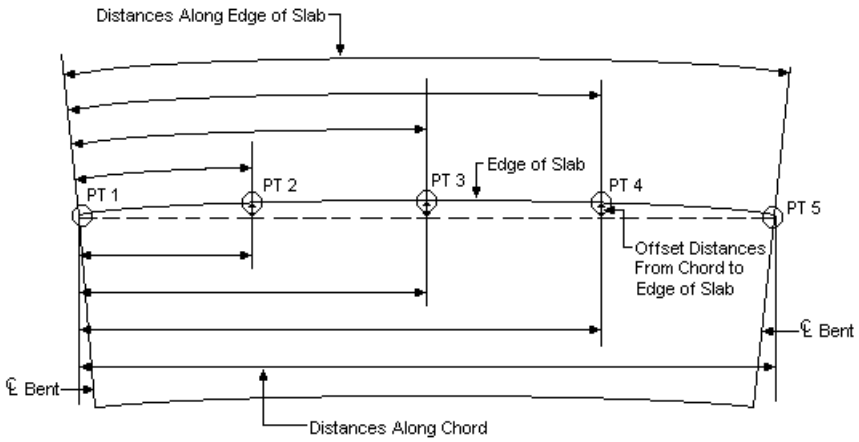
The Slab Elevation (SLEL) command dialog box is activated by pressing the "Elevations" button on the SLAB dialog box. This must be done after the slab has been calculated. Multiple Slab Elevation calculations may be requested, as desired. The SLEL command will produce a tabulation of distances, surface elevations, bottom of slab elevations, and bottom of slab elevations plus deflection along the boundaries of the slab. Tabulations along any edge may be omitted.

The tabulation may be requested by one of two options as shown below.

Option 1. Elevations are tabulated at an incremented distance along the transverse and longitudinal edges of the slab. The increment must be large enough to limit the total number of points to 51 (including beginning and ending points) along each edge of the slab. If the increment yields more than 51 points, the slab edge will be divided into 50 equal divisions.

Option 2. Elevations are tabulated at equal divisions along the transverse and longitudinal edges of the slab. There is a maximum of 50 divisions along each slab edge.

Defections are computed assuming a normal deflection curve based on the midpoint deflection. Caution should be exercised when using this method of skewed structures to be sure that the computed deflections are acceptable. Following is the Plan View Showing Location of Slab Elevations:



Midpoint Dead Load Deflection	Enter deflection.
Edge Report Options	Push buttons for elevations on desired slab edge. Back Forward Left Right
Spacing	Select spacing option. Distances Divisions

Spacing by Distance.

Increment Size	
Back/Front Lines	Enter Distance
Edges	Enter Distance

Spacing by Divisions.

Number of Divisions	
Back/Front Lines	Enter number of Divisions
Edges	Enter number of Divisions

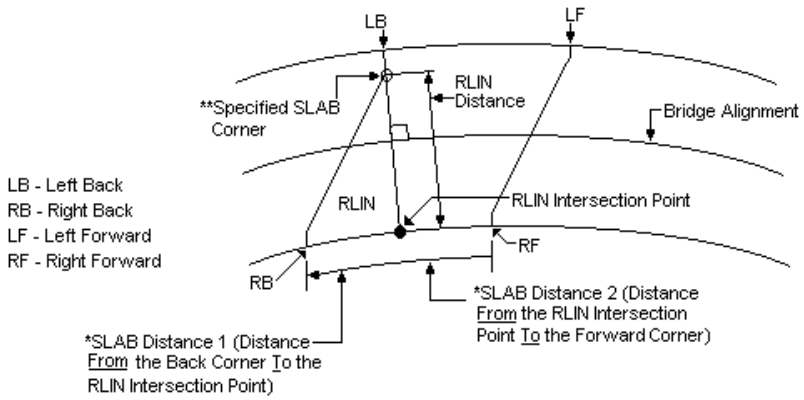
Apply	Execute the command. Push this button after all desired components have been stored.
Close	Close the dialog box.
Help	Display Help for this command.

RADIAL LINE (RLIN)

The Radial Line (RLIN) command dialog box is activated by pressing the "Radial Line" button on the SLAB dialog box. This must be done after the slab has been calculated. Multiple Radial Line calculations may be requested, as desired.

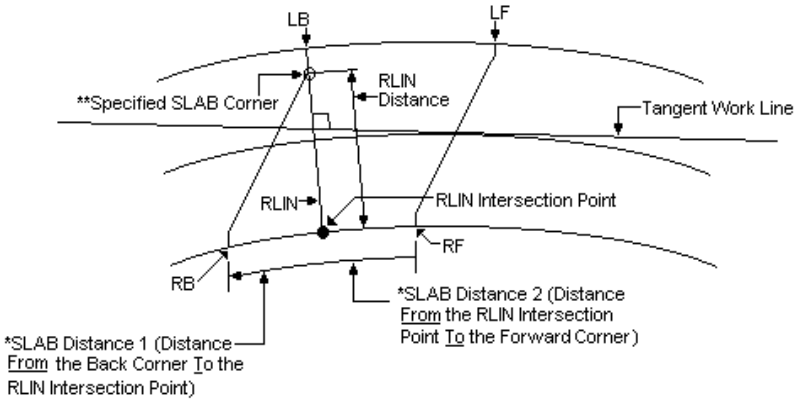
The RLIN (radial line) command is used to construct a line which passes through a specified slab corner and intersects the opposite side of the slab. It then computes distances that are useful in the layout of reinforcement bars. The slab corner and intersection point can optionally be stored as geometry points. There are three options for the direction of the intersecting line.

Option 1. The slab corner and horizontal alignment (does not need to be bridge alignment) number must be specified. A line will be defined through the specified corner of the slab perpendicular to the given alignment. The designation of the specified slab corner is as follows:



Forward and back designate the forward and back slab edges, respectively. Right and left may be determined by looking in the direction of increasing stations.

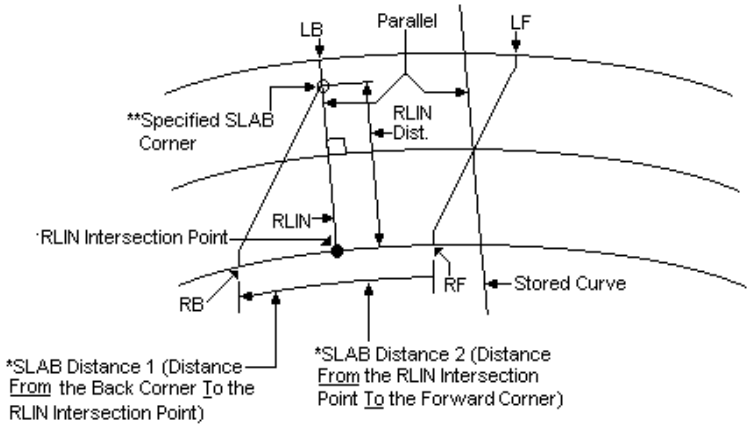
Option 2. The specified slab corner and the number of a previously stored curve must be entered. A line will be defined through the specified corner of the slab perpendicular to the stored curve. This option is normally used when the reinforcing steel is perpendicular to the tangent work line.



*These distances will be negative (-) when they are measured in the direction of decreasing stations.

**The RLIN normally passes through the outside corner of the slab. However, when the transverse edge of the slab is broken, as shown here, the RLIN passes through the break point of the transverse slab line.

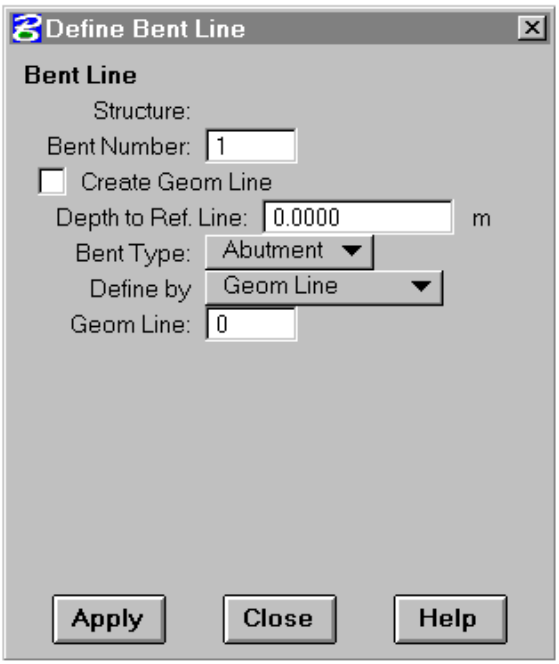
Option 3. The specified slab corner and the number of a previously stored curve must be entered. A line will be defined through the specified slab corner parallel to the stored curve.



Output. The output includes all of the input information, the coordinates of the specified slab corner, and the RLIN intersection point (Geometry points for the slab corner and RLIN intersection point may be stored, if desired). The RLIN distance, slab distance 1, slab distance 2, and the bearing of the RLIN are also output.

Create Geometry Point for Slab Corner	Push to create point and enter desired number.
Create Geometry Point for RLIN Intersection	Push to create point and enter desired number.
Slab Corner	Push button to indicate the desired corner. Forward Left Forward Right Back Left Back Right Repeat command for other corner.
Direction	Select the desired option for the direction of the intersecting line. Alignment (Perpendicular to Alignment) Geometry Curve (Perpendicular to Curve) Enter Curve Number Parallel Line (Parallel to Line) Enter Line Number
Apply	Execute the command. Push this button after all desired components have been stored.
Close	Close the dialog box.
Help	Display Help for this command.

BENT LINE (BENT)



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

Bent Lines should be numbered consecutively from 1-75 for each structure from beginning to end of the structure. Bent Lines may be defined by eight transverse line options similar to those used for defining TSLB Lines. These options are shown on the following pages.

Structure	Active Structure Name is displayed.
BENT Number	The next available number is displayed. Enter another number if desired.
Create Geometry Line (Optional)	Push button to store a general geometry line coinciding with the BENT line, if desired, and enter number for the line to be created.
Depth to Ref. Line	Enter depth. (See Reference Line discussion.)
Bent Type	Select type: Abutment Pier Transition Interior
Define By	Select the desired option for defining the Bent line by: Geometry Line Point & Direction

Input for the Define By options is explained on the next page.

Apply	Execute the command. Push this button after all desired components have been stored.
Close	Close the dialog box.
Help	Display Help for this command.

Define by Geometry Line.

Geometry Line	Enter number or select line.

Define by Point and Direction.

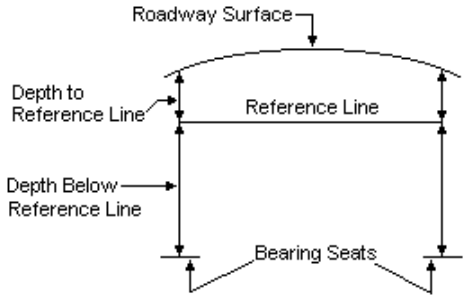
Direction	Select the desired option for establishing direction. Bearing Azimuth Skew Geometry Line (for direction) Radial Enter requested data.
Station/Location	Select the desired option for establishing a point through which the line passes. Geometry Point Coordinates Station Enter requested data. (Station is the only valid selection for direction by skew or radial.)

Note: Existing geometry points can be selected graphically. Points for coordinates and stations may also be selected graphically.

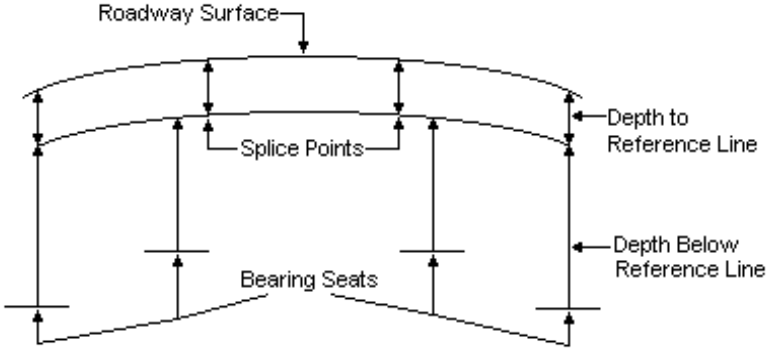
REFERENCE LINE

The Reference Line is a line through space that gives the designer facility for placement of the beam with reference to the roadway surface. It also serves to establish bearing seat elevations. Horizontally, the Reference Line always follows the actual position of the beam, but its vertical position is established by input depths from the roadway surface. The designer might choose to have the Reference Line represent top of rolled section or top of web for plate girders, or let the reference line follow the top of beam. Whatever the case might be, the user must enter a depth to reference line on the BENT command or a depth below reference line on the BRNG command to obtain depths other than zero.

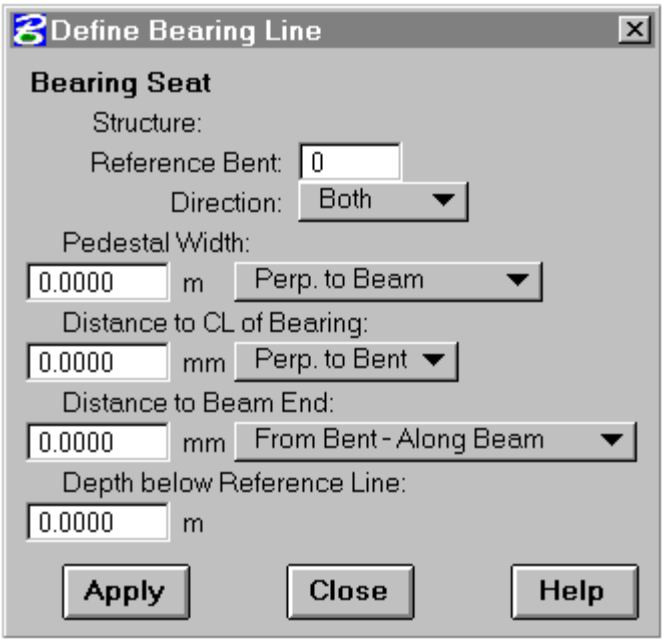
Simple Span. The depth to the Reference Line is input on the BENT command and the depth below the Reference Line is input on the BRNG command. If both are left blank, for a simple span, then a zero depth will be used.



Continuous Unit. The depth to the Reference Line is input on the end bents (BENT) of the unit and at splice points (SPLC). The depth below the Reference Line is input on the BRNG command. Continuous frame options (FOPT command) chord the reference line through successive end bents and splice points.



BEARING SEAT (BRNG)



The BRNG command is used to locate the centerline of bearing seats relative to the Bent Lines and Reference Line. Three options are available by which the centerline of the bearing seat may be defined.

The options for locating bearing seats and beam ends are illustrated in Figures 12-3 and 12-4. Bearing seats may be located by a perpendicular distance from the centerline of Bent or at a specified distance measured along the centerline of each beam. The ends of beams can be located either from the centerline of bent or from the centerline of bearing.

Structure	Active Structure Name is displayed.
Reference Bent	Enter/select the Bent referenced.
Direction	Select the direction from Bent for which data is to be applied. Both Back Forward
Pedestal Width	Enter width. Select option: Perpendicular to Beam Along Centerline of Bearing (See U Beam Options 20, 21, and 22 for discussion of pedestal widths.)
Distance to Centerline of Bearing	Enter Distance Select option: Perpendicular to Bent Along Beam
Distance to Beam End	Enter Distance Select option: From Bent - Along Beam From Bearing - Along Beam From Bent - Perpendicular to Bent

Depth Below Reference Line	Enter depth (See Reference Line discussion.)
Apply	Execute the command. Push this button after all desired components have been stored.
Close	Close the dialog box.
Help	Display Help for this command.

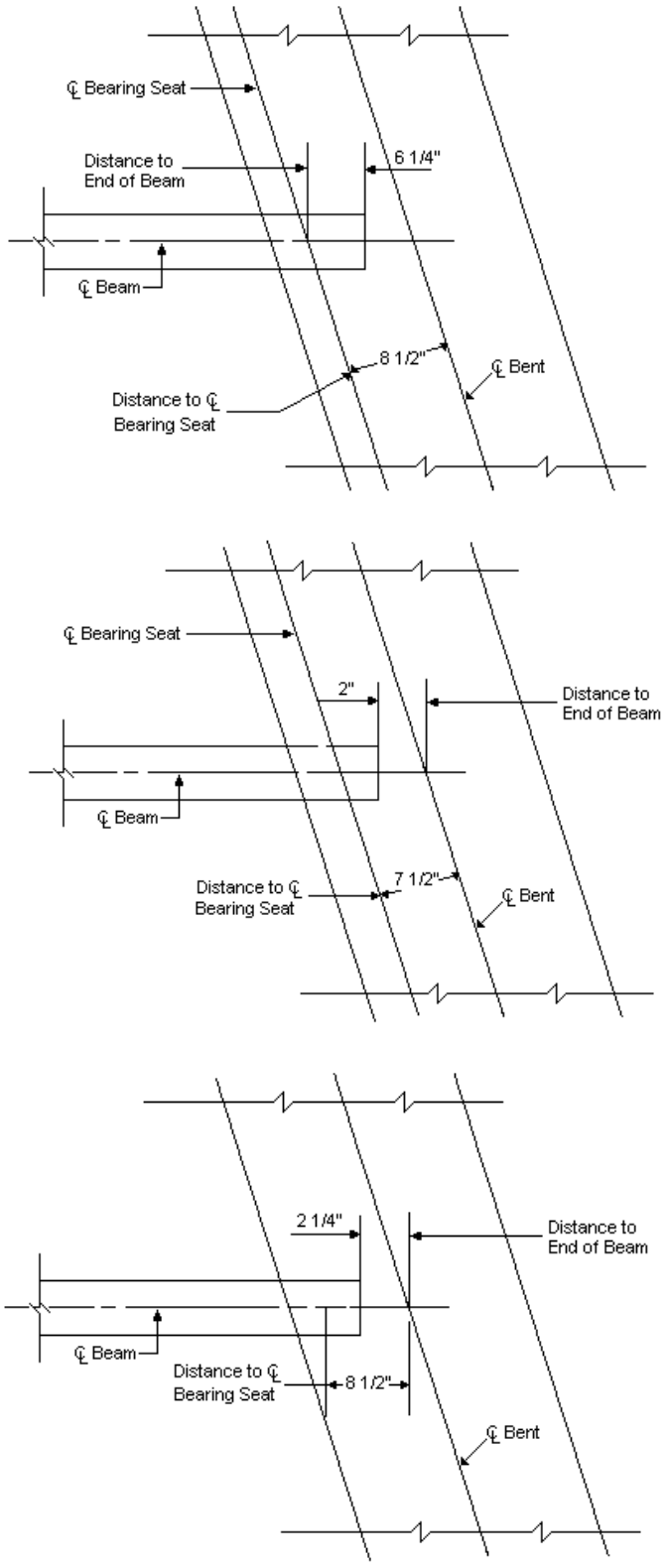

℄ Bearing Seat
Distance to
End of Beam
6 1/4"
℄ Beam
8 1/2"
℄ Bent
Distance to ℄
Bearing Seat
℄ Bearing Seat
2"
Distance to
End of Beam
℄ Beam
Distance to ℄
Bearing Seat
7 1/2"
℄ Bent
2 1/4"
Distance to
End of Beam
℄ Beam
Distance to ℄
Bearing Seat
8 1/2"
℄ Bent

Figure 12-3

U-BEAM OPTION

For U-Beams, both the "Distance to end of beam" and "Distance to CL bearing seat" must be specified as perpendicular offsets from the centerline of bent. This simplifies the framing of inverted "T" bent caps.

A constant two inch (50mm) clearance can be maintained between the end of the beam and the face of the bent cap web by inputting half the web width minus two inches (50mm) in the "Distance to end of beam" field.

Pedestal width and orientation may be entered for this option in either form.

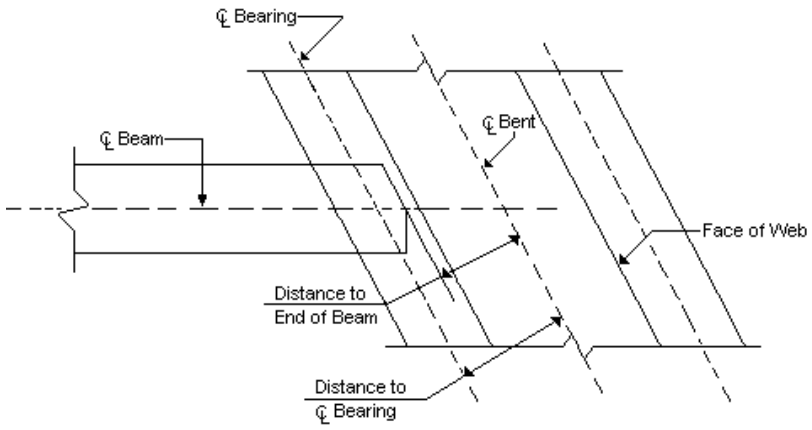
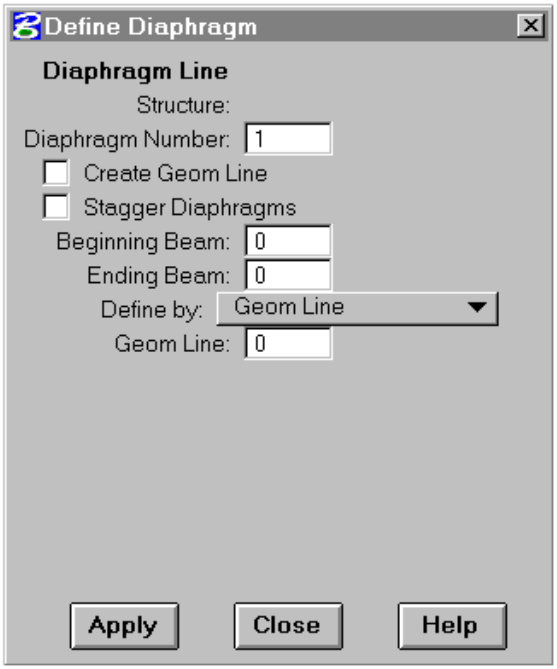
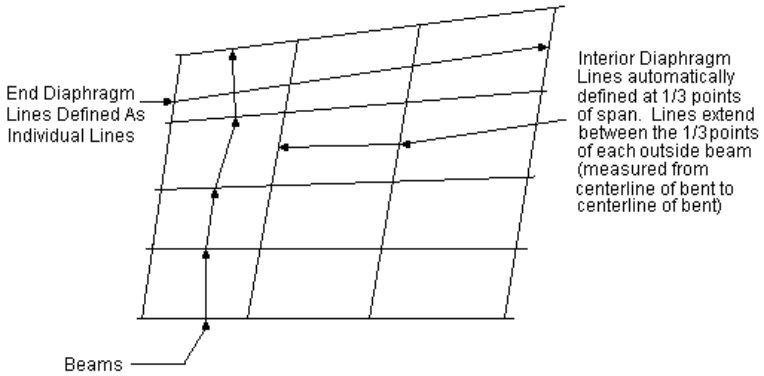


Figure 12-4

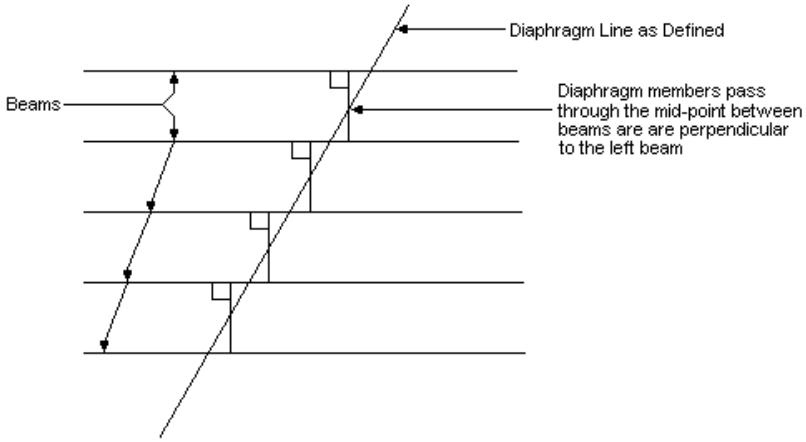
DIAPHRAGM LINE (DIAF)



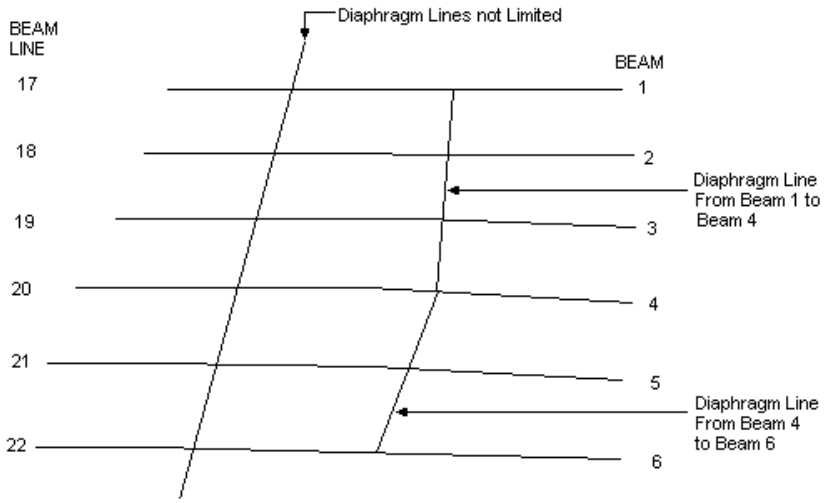
The DIAF command is used to define straight lines which indicated the locations of diaphragm members between beams. Diaphragm locations may be specified by defining a straight line by one of the transverse line methods, or an automatic option may be exercised to specify location of Diaphragm Lines at the midpoint, quarter points, third points, etc., of the simple or continuous span. Diaphragms must be entered in order of increasing stations. A typical application of both approaches is shown here.



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



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



Diaphragm Lines are not assigned numbers; they are applied automatically to the appropriate units. There is a maximum of 60 diaphragm entries per structure.

Diaphragm Lines may be defined by eight transverse line options similar to those used for TSLB and Bent Lines. These options are shown below.

Structure	Active Structure Name is displayed.
DIAF Number	The next available number is displayed. Enter another number if desired.
Create Geometry Line (Optional)	Push button to store a general geometry line coinciding with the Diaphragm line, if desired, and enter number for the line to be created.
Stagger Diaphragms	Push for staggered diaphragm option.

Beginning Beam	Enter number of Beam at the beginning of diaphragm.
Ending Beam	Enter number of Beam at the end of diaphragm.
Define By	Select the desired option for defining the Diaphragm line by: Geometry Line Point & Direction Equal Space - Bent Equal Space - Station

Input for the Define By options is explained on the next page.

Apply	Execute the command. Push this button after all desired components have been stored.
Close	Close the dialog box.
Help	Display Help for this command.

Define by Geometry Line.

Geometry Line	Enter number or select line.

Define by Point and Direction.

Direction	Select the desired option for establishing direction. Bearing Azimuth Skew Geometry Line (for direction) Radial Enter requested data.
Station/Location	Select the desired option for establishing a point through which the line passes. Geometry Point Coordinates Station Enter requested data. (Station is the only valid selection for direction by skew or radial.)

Define be Equal Space - Bent

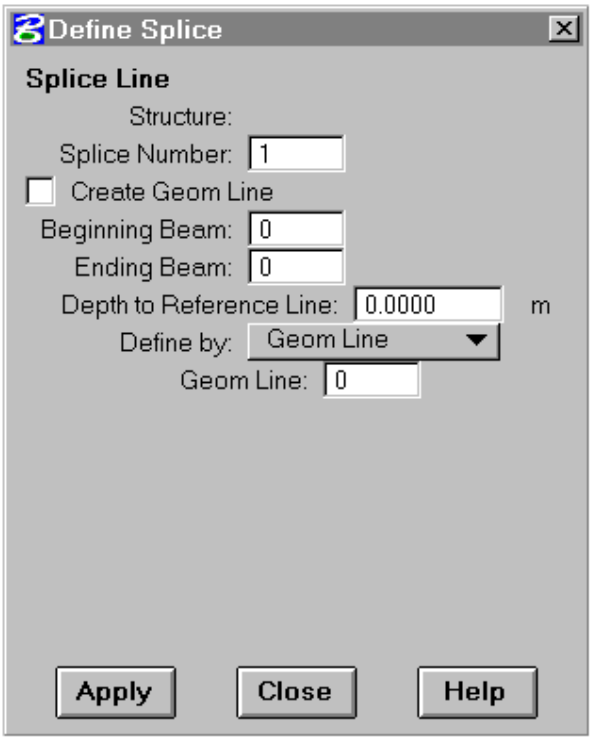
Beginning Bent No.	Enter or Select
Number of Equal Spaces	Enter

Define by Equal Space - Stations

Beginning Bent No.	Enter or Select
Number of Equal Spaces	Enter
Station Range	
Beginning	Enter or Select
Ending	Enter or Select

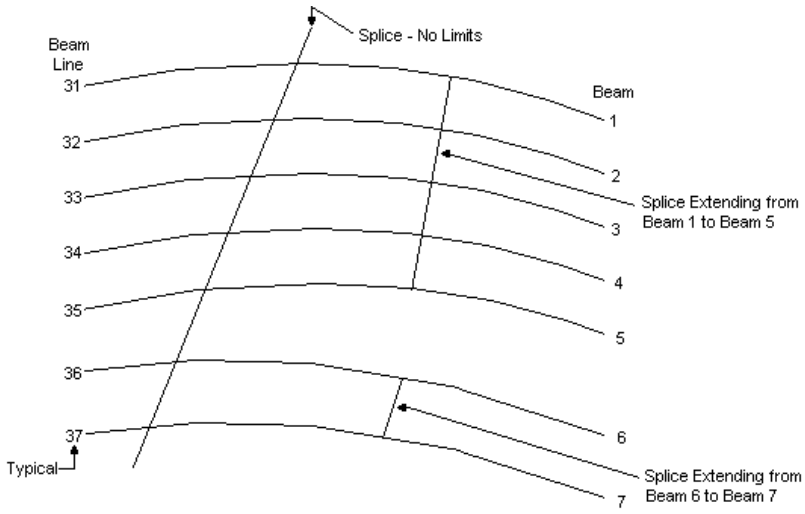
Note: Existing geometry points can be selected graphically. Points for coordinates and stations may also be selected graphically.

SPLICE LINE (SPLC)



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

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



Splice Lines should be numbered consecutively from 1 to 20 for each structure from beginning to end of the structure. Splices are defined by the eight transverse line options similar to those used for TSLB, Bent and Diaphragm Lines.

Structure	Active Structure Name is displayed.
SPLICE Number	The next available number is displayed. Enter another number if desired.
Create Geometry Line (Optional)	Push button to store a general geometry line coinciding with the Splice line, if desired, and enter number for the line to be created.
Beginning Beam	Enter Number or Select
Ending Beam	Enter Number or Select
Depth to Reference Line	Enter depth. (See Reference Line discussion.)
Define By	Select the desired option for defining the Splice line by: Geometry Line Point & Direction

Input for the Define By options is explained on the next page.

Apply	Execute the command. Push this button after all desired components have been stored.
Close	Close the dialog box.
Help	Display Help for this command.

Note: If beginning and ending beams are not defined, all beams will be used.

Define by Geometry Line.

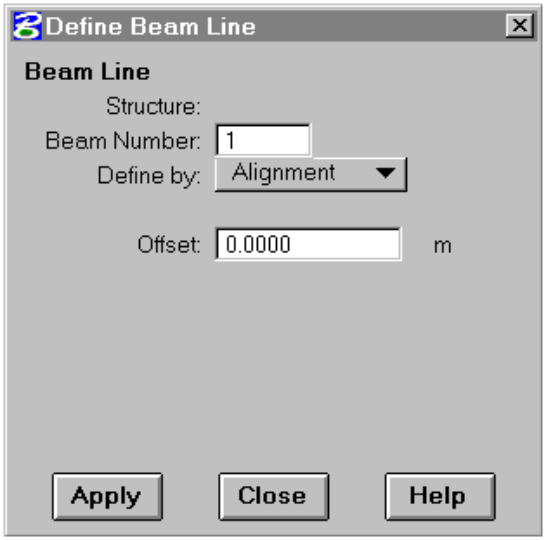
Geometry Line	Enter number or select line.

Define by Point and Direction.

Direction	Select the desired option for establishing direction. Bearing Azimuth Skew Geometry Line (for direction) Radial Enter requested data.
Station/Location	Select the desired option for establishing a point through which the line passes. Geometry Point Coordinates Station Enter requested data. (Station is the only valid selection for direction by skew or radial.)

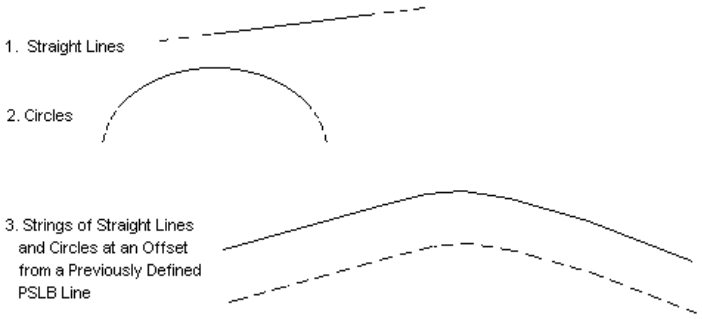
Note: Existing geometry points can be selected graphically. Points for coordinates and stations may also be selected graphically.

BEAM LINE (BEAM)



The BEAM command is used to define Beam Lines.

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



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

Structure	Active Structure Name is displayed.
BEAM Number	The next available number is displayed. Enter another number if desired.
Define By	Select the desired option for defining the Beam line. Alignment PSLB Geometry Curve Line Arc

Input for the Define By options is explained on the next page.

Apply	Execute the command. Push this button after all desired components have been stored.
Close	Close the dialog box.
Help	Display Help for this command.

Define by Alignment, PSLB, or Geometry Curve

Offset	Enter desired offset.

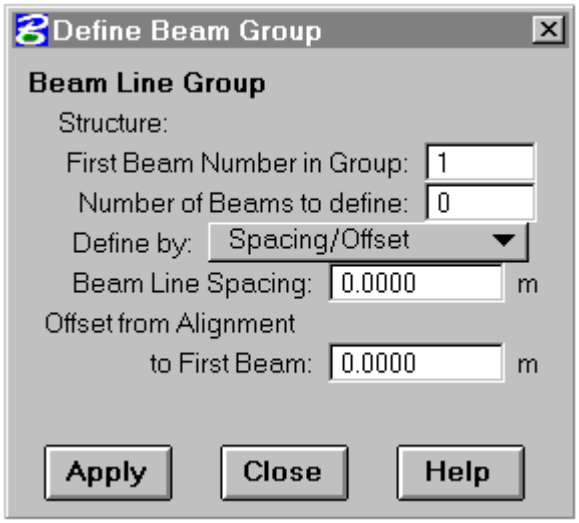
Define by Line.

Point	Select the desired option for defining a point on the line. Geometry Point Coordinates Enter requested data
Direction	Select the desired option for establishing direction. Bearing Azimuth Enter requested data.

Define by Arc.

Center	Select desired option for establishing Arc center. Geometry Point Coordinates Enter requested data.
Radius	Select desired option for establishing arc radius. Radius Point on Arc Enter requested data

BEAM LINE GROUP (BGRP)



The BGRP is an alternate method for defining Beam Lines. It provides a convenient way to define groups of beams for noncomplex structures when beam lines are parallel to the structure alignment or the slab edges.

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

When slab edges are referenced, a SLAB command must precede the entry of the BGRP command. The Beam Lines will have the limits of the PSLB Lines used for the SLAB command. In the case when both slab edges are referenced, the two slab edges (PSLB's in SLAB command) must be parallel or concentric and have the same limits.

Structure	Active Structure Name is displayed.
First Beam Number in Group	Enter number.
Number of Beams to be Defined	Enter number.
Define By	Select the desired option for defining the beam line by: Spacing/Offset Spacing/Edge Distance Edge Distance/Edge Distance

Input for the Define By options is explained below.

Apply	Execute the command. Push this button after all desired components have been stored.
Close	Close the dialog box.
Help	Display Help for this command.

Define by Spacing/Offset.

Beam Line Spacing	Enter spacing.
Offset From Alignment To Leftmost Beam	Enter distance.

Define by Spacing/Edge Distance.

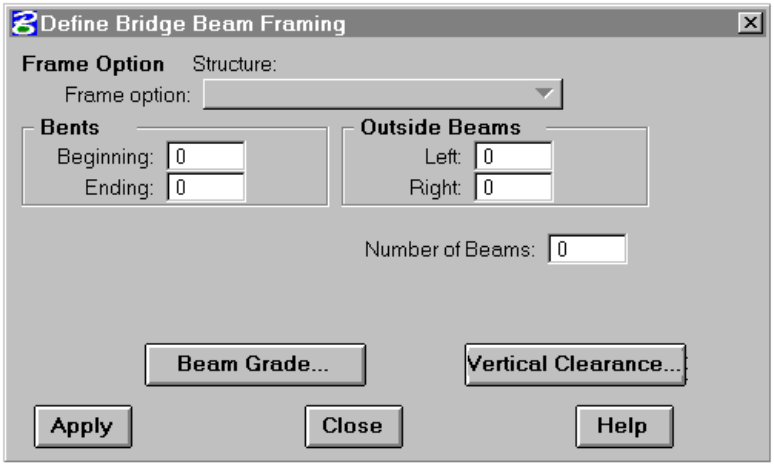
Beam Line Spacing	Enter spacing.
Distance From Left Edge of Slab to Leftmost Beam	Enter distance.

Define by Edge Distance/Edge Distance

Distance From Left Edge of Slab to Leftmost Beam	Enter Distance.
Distance From Right Edge of Slab to Rightmost Beam	Enter Distance.

Note: The Beam Group command must immediately follow the slab referenced when outside beams are defined by edge distance.

FRAME OPTION (FOPT)



The FOPT command is used to request computation of bridge frame layout dimensions. In addition to producing several reports which present dimensional aspects of the bridge frame, it will cause the plan view of the frame layout to be plotted. The designer may select one of 14 options for controlling the layout of beams. Seven of these options are for simple span units and three are for continuous units. In each option, the designer specifies the beginning and ending bents for the unit and selects output options. In addition, he gives information for controlling the geometry of the beams by one of four approaches. The discussion of input is grouped by these approaches which are as follows:

1. Give maximum and minimum overhang dimensions which establish the outside beams. Interior beams are automatically located according to the option selected.

2. Define all Beam Lines.

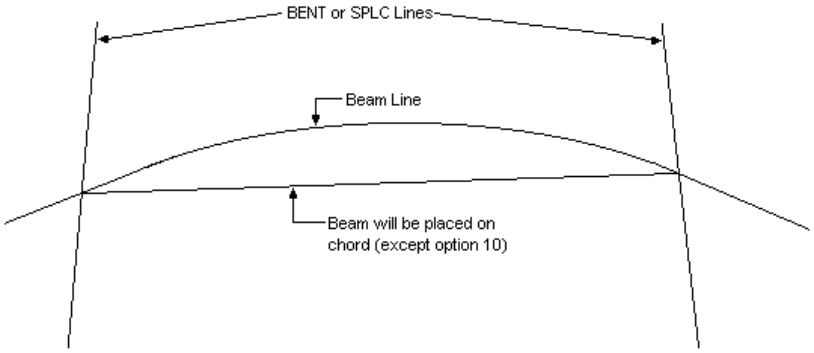
3. Define outside Beam Lines. Interior beams are automatically located according to the option selected.

4. Define outside Beam Lines and give maximum and minimum beam spacing. Interior beams are automatically located according to the option selected.

The FOPT process computes the intersections of Bent and Splice Lines with Beam Lines. Bearing seat locations and diaphragm intersections are computed on chords between successive bents and splices. An option is available for curved continuous beams. All pertinent Bent Lines, Splice Lines, Diaphragm Lines, Bearings and Beam Lines must be defined prior to executing the FOPT commands.

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

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



The Beam Grade (BMGD) and Vertical Clearance (VCLR) dialog boxes are activated from the Frame Option (FOPT) dialog box. These capabilities must be selected <u>after</u> the frame calculations are performed.

Structure	Active Structure Name is displayed.
Frame Option	Select desired option. Max/Min OH-Single (2) Max/Min OH-Multiple (1) Max/Min OH-Continuous (8) All Beams - Simple (4) All Beams - Chorded (9) All Beams - Curved (10) OS Beams - First/Second (6) OS Beams - Left/Right (7) OS Beams - EQ Space, One (3) OS Beams - EQ Space, Both (5) Box Beams (15) U Beams - EQ Space, Both (20) U Beams - Par Beam Groups (21) U Beams - Def All Beams (22)

Input for the Frame Options is described below.

Beam Grade	Push to display the dialog for Beam grades on the current frame - AFTER EXECUTING FRAME OPTION DATA.
Vertical Clearance	Push to display the dialog for Vertical clearance computations on the current frame - AFTER EXECUTING FRAME OPTION DATA.
Apply	Execute the command. Push this button after all desired components have been stored.
Close	Close the dialog box.
Help	Display Help for this command.

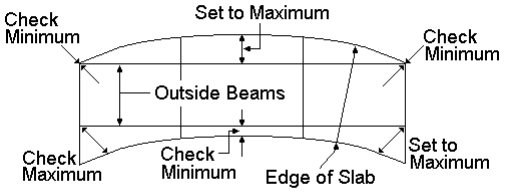
Notes: Bents and Beams referenced by this command must be in consecutive location and number order (Bents increasing station - Beams left to right).

The Box Beam and U Beam options do not produce graphics.

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

Beg Bent	Enter/Select
End Bent	Enter/Select
Left Outside Beam	Enter/Select
Right Outside Beam	Enter/Select
Number of Beams	Enter Number
Max. Allowable Edge Distance	Enter Distance
Min. Allowable Edge Distance	Enter Distance

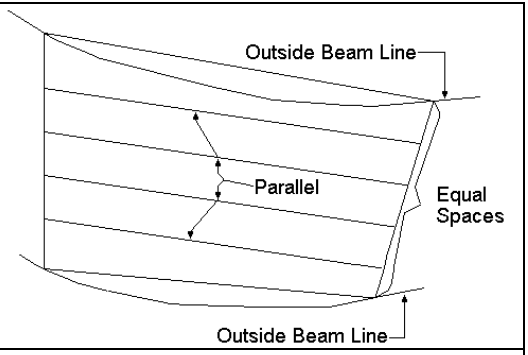
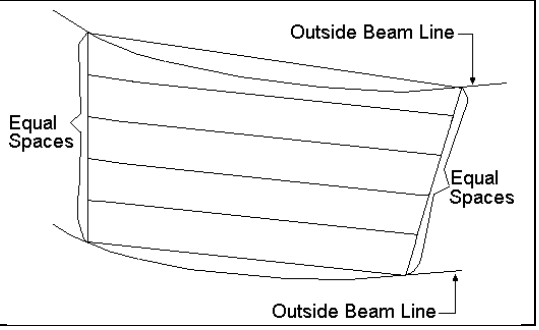
Note: These options locate the beams automatically in lieu of location by BEAM or BMGR commands.

<table>
<tr><th>UNIT TYPE</th><th>OPTION</th><th>BEAM LOCATION CRITERIA</th></tr>
<tr><td>MULTIPLE SIMPLE SPAN</td><td>1</td><td rowspan="2">SHORT BRIDGE ON SMALL DEGREE CURVE
 

ALL BEAMS PARALLEL, EQUAL SPACING</td></tr>
<tr><td>CONTINUOUS UNIT</td><td>8</td></tr>
<tr><td>SIMPLE SPAN</td><td>2</td><td>Same as above for one Span</td></tr>
</table>

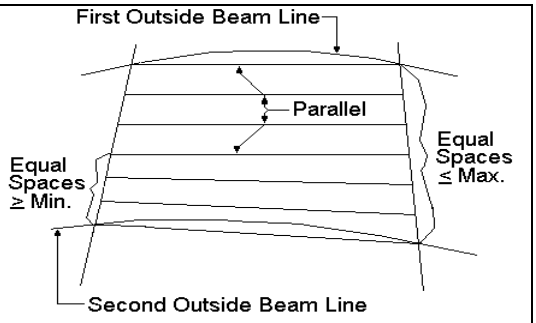
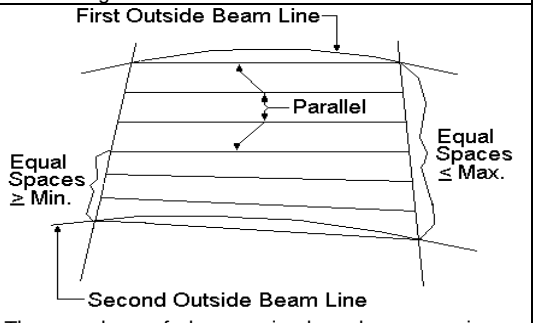
Options where outside beams are defined and interior beams are automatically located in accordance with option criteria. Outside Beam Line numbers may be any previously defined Beam Lines. Both outside and interior beams will be numbered beginning with one for storage purposes. Beam Line numbers for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

Beg Bent	Enter/Select
End Bent	Enter/Select
Left Outside Beam	Enter/Select
Right Outside Beam	Enter/Select
Number of Beams	Enter Number

UNIT TYPE	OPTION	BEAM LOCATION CRITERIA
SIMPLE SPAN*	3	
SIMPLE SPAN* *(Command may refer to more than 1 span if applicable)	5	

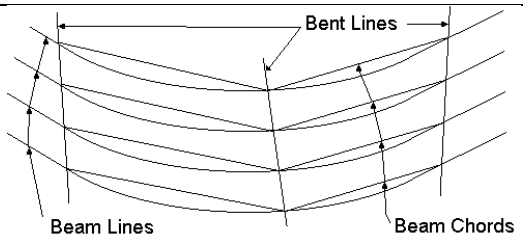
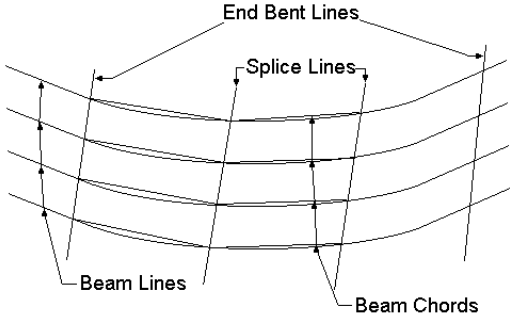
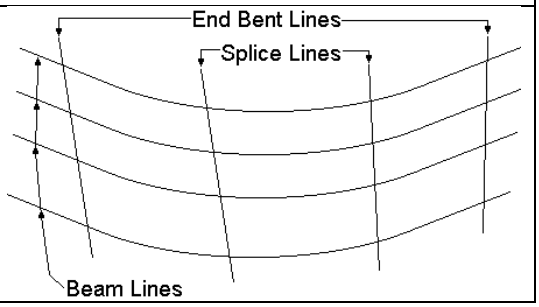
Option where outside beams are defined and interior beams are automatically located based on maximum and minimum spacing in accordance with option criteria. Outside beam numbers may be any previously defined Beam Lines. Both outside and interior beams will be numbered beginning with one for storage purposes.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

Beg Bent	Enter/Select
End Bent	Enter/Select
First or Left Outside Beam	Enter/Select
Second or Right Outside Beam	Enter/Select
Number of Beams	Enter Number
Max. Allowable Beam Space	Enter Distance
Min. Allowable Beam Space	Enter Distance

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

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

Beg Bent	Enter/Select
End Bent	Enter/Select
Left Outside Beam	Enter/Select
Right Outside Beam	Enter/Select
Number of Beams	Enter Number
Vertical Blocking (Options 9 & 10)	Select desired option. Standard Alternate

UNIT TYPE	OPTION	BEAM LOCATION CRITERIA
SIMPLE SPAN (Command may refer to more than 1 span if applicable)	4	
CONTINUOUS (Beams on Chords from Splice to Splice)	9	
CONTINUOUS (Beams follow Beam Lines)	10	

Horizontal Blocking Report for Continuous Spans (Options 9 and 10). The Horizontal Blocking Report will give the user layout information for a continuous structure with curved beams. The two Horizontal Blocking Diagrams on Figures 12-5 and 12-6 will give the user an idea of how to interpret a Horizontal Blocking Report. These diagrams are not displayed by the system, but are used for example purposes only. The diagrams shown on these pages are exaggerated for clarity. The angles and distances for each figure are given by special characters and letters in parentheses. These special characters and letters will not appear in the actual report, but are used here to illustrate where the angles and distances are located on the Horizontal Blocking Diagram.

HORIZONTAL BLOCKING REPORT

LOCATION	CHORD BETWEEN SPLICES BEARING & DIST.	DEF ANG & OFF	CHORD TO END BRGS. DISTANCE	OFFSET	CHORD TO ATL. SPLCS. DISTANCE	OFFSET
BEARING	N 6 44 16.13 E		0.0000	0.0000		
SPLICE	N 8 16 20.53 E	(O) 1 32 4.40	(a) 53.5173	(b) 2.3043	(j) 53.5587	(k) 0.9349
SPLICE	N 10 16 20.53 E	(*) 2 0 0.00	(c) 100.1911	(d) 3.9322	(l) 100.1891	(m) 1.7488
SPLICE	N 11 44 16.13 E	(*) 1 27 55.60	(e) 100.1869	(f) 2.0626	(n) 100.2010	(o) 0.8140
SPLICE			(g) 46.5957	(h) 0.0000		

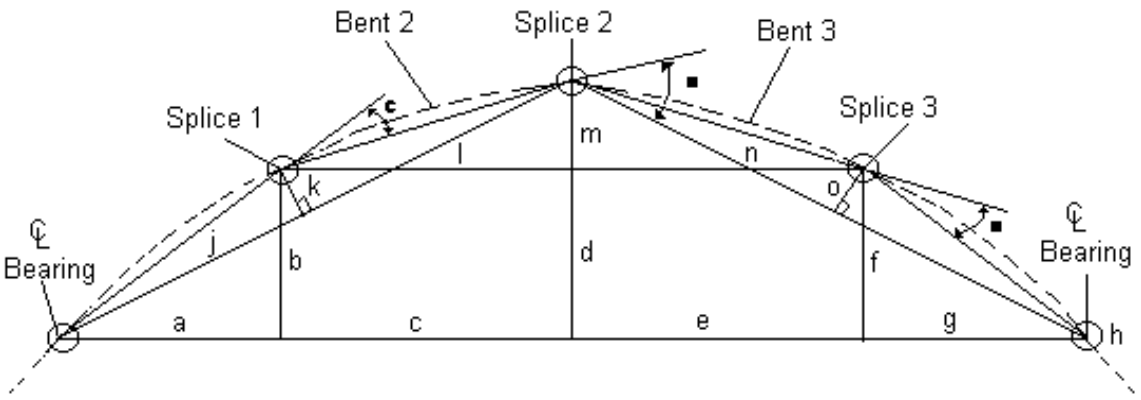


Figure 12-5
Horizontal Blocking Report and Diagram for Option 9

HORIZONTAL BLOCKING REPORT

LOCATION	CHORD BETWEEN SPLICES BEARING & DIST.	DEF ANG & OFF	CHORD TO END BRGS. DISTANCE	OFFSET	CHORD TO ATL. SPLCS. DISTANCE	OFFSET
BEARING	N 6 44 16.13 E		0.0000	0.0000		
MID POINT	(a) 26.7834	(b) 0.1249				
SPLICE	N 8 16 20.53 E	(O) 1 32 4.40	(m) 53.5173	(n) 2.3043	(u) 53.5587	(v) 0.9349
BEARING	(c) 46.6393	(d) 0.4351				
MID POINT	(e) 50.1022	(f) 0.4372				
SPLICE	N 10 16 20.53 E	(*) 2 0 0.00	(o) 100.1911	(p) 3.9322	(w) 100.1891	(x) 1.7488
BEARING	(g) 46.6393	(h) 0.4351				
MID POINT	(I) 50.1022	(j) 0.4372				
SPLICE	N 11 44 16.13 E	(*) 1 27 55.60	(q) 100.1869	(r) 2.0626	(ny 100.2010	(z) 0.8140
MID POINT	(k) 23.3207	(l) 0.0947				
BEARING			(s) 46.5957	(t) 0.0000		

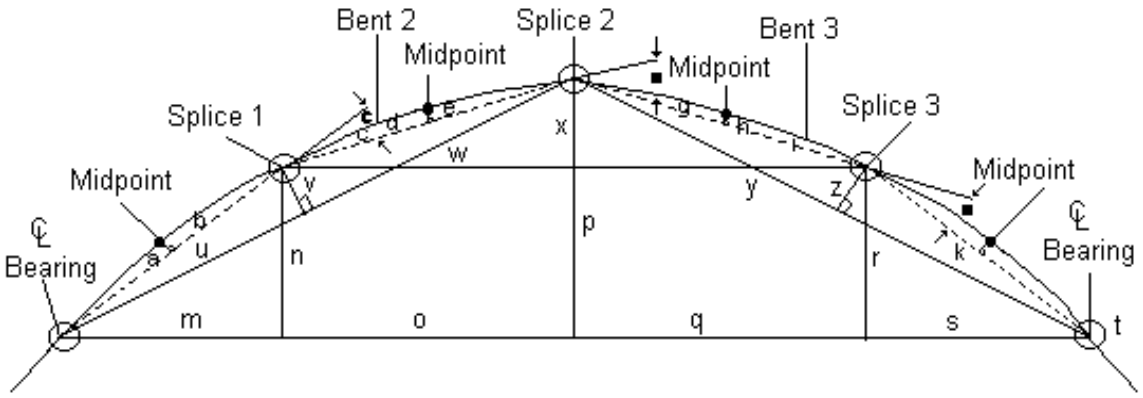


Figure 12-6
Horizontal Blocking Report and Diagram for Option 10

Vertical Blocking Options for Continuous Span Units (Options 9 and 10)

There are two vertical blocking options for continuous span units, standard and alternative, both are discussed below.

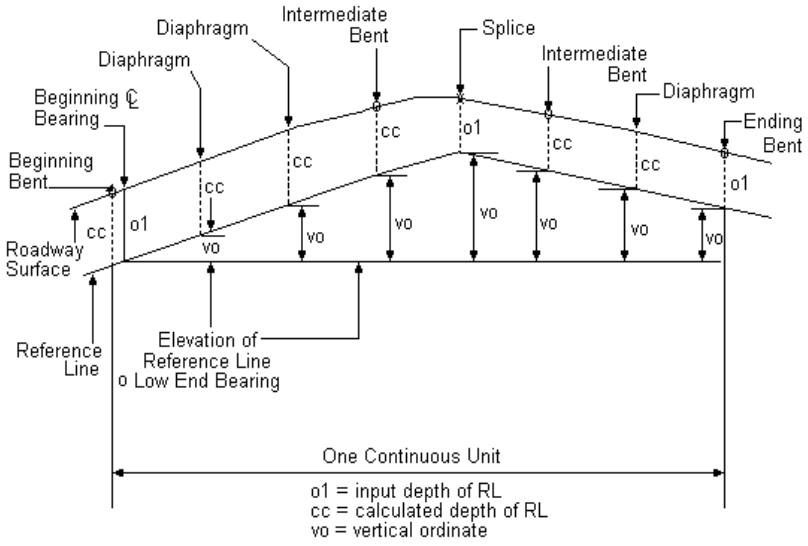
Standard Vertical Blocking Option. The standard or default vertical blocking option is intended to model straight members connected at splice points, such as rolled or wide flange steel beams.

The reference line (RL) is linear between vertical blocking control points. For the standard option these control points are splice points and the centerline of bearing at the first and last bents in a unit. If no bearing is defined, the control point defaults to CL bent.

The depth to RL specified at an end bent is applied at the centerline of bearing if one exists. At splice points, the RL elevation is obtained by subtracting from the surface elevation at the splice, the depth to RL specified at the splice.

At the intermediate bent locations, any depth value input for that bent will be ignored. An RL depth will be calculated by subtracting from the surface elevation, an RL elevation interpolated between the nearest control point on either side of the intermediate bent. RL elevations and depths at diaphragm locations are calculated in the same manner.

The vertical ordinate is the difference between the RL elevation at a given point and the RL elevation at the lower of the two end bearings.



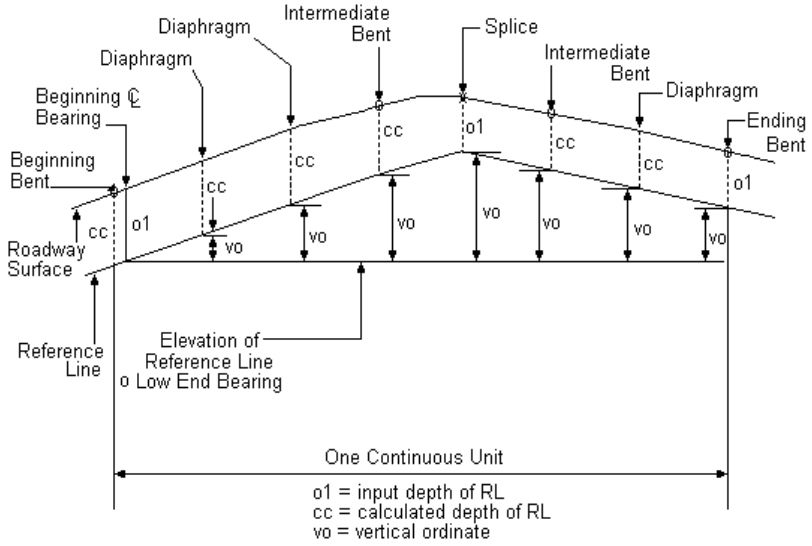
Vertical Blocking Options for Continuous Span Units (Options 9 and 10)

Alternative Vertical Blocking Option. The alternative vertical blocking option is intended to model a plate girder whose web has been cut to follow at a fixed, or linearly varying, depth below the roadway surface.

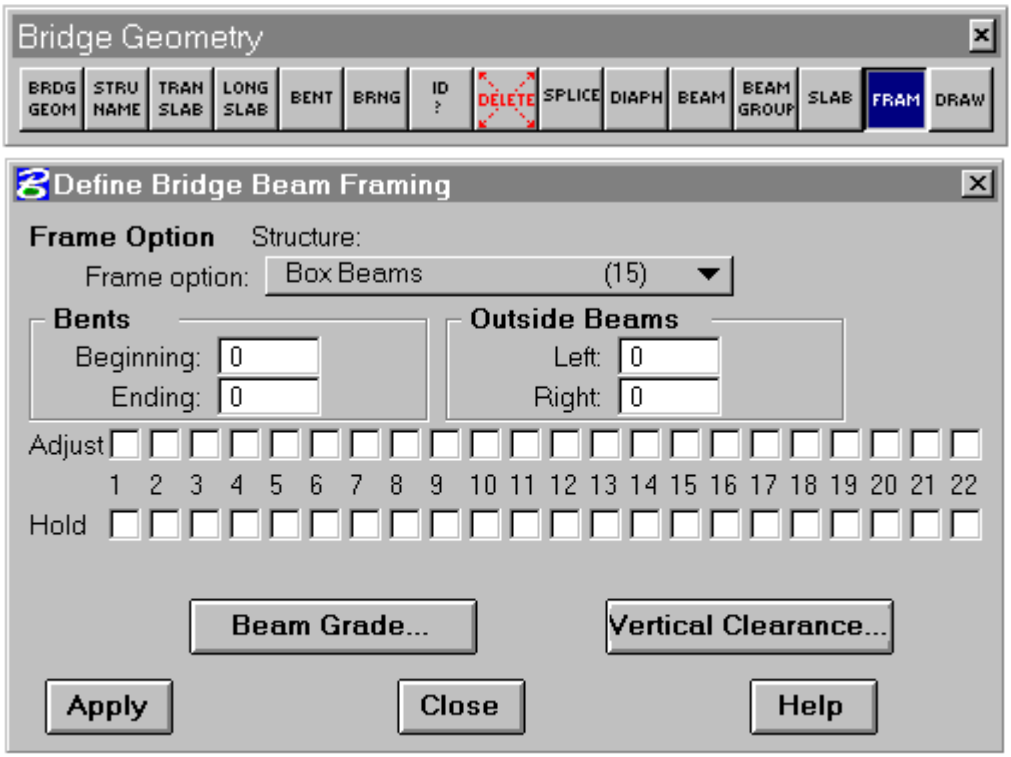
The reference line (RL) follows the roadway surface at a depth that varies linearly between control points. For the alternative option these are the same as the control points defined for the standard option.

A calculated RL depth at a diaphragm or an intermediate bent will be linearly interpolated between the RL depths input for the control point on either side of the point in question. As with the standard option, an RL depth input at an intermediate bent will be replaced by a calculated depth.

RL elevations at all points are found by subtracting the RL depths from the corresponding surface elevations. Vertical ordinates at all points are found by subtracting the RL elevation of the lower of the two end bearings from the RL elevation of the point in question.



DEFINE BRIDGE BEAM FRAMING



Option 15 is used to maintain the box beams with no torsion by adjusting the box beam bearing seat elevations to make the cross slope of the boxes at the backward bent match the forward bent. This option is used for box beams when the slopes of the backward and forward bents are not the same. This occurs in bridges on a skew or bridges with superelevation.

It is recommended that the BGRP command be used to define the beam edge lines (step lines) for the box beams in lieu of the BEAM command. A maximum of 22 step lines can be defined (21 beams). The step lines to be adjusted are indicated by push buttons on the dialog.

Bent	Enter/Select
End Bent	Enter/Select
Left Outside Beam Edge	Enter/Select
Right Outside Beam Edge	Enter/Select

Number of Steps Adjusted	Enter Number
Adjust Steps	Push buttons to indicate the edge lines to be adjusted.
Hold Steps	Push buttons to indicate the edge lines where elevation is to be held. Note that edges adjacent to a "held" edge can not be held.
Apply	Execute the command. Push this button after all desired components have been stored.
Close	Close the dialog box.
Help	Display Help for this command.

SAMPLE OUTPUT - BOX BEAMS

BENT REPORT

DISTANCE BETWEEN STATION LINE AND STEP LINE 6, 13.4618l

		STEP SPAC. (C.L. BENT)	COORDINATES X	@ FWD BRG Y	SURFACE ELEVATION	DELTA (FT)
STEP	6	0.0000	100009.6426	100210.2421	3206.5908	
			100014.2283	100217.9567	3206.7100	0.0344
STEP	8	17.9491	100018.8140	100225.6712	3206.8245	
			100023.3997	100233.3857	3206.9331	0.0344
STEP	10	17.9491	100027.9853	100241.1002	3207.0369	
			100032.5710	100248.8147	3207.1355	0.0349
STEP	12	17.9491	10037.1567	100256.5293	3207.2285	
			100041.7423	100264.2438	3207.3164	0.0347
STEP	14	17.9491	100046.3280	100271.9583	3207.3992	
TOTAL		71.7963				

NOTE: The DELTA value is the average of the overlay thickness at the bearing lines.

Figure 12-7

SAMPLE OUTPUT - BOX BEAMS

BEAM REPORT, SPAN 1

	HORIZONTAL DISTANCE C-C BENT	C-C BRG.	TRUE DISTANCE BOT. BM. FLG.	BEAM SLOPE	BEAM BEARING
BEAM 6	100.0000	98.5833	99.5217	0.02089	N 4 15 34.70 E
BEAM 7	100.0000	98.5833	99.5217	0.02089	N 4 15 34.70 E
BEAM 8	100.0000	98.5833	99.5191	0.01958	N 4 15 34.70 E
BEAM 9	100.0000	98.5833	99.5191	0.01958	N 4 15 34.70 E
BEAM 10	100.0000	98.5833	99.5166	0.01828	N 4 15 34.70 E
BEAM 11	100.0000	98.5833	99.5166	0.01828	N 4 15 34.70 E
BEAM 12	100.0000	98.5833	99.5143	0.01698	N 4 15 34.70 E
BEAM 13	100.0000	98.5833	99.5143	0.01697	N 4 15 34.70 E

Figure 12-8

SAMPLE OUTPUT - BOX BEAMS

BENT REPORT

BENT NO. 2 (N 30 43 41. 30 E)

DISTANCE BETWEEN STATION LINE AND STEP LINE 6, 13.4618 L

	STEP SPAC. (C. L. BENT)		COORDINATES @ BK BRG X	Y	SURFACE ELEVATION	DELTA (FT)	COORDINATES @ FWD BRG		SURFACE ELEVATION	DELTA (FT)
STEP	6	0.0000	100016.9650	100308.5532	3208.7144		100017.0703	100309.9659	3209.7393	
			100021.5507	100316.2677	3208.7693	0.0344	10021.6559	100317.6804	3208.7932	0.0540
STEP	8	17.9491	100026.1364	100323.9822	3208.8193		100026.2416	100325.3950	3208.8423	
			100030.7221	100331.6967	3208.8638	0.0344	100030.8273	100333.1095	3208.8860	0.0542
STEP	10	17.9491	100035.3077	100339.4112	3208.9033		100035.4130	100340.8240	3208.9243	
			100039.8934	100347.1258	3208.9375	0.0347	100039.9986	100348.5385	3208.9575	0.0542
STEP	12	17.9491	100044.4791	100354.8403	3208.9663		100044.5843	100356.2530	3208.9856	
			100049.0647	100362.5548	3208.9900	0.0347	10049.1700	100363.9676	3209.0081	0.0540
STEP	14	17.9491	100053.6504	100370.2693	3209.0083		100053.7556	100371.6821	3209.0256	
TOTAL		71.7963								

Figure 12-9

SAMPLE OUTPUT - BOX BEAMS

BEAM REPORT, SPAN 2

	HORIZONTAL DISTANCE C-C BENT	C-C BRG.	TRUE DISTANCE BOT. BM. FLG.	BEAM SLOPE	BEAM BEARING
BEAM 6	159.7400	158.3233	159.2485	0.01034	N 4 15 34.70 E
BEAM 7	159.7400	158.3233	159.2485	0.01034	N 4 15 34.70 E
BEAM 8	159.7400	158.3233	159.2465	0.00904	N 4 15 34.70 E
BEAM 9	159.7400	158.3233	159.2465	0.00904	N 4 15 34.70 E
BEAM 10	159.7400	158.3233	159.2448	0.00773	N 4 15 34.70 E
BEAM 11	159.7400	158.3233	159.2448	0.00773	N 4 15 34.70 E
BEAM 12	159.7400	158.3233	159.2433	0.00643	N 4 15 34.70 E
BEAM 13	159.7400	158.3233	159.2433	0.00643	N 4 15 34.70 E

Figure 12-10

SAMPLE OUTPUT - BOX BEAMS

BENT REPORT
BENT NO. 3 (N 30 43 41.30 E)

DISTANCE BETWEEN STATION LINE AND STEP LINE 6, 171.8955 L

		STEP SPAC. (C.L. BENT)	COORDINATES X	@ BK BRG Y	SURFACE ELEVATION	DELTA (FT)
STEP	6	0.0000	100028.8299	100467.8519	3210.4800	
			100033.4156	100475.5664	3210.4307	0.0540
STEP	8	17.9491	100038.0013	100483.2809	3210.3765	
			100042.5869	100490.9955	3210.3169	0.0542
STEP	10	17.9491	100047.1726	100498.7100	3210.2520	
			100051.7583	100506.4245	3210.1819	0.0542
STEP	12	17.9491	100056.3440	100514.1390	3210.1064	
			100060.9296	100521.8535	3210.0259	0.0542
STEP	14	17.9491	100065.5153	100529.5681	3210.9399	
TOTAL		71.7963				

Figure 12-11

SAMPLE OUTPUT - BOX BEAMS

BOX BEAM STEP ELEVATIONS

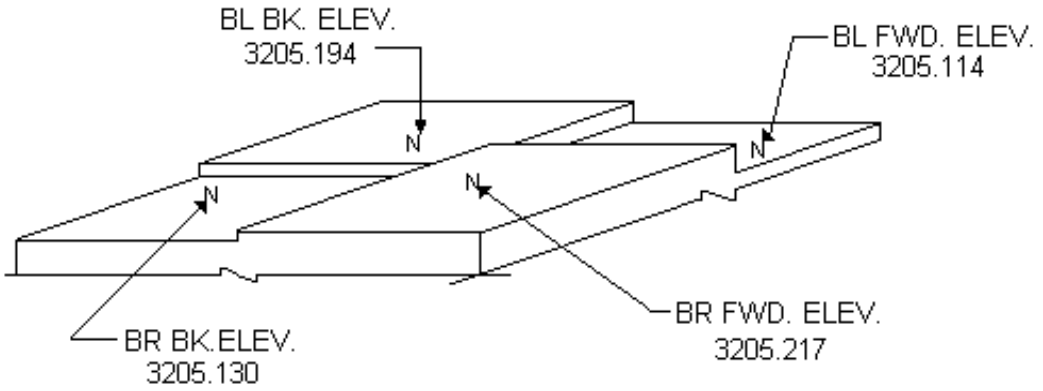
		STEP 6	STEP 8		STEP 10		STEP 12		STEP 14
		(RIGHT)	(LEFT)	(RIGHT)	(LEFT)	(RIGHT)	(LEFT)	(RIGHT)	(LEFT)
BENT 1	(FWD)	3202.966	3203.135	3203.199	3203.348	3203.412	3203.539	3203.604	3203.710

		STEP 6	STEP 8		STEP 10		STEP 12		STEP 14
		(RIGHT)	(LEFT)	(RIGHT)	(LEFT)	(RIGHT)	(LEFT)	(RIGHT)	(LEFT)
BENT 2	(BK)	3205.025	3205.194	3205.130	3205.278	3205.214	3205.341	3205.277	3205.383
	(FWD)	3205.114	3205.114	3205.217	3205.196	3205.299	3205.257	3205.361	3205.297

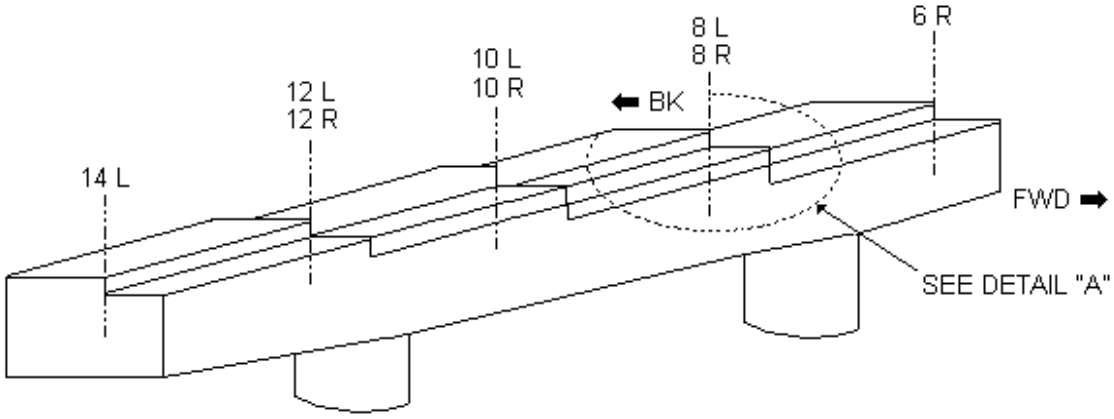
		STEP 6	STEP 8		STEP 10		STEP 12		STEP 14
		(RIGHT)	(LEFT)	(RIGHT)	(LEFT)	(RIGHT)	(LEFT)	(RIGHT)	(LEFT)
BENT 3	(BK)	3206.752	3206.751	3206.648	3206.627	3206.524	3206.481	3206.378	3206.315

Figure 12-12

SAMPLE OUTPUT - BOX BEAMS



DETAIL "A"



Stepped Bent
Figure 12-13

U BEAM OPTIONS 20, 21, 22

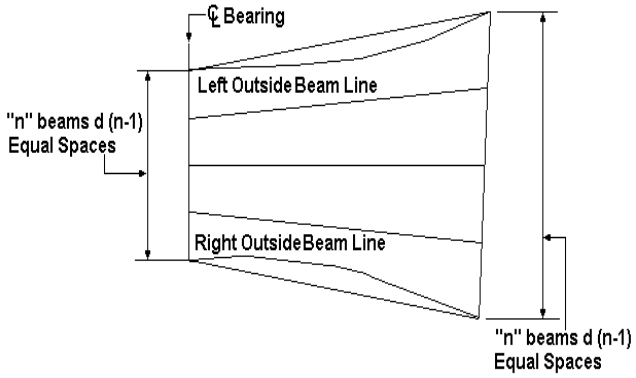
There options are similar to other options, but they also compute pedestal dimensions which are based on input specified by the Bearing command. The input for this option is shown below and the options are described on the following page.

Beg Bent	Enter/Select
End Bent	Enter/Select
Left Outside Beam Edge	Enter/Select
Right Outside Beam Edge	Enter/Select
Number of Beams	Enter Number

Note: Refer to Bearing Seat command for input of Pedestal dimension.

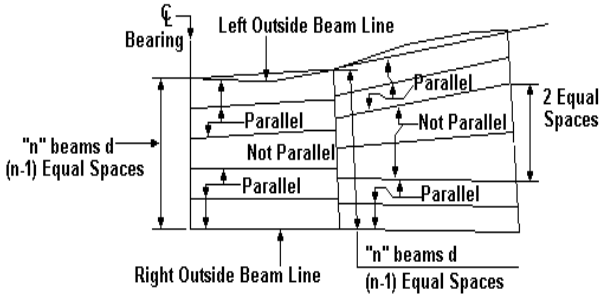
FOPT 20: EQUALLY SPACED BEAMS

All beams are equally spaced between left and right outside beam lines. Exterior beams are defined along the chord of the exterior beam lines between centerlines of bearing. Note: FOPT 20 spaces U-beams the same way FOPT 5 spaces I-beams.



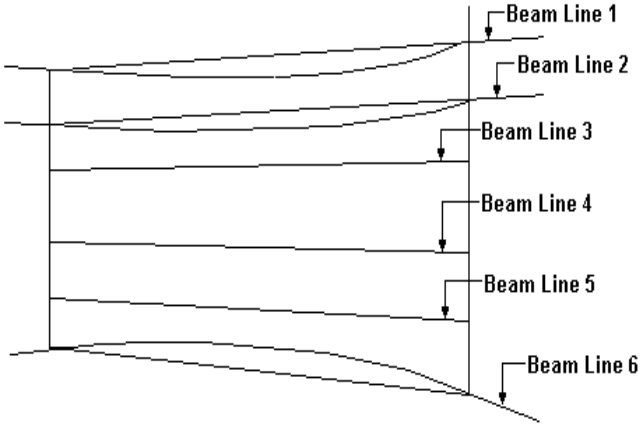
FOPT 21: Parallel Beam Groups

The left and right exterior beam lines must be defined with the BEAM command. Exterior beams will be defined along the chord of the exterior beam lines between the centerlines of bearing. Interior beams will be divided into two groups, each parallel to its adjacent exterior beam. If there is an odd number of beams, the middle beam will be centered between the two groups. Unlike FOPT 7, which places beams by checking MIN and MAX allowable beam spacings, FOPT 21 spaces beams equally along the shorter bent of the span.



FOPT 22: All Beams Individually Defined

All beam lines are individually defined with BEAM or BMGP commands. Beam Lines must be consecutively numbered from left to right, but numbering need not begin at 1. Beams will be defined along the chord of the beam lines between centerlines of bearing.



Pedestals are always centered under each beam; therefore, the left edge of pedestal at the centerline of bearing is the same distance from the centerline of beam as the right edge of pedestal at the centerline of bearing.

When Pedestal Widths are defined perpendicular to the centerline of the beam, they are internally converted to Pedestal Widths measured along the centerline of bearing before they are used in calculations (i.e., on a span with 70^{o} 00' 00.0" beam angles, entering a Pedestal Width of 5.2500 ft defined perpendicular to the centerline of the beam, yields the same results as entering a Pedestal Width of 5.5869 ft along the centerline of bearing.

When Pedestal Widths are defined perpendicular to the centerline of the beam where the beam angle varies, a different Pedestal Width along CL of bearing is calculated for each beam of the span. Only the largest calculated Pedestal Width will be applied to all of the beams.

Example:

> Suppose you are framing a span where the bridge is widening and the beam angles on the Bent Report vary from 90^{o} 00' 00.0" to 65^{o} 00' 00.0". You enter a Pedestal Width of 5.0000 ft and select "Perpendicular to Beam" in the BRNG dialog box. The system will determine the equivalent Pedestal Width along CL of bearing for each of the beams. In this example, the calculated Pedestal Widths will vary from 5.0000 ft for the 90^{o} 00' 00.0" beam angle to 5.5169 ft for the 65^{o} 00' 00.0" beam angle. The system then selects 5.5169 as the largest calculated Pedestal Width along the CL of bearing to apply to all beams at this location. The Bearing Elevation Report will show 5.5169 for this location as the "Distance Between BRNG Elevations along CL BRNG". This is also reflected in the Coordinates at Centerline of Bents and Bearings Report.

Bearing Pad Taper

The bottom flange of a "balanced" U-beam is a flat surface or plane that is located a short distance above another plane, the bent cap. The orientation of one surface with respect to the other is arbitrary. The bearing pad, which normally fills this void, would need to slope in two orthogonal directions in order to match both top and bottom surfaces. A bearing pad tapering in two directions is very difficult, hence costly, to fabricate. A solution to this problem is to use pedestals that slope in one of the two directions, thus requiring the pad to taper only in the orthogonal direction. The way this has been implemented in all of the U-beam framing options is as follows:

- Bearing pads are assumed rectangular, aligned with and centered on the centerline of bearing.

- Pedestals will slope along the centerline of bearing and remain level perpendicular to the centerline of bearing.

- Bearing pads will taper in a direction perpendicular to the centerline of bearing and remain a constant thickness parallel to the centerline of bearing.

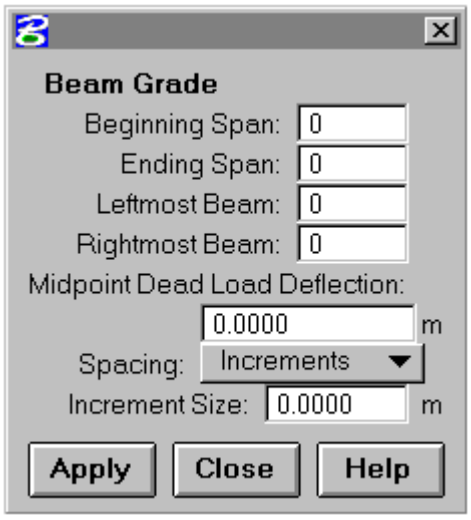
- The Bearing Pad Taper - Fabricator's Report lists the required taper perpendicular to centerline of bearing. Tapers are given as the slope of the top surface if the pad were resting on a level surface. A positive taper indicates increasing pad thickness in the direction of increasing stations.

- The Bearing Pad Taper - Designer's Report lists the required taper of the pad along the centerline of the beam. This report is of use only to help the design engineer reconcile pad tapers with beam grades and roadways cross slope information. The Fabricator's Report and the Designer's Report are completely redundant and only display the same information in a different form.

Bearing Elevations

The Bearing Elevation Report lists the required elevations at the right and left edge of each pedestal. Recall that the pedestals will remain level perpendicular to the centerline of bearing, and will slope along the centerline of bearing between the two elevations listed. Locations at which these elevations are calculated coincide with the coordinates of the right and left pedestal edge of the centerline of bearing as tabulated in the Coordinates of Centerline of Bents and Bearings Report.

BEAM GRADE (BMGD) - For Simple Spans Only



The Beam Grade (BMGD) dialog box is activated by pressing the "Beam Grade" button on the Frame option dialog box. This must be done after the frame has been calculated. Multiple Beam Grade calculations may be requested, as desired.

The BMGD command will produce a tabulation of surface elevations, bottom of slab elevations and bottom of slab elevations, plus deflection along the centerline of each beam. This tabulation may be requested by one of two options as shown below.

Option 1. Elevations tabulated at an incremented distance along the centerline of the beam between bearing seats. The increment must be large enough to limit the total number of points to 51 (including beginning and ending bearings) along each beam. If the increment causes more than 51 points, then the beam will be divided into 50 equal divisions.

Option 2. Elevations tabulated at equal divisions along the centerline of the beam between bearing seats. There is a maximum of 50 divisions along each beam.

Beginning Span	Enter Number
Ending Span	Enter Number
Leftmost Beam	Enter/Select Beam
Rightmost Beam	Enter/Select Beam
Midpoint Dead Load Deflection	Enter
Spacing	Select Spacing

Spacing by Increments.

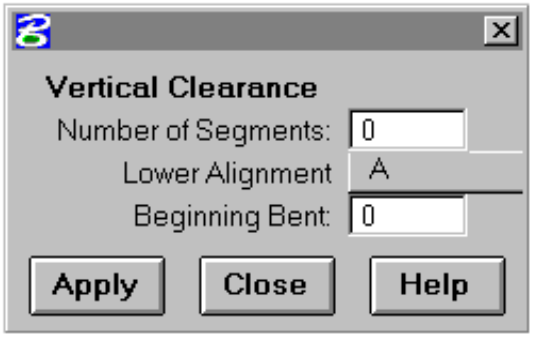
Increment Size	Enter increment size.

Spacing by Divisions.

Number of Division	Enter number of divisions.

Apply	Execute the command. Push this button after all desired components have been stored.
Close	Close the dialog box.
Help	Display Help for this command.

VERTICAL CLEARANCE (VCLR)



The Vertical Clearance (VCLR) dialog box is activated by pressing the "Vertical Clearance" button on the Frame option dialog box. This must be done after the frame has been calculated. Multiple Vertical Clearance calculations may be requested, as desired.

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

Vertical clearance to the lower roadway surface will be computed at increments along the centerline of the beams. In the case of prestressed beams, the clearance will be based on the straight line between bearing seat elevations. For continuous structures, the clearance will be computed on the basis of distance from the Reference Line to the floor surface. (Refer to the Reference Line discussion.) In either case, the designer can modify the clearance as necessary to take into account deflections or depths of the beam below the Reference Line.

The vertical clearance command (VCLR) may also be used to assist in determining the required haunch. By calling for vertical clearances of a span to its own roadway alignment, the vertical offset from roadway surface to chord through the bearings will be produced at increments along each beam.

There are three methods that may be used to determine the required haunch. These methods are listed below and shown on the following three pages.

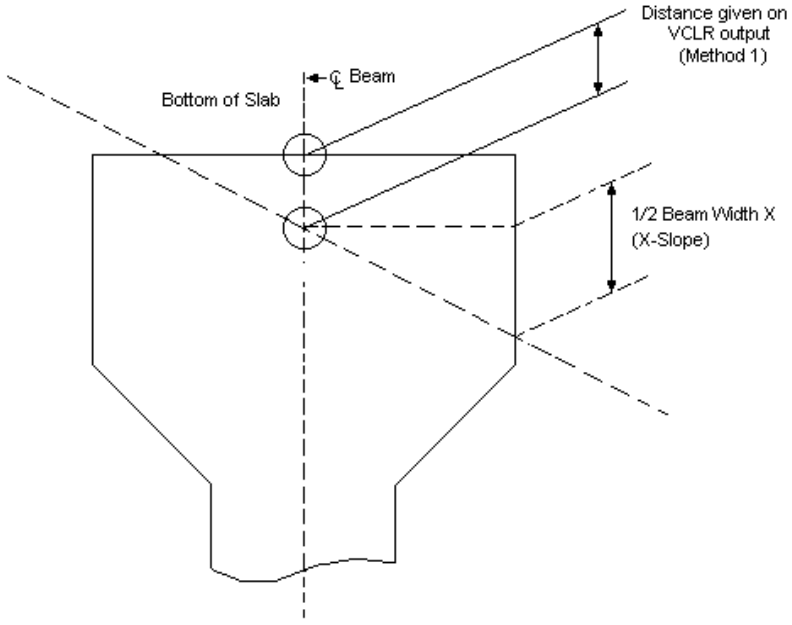
Method A: Enter zero deduct in the "Depth Below Reference Line" field in the BRNG dialog box.

Method B: Enter the anticipated haunch as deduct in the "Depth Below Reference Line" field in the BRNG dialog box.

Method C: Enter the total anticipated bearing seat deduct in the "Depth Below Reference Line" field in the BRNG dialog box.

Number of Segments	Enter Number
Lower Alignment	Select the lower alignment from available list.
Beginning Bent	Enter/select Bent.
Apply	Execute the command. Push this button after all desired components have been stored.
Close	Close the dialog box.
Help	Display Help for this command.

The required haunch is computed along the centerline of the beam. There may be encroachment of the slab into the beam. If this occurs, an additional calculation using one-half the top of beam width multiplied by the roadway cross slope must be considered in determining the total required beam haunch. The diagram below illustrates an example of this type of beam.



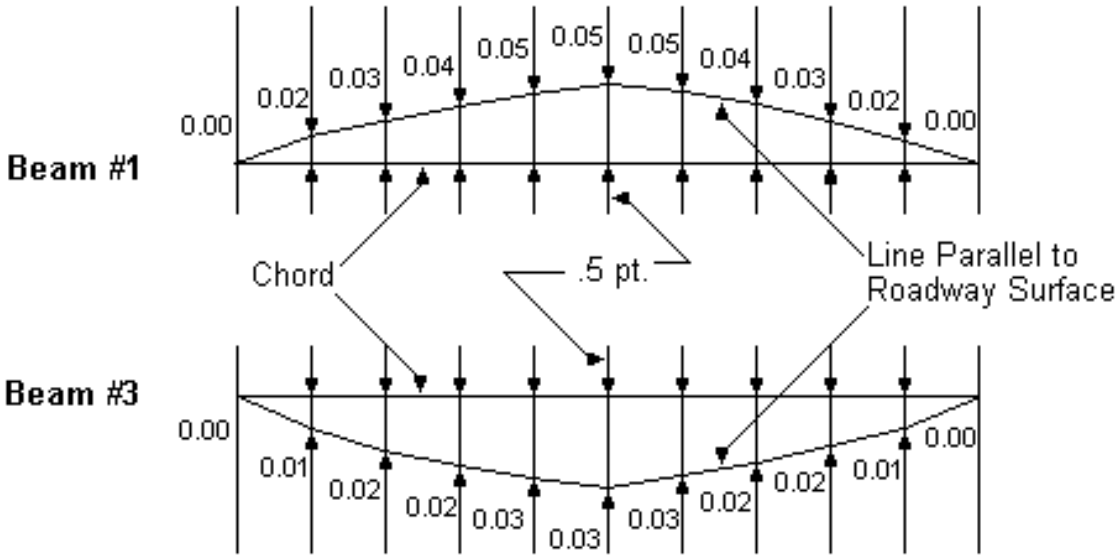
Note: Regardless of the value entered in the "Depth Below Reference Line" field in the Bearing Command (BRNG) dialog box, a careful analysis of the relative differences in the tabular values given in the VCLR output will assist in detecting when beams encroach into the slab due to sag vertical curves, slope transitions, horizontal curvature and/or superelevation.

Calculations are based on a straight line between bearing seats. Any permanent camber in beams or dead load deflections, due to slab, are not taken into account in the VCLR command. However, for total required beam haunch, these values must be included in the calculations.

VERTICAL CLEARANCE BETWEEN SPAN 1 OF ROADWAY H WITH ROADWAY H

	0.00 L	0.10 L	0.20 L	0.30 L	0.40 L	0.50 L	0.60 L	0.70 L	0.80 L	0.90 L	1.00 L
BEAM 1	-0.00	-0.02	-0.03	-0.04	-0.05	-0.05	-0.05	-0.04	-0.03	-0.02	-0.00
BEAM 2	-0.00	-0.01	-0.03	-0.03	-0.04	-0.04	-0.04	-0.03	-0.03	-0.01	-0.00
BEAM 3	0.00	0.01	0.02	0.02	0.03	0.03	0.03	0.02	0.02	0.01	0.00
BEAM 4	0.00	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.00
BEAM 5	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00

Method A: Enter Zero Below Line is +
Above Line is -

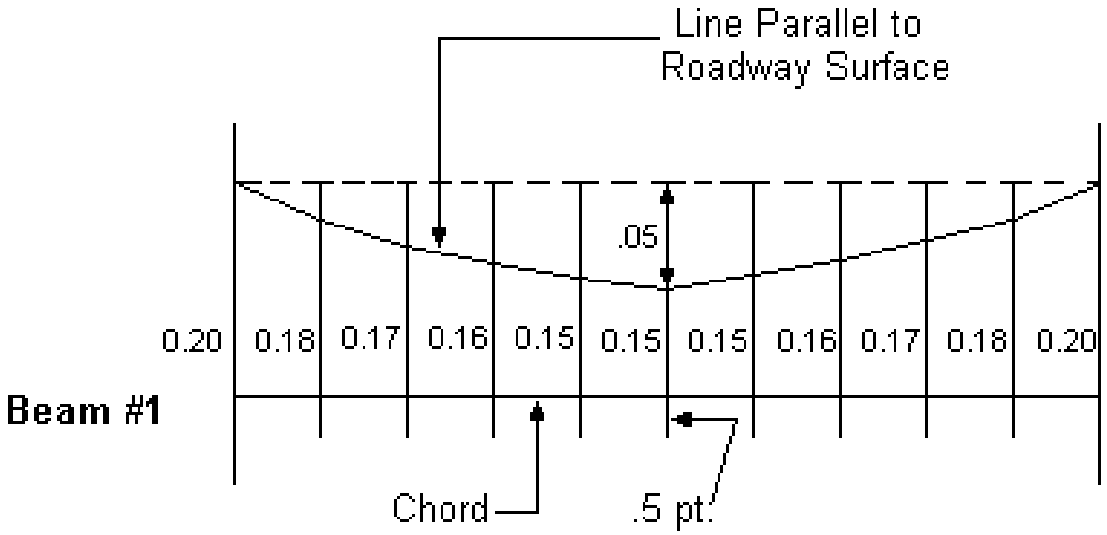


Example - Method A
Figure 12-14

VERTICAL CLEARANCE BETWEEN SPAN 1 OF ROADWAY H WITH ROADWAY H

	0.00 L	0.10 L	0.20 L	0.30 L	0.40 L	0.50 L	0.60 L	0.70 L	0.80 L	0.90 L	1.00 L
BEAM 1	-0.20	-0.18	-0.17	-0.16	-0.15	-0.15	-0.15	-0.16	-0.17	-0.18	-0.20
BEAM 2	-0.20	-0.19	-0.17	-0.17	-0.16	-0.16	-0.16	-0.17	-0.17	-0.19	--0.20
BEAM 3	-0.20	-0.19	-0.18	-0.18	-0.17	-0.17	-0.17	-0.18	-0.18	-0.19	-0.20
BEAM 4	-0.20	-0.19	-0.19	-0.18	-0.18	-0.18	-0.18	-0.18	-0.19	-0.19	-0.20
BEAM 5	-0.20	-0.20	-0.19	-0.19	-0.19	-0.19	-0.19	-0.19	-0.19	-0.20	-0.20

Method B: Enter Anticipated Haunch

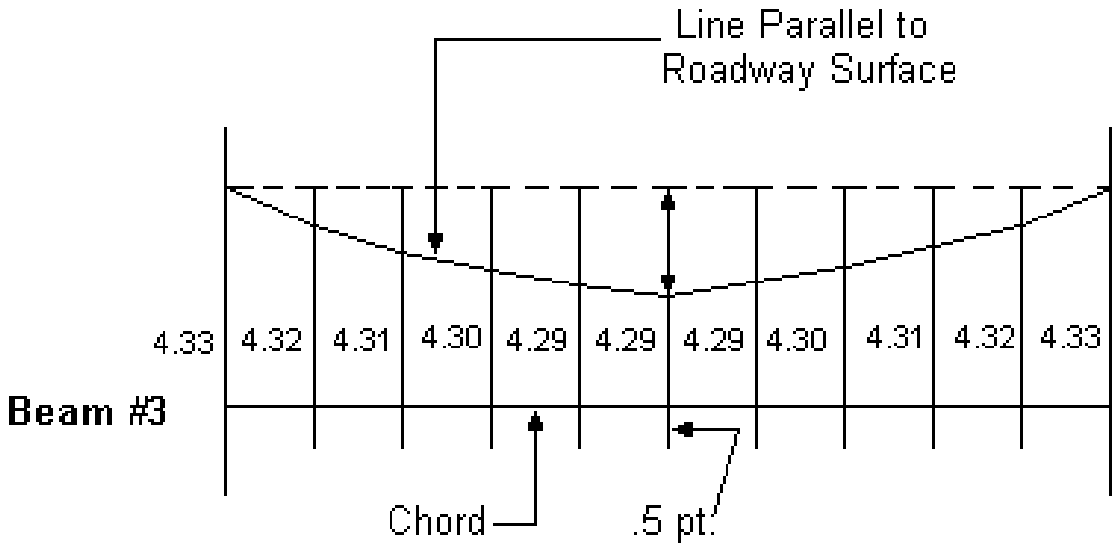


Example - Method B
Figure 12-15

VERTICAL CLEARANCE BETWEEN SPAN 3 OF ROADWAY H WITH ROADWAY H

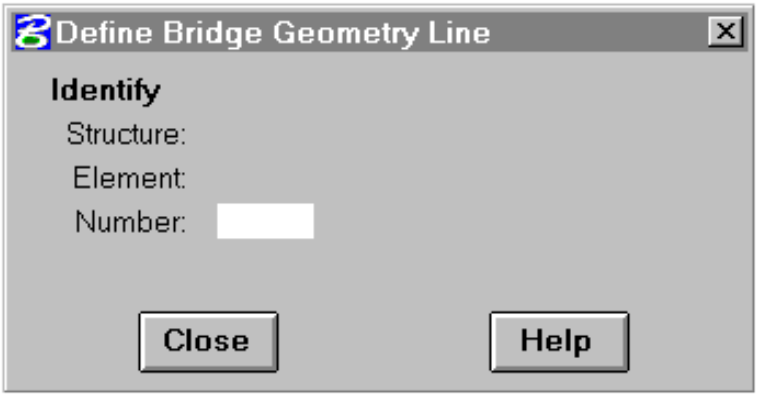
	0.00 L	0.10 L	0.20 L	0.30 L	0.40 L	0.50 L	0.60 L	0.70 L	0.80 L	0.90 L	1.00 L
BEAM 1	-4.33	-4.32	-4.32	-4.31	-4.31	-4.30	-4.30	-4.31	-4.31	-4.32	-4.33
BEAM 2	-4.33	-4.32	-4.31	-4.30	-4.30	-4.30	-4.30	-4.30	-4.31	-4.32	-4.33
BEAM 3	-4.33	-4.32	-4.31	-4.30	-4.29	-4.29	-4.29	-4.30	-4.31	-4.32	-4.33
BEAM 4	-4.33	-4.32	-4.30	-4.29	-4.29	-4.29	-4.29	-4.30	-4.30	-4.32	-4.33
BEAM 5	-4.33	-4.31	-4.30	-4.29	-4.29	-4.28	-4.29	-4.29	-4.30	-4.32	-4.33

Method C: Enter Depth of Section



Example - Method C
Figure 12-16

IDENTIFY (ID)



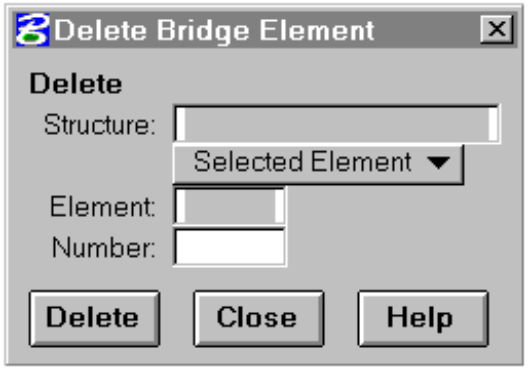
The Identify command provides for identifying Bridge Geometry graphic elements. When an element is selected using the left button; its Structure Name, Element Type, and Number (where applicable) will be displayed.

When there are several elements in the selection area, the right button can be used to reject undesired elements. Other elements can be selected using the left button.

If the element is not on the active structure, it will be identified, but a message to this effect will be displayed.

Close	Push to close dialog.
Help	Push to display Help for this command.

DELETE



The Delete command provides the for all data for the active structure or for deleting selected elements for the active structure.

When the "Entire Structure" option is selected all graphics and files for the active structure will be deleted after confirmation.

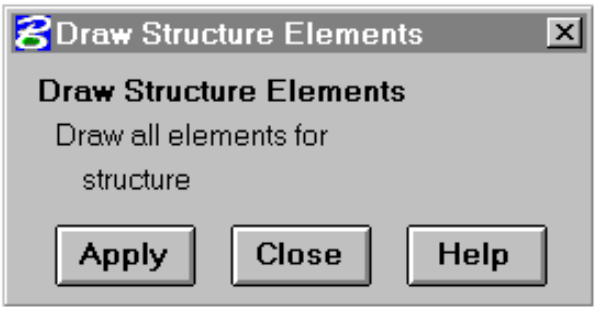
When the "Selected Elements" selections are made with the left button. Structure Name, Element Type, and Number (where applicable) will be displayed.

When there are several elements in the selection area, the right button can be used to reject undesired elements.

If the element is not on the active structure, it will be identified, but a message to this effect will be displayed. Delete will not be allowed. When it is desired to delete an element that has been identified, press Delete. This will display a confirmation dialog box to complete the deletion.

Delete	Push to display identification.
Cancel	Push to display close dialog.
Help	Push to display Help for this command.

DRAW



The Draw command provides for drawing all of the previously defined elements for the active structure. It can be used when the graphic file has been modified inadvertently or when a bridge file created by the AN option is to be displayed.

When the command is executed any existing graphics for the active structure will be erased before redrawing. Slab and Frame graphics will not be drawn since they are not stored in the file.

Apply	Push to execute the command.
Close	Push to close dialog.
Help	Push to display Help for this command.

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