

## CHAPTER 3

### GEOMETRY PROCESSES

The IGrds geometry functions provide powerful flexible means for establishing and graphically presenting plan view features and, optionally, 3D features. See the discussion below regarding 3D geometry. Each of the functions is based on plane coordinate computations (2D), with the elevation component taken into account for 3D usage. The functions may be used in any order, and may take advantage of previous computations. Some ways geometry computations might be used include:

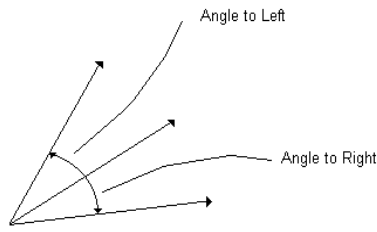
- Survey data reduction
- Locating PIs for horizontal alignments
- Geometric template modification
- Special ditch grades
- Intersection layout
- Construction dimensions
- Right-of-way geometry
- Bridge geometry

Geometry functions are accomplished by using commands that create and store points, lines, arcs, chains and shapes, or combinations of these elements. Previously stored elements can be used in current computations. In addition to these coordinate based elements, computations may include elements such as angles, distances, deflection angles, skews, stations, offsets, azimuths, and bearings as illustrated in Figure 3-1.

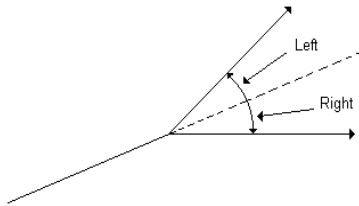
In the IGrds/IG Option, commands are accessed through a Graphic User Interface (GUI) with results displayed and stored immediately. Icons on the menu are helpful in selecting the proper commands. Input in response to prompts can be reduced by selecting desired geometry elements from the graphic screen and by taking advantage of automatic element numbering and graphic labeling.

A command structured language is used to access commands in the IGrds/AN Option Command Structured Language. IGrds/AN and IGrds/IG Option considerations are discussed below.

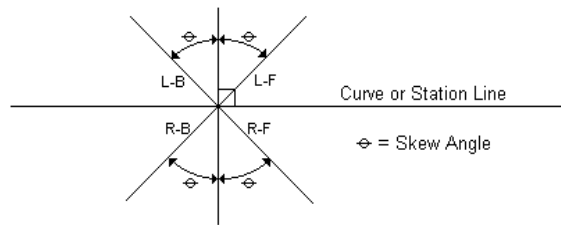
Angles



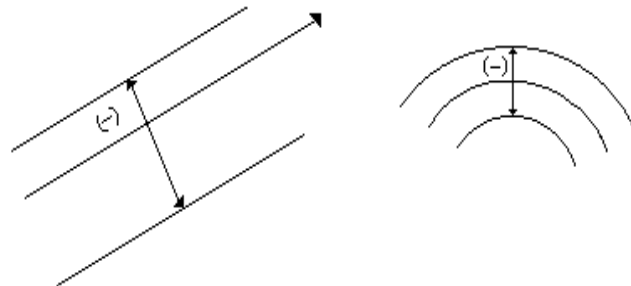
Deflection Angles



Skews



Offsets



Azimuths/Bearings

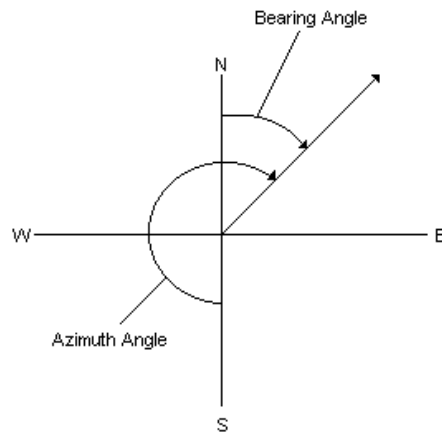


Figure 3-1 - Geometry Elements

## **TWO DIMENSIONAL PLAN VIEW COORDINATE GEOMETRY FUNCTIONS**

The coordinate geometry functions use stored points, lines, and arcs to compute distances, directions, angles, and other values, and to compute and store other points, lines, and arcs in the same horizontal reference plane. Standard analytical geometry methods are used in the computations. Command Structured Language (IGrds/AN) or interactive dialog input (IGrds/IG) is used to invoke coordinate geometry functions. Examples include:

- Compute the bearing and distance between two points
- Compute the angle between three points
- Locate and store a point at a bearing and distance from a given point
- Locate and store a point at the intersection of two lines

## **THREE DIMENSIONAL COORDINATE GEOMETRY FUNCTIONS**

The IGrds/IG Option also provides the capability to define, display, compute and modify three dimensional geometry elements. These elements are displayable and measurable in plan, profile and cross section views, as well as MicroStation isometric and perspective views.

The specific capabilities are discussed below.

- The 3D capability is completely compatible with the 2D capability so that users can still operate in the “top” (plan) view only if desired.
- All geometry arcs are defined in the “top” view only, and appear as circular arcs in this view. They appear as ellipses, lines, etc. in other views.
- All intersection calculations return both Z values as well as the X, Y intersection. Intersections with arcs usually return two sets of values.
- The 3D capability allows for the automatic (optional) calculation of elevations (Z values) for geometry points based on IGrds design data, including side slopes and medians and/or the DTM active surface.
- The 3D capability allows for the attachment of 3D primitives (i.e., circles, ellipses, rectangles, predefined cells, etc.) to geometry elements so that the element can represent storm sewer links, other underground utilities, etc. The process also allows for projecting 3D elements into IGrds profile and cross section views, as well as 2D and 3D views.
- The 3D capability allows for the creation of 3D geometry points from IGrds vertical reference lines, with a specified offset, if desired.

Figure 3-2 shows examples of 3D geometry elements. See Appendix C for a more detailed description of 3D geometry.

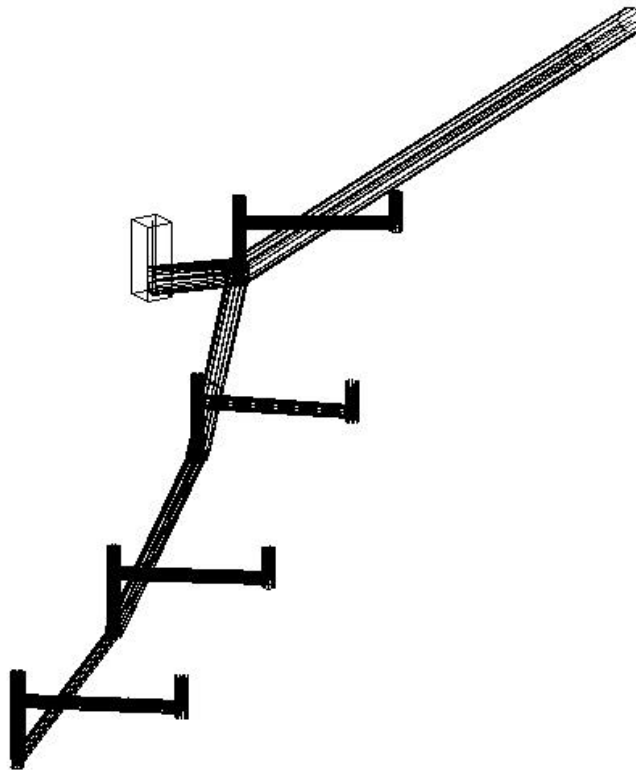


Figure 3-2 - 3D Geometry Elements

## **HORIZONTAL ALIGNMENT RELATED GEOMETRY FUNCTIONS**

The horizontal alignment geometry functions are similar to other coordinate geometry functions, except they also use the coordinate-based definition of horizontal alignments in their computations. Command Structured Language (IGrds/AN) or interactive dialog input (IGrds/IG) is used to invoke horizontal alignment geometry functions. Examples include:

- Locate and store a point at a given station and offset (optionally compute elevation from surface or active DTM)
- Compute the station and offset of a given point (optionally compute elevation from surface or active DTM)
- Compute the intersection of a line with an alignment or offset alignment
- Compute surface elevations for an incremented set of points

## **BRIDGE GEOMETRY FUNCTIONS**

The bridge geometry functions make use of coordinate and horizontal alignment geometry functions to define bridge geometry elements such as:

- Beam lines
- Bent lines
- Bearing lines
- Transverse lines
- Longitudinal lines
- Slab outlines

These elements are then used in computing and displaying the horizontal and vertical properties of bridge frames. A powerful set of bridge framing options provides for automatic layout of beams using combinations of parallel and equal spacing requirements. The program has options for simple and continuous spans, with straight, curved, box and U shaped beams. Construction layout of the bridge slabs are made easy with the BMGD and SLEL commands, which provide both horizontal layout and elevations corrected for dead load deflection. See the IGrds IG User Manual for a detailed description of the bridge geometry capabilities.

## **GEOMETRY PLOTTING**

The IGrds/IG Option places geometry elements in the graphic file from which they may be plotted. The IGrds/AN Option provides Command Structured Language for producing pen plotter plots of any stored geometry elements.

## **COMMAND STRUCTURED LANGUAGE - IGrds/AN**

The IGrds/AN Option uses a generalized data record for a wide variety of functions. This format has data fields which determine the function to be performed and provide the necessary data to complete the desired function in a single record. Command Structured Language is used for:

- Geometry computations
- Special bridge geometry computations
- Output requests
- Plot requests

Note that the IGrds/AN Option offers 2D capability only.

## IGrds/AN/IG OPTION CONSIDERATIONS

The geometry functions are similar for IGrds/AN and IGrds/IG, but are necessarily different in some cases. Some IGrds/AN functions are not repeated in IGrds/IG.

There is a basic difference in the way lines and arcs are stored in the IGrds/AN and IGrds/IG Options. In IGrds/AN, they are stored as infinite length lines or complete circles without elevations. In IGrds/IG, they are stored with finite lengths with elevations since they must be graphically displayed. In IGrds/IG, they are said to be bounded. The data stored is as follows:

<u>Element</u>	<u>IGrds/AN</u>	<u>IGrds/IG</u>
Points	X,Y	Same + Elevation
Lines	X,Y Dir	Same + Elevation and End Points
Arcs	Center X,Y, Radius	Same + Elevation and End Points
Chains	NA	Series of Lines and Arcs with Elevations

IGrds/IG computations, however, are based on infinite lines and complete circles.

## RAMP DESIGN AND SPECIAL GEOMETRY FUNCTIONS

Ramps are used at roadway intersections to provide greater safety and ease of driving when changing the direction of travel from one roadway to another. Ramps may range from the very basic diamond shape, or variations thereof, to the very complex cloverleaf patterns employed at high volume roadway interchanges.

The horizontal alignment components of a ramp design are the same as those that comprise the roadways they connect to. In other words, ramps are designed with tangent lines, circular curves, and spirals. However, due to the fact that ramps have greater positional restraints placed on them, as well as more complex shape combinations than that of roadways, they require the use of a special set of graphic tools for their design. To help efficiently design roadway interchange ramps, the general ramp design command permits the interactive design and display of a ramp according to designer specifications.

In addition to the general ramp design command mentioned above, several other commands have been added to the capabilities of IGrds. These provide the designer with the means to efficiently design reverse curve layouts, determine intersection flared areas (radial offsets), design median ends, design left turn lanes, determine alignment intersection data, generate right-of-way stakeout designs, and create horizontal alignments from offsets. See Appendix M for a detailed discussion of all of these capabilities.

## **MICROSTATION ELEMENTS USED AS IGrds GEOMETRY ELEMENTS**

IGrds Geometry commands allow the selection of MicroStation graphics elements (i.e., points, lines, line strings, chains, b-spline elements, circular arcs, etc.) as input. For example, two MicroStation lines can be selected to produce an IGrds point or a series of MicroStation elements can be selected to produce an IGrds chain. If necessary, the selected MicroStation elements are automatically converted to IGrds geometry elements. Another capability allows selection of MicroStation elements, singly or within a fence, for manual conversion into IGrds Geometry elements.

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