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INTRODUCTION

Background & Purpose

As computerized grading equipment has come into increasing usage, there has been a proportional increase in demand for readily available 3 dimensional data for a roadway project’s proposed finished surfaces.

To date, the typical practice for users of ODOT’s plans is to manually compile the various finished ground grade-break points that are provided by a project’s cross sections into strings of station-offset-elevation points that can be read by the grading control application.

Proposed pavement surfaces are primarily being modeled from their alignment and cross section design information and require varying degrees of manual manipulation, depending on the extent to which the plans uphold the ODOT CADD standards and the software available to the Contractor.

Despite the difficulty and costs of preparing plan data for use with automated grading, despite the fact that there is not a good means of modeling intersection surfaces from our 2 dimensional plans, the cost savings presented by the technology is so significant that its use continues to grow. Unfortunately, that growth has been essentially limited to large projects, where the magnitude of the potential benefit outweighs the tremendous chore of preparing the data.

It is in our best interest to tailor our design products to be more readily adaptable for use by automated grading and control software. The technology, applied properly, improves construction quality and provides considerable savings in construction time and costs. By reducing data preparation time and costs, we enhance these benefits, and, more importantly, we help to make the technology feasible for the builders of our multitude of smaller projects, as well, thereby deriving program-wide time, cost and quality improvements.

ODOT’s long term goal is to provide accurate 3 dimensional models that can be electronically read by the computerized grading software. The short term goal is to reduce, as much as is possible/feasible, the amount of manual labor that currently goes into preparing data from our 2 dimensional plan sets.

Intent & Capabilities

ODOT_XS_Pts.mvba is intended to relieve the user from having to do manual take-off for cross-section break points. It provides the user with:

- An interactively editable set of 3 dimensional grade points for each cross section of each user-defined alignment in the project.
- The capability to create simple line strings from plan view representations of the alignment’s grade points.
- Options for outputting the points or line string information in a variety of electronic formats. These output formats, in turn, are conducive to electronic – rather than manual – translation by the Contractor into the specific formats required by his/her software.

The intended user of the program is the designer, not necessarily the contractor. The program uses both MicroStation and GEOPAK and is heavily tied to the ODOT CADD Standards – none of which a contractor is required to have to build for ODOT. Furthermore, the program provides the designer some fast and effective comparison checking between plan view and cross section features.
Requirements

The application runs in MicroStation version 08.09.04.51, or better, with Bentley Civil V8i Edition version 08.11.05.17 or better. Microsoft Access 2002, version 10.6771.16830 SP3, or better, and Microsoft Excel 2002, version 10.6771.6830 SP3, or better, must be present, as well.

The project directory structure and naming conventions for files and GEOPAK (Bentley Civil) elements are expected to be in accordance with ODOT’s CADD standards. The last two sub-folders in the project path must be the 3 character county abbreviation and the 5 digit Project I.D. number. Adherence to the naming conventions is especially important for roadway basemap design files and GEOPAK chains.

All sections in the XC files that are used in the finished cross section sheet must be generated by GEOPAK according to the ODOT recommended/required practices as set forth in our Roadway training. Also, the finished surfaces in each such cell must be drawn in the XC file and on its required ODOT level.

HOW IT WORKS, IN BRIEF

General

What the user sees when running the program is the typical sort of thing one has come to expect with MicroStation vba programming: graphic user interfaces and dynamic interaction between the MicroStation graphics, the user, and the program. This brief section talks only about those things that the user doesn’t see and that are of importance to how the program goes about its two fundamental tasks: finding grade break points and keeping information about them.

The section on grade point identification is a very bare-bones description of the underlying algorithm. It should help give those that use the program some insight into how it works with their design files.

The very brief section on the database is expected to be of interest to the user only in terms of what additional information may be gleaned from it, independently of the program, and for purposes of determining causes/effects of various errors/problems one may encounter in running the program.

Identifying Grade Break Points in the Proposed Cross Sections

The current version of the program is set up to provide grade break points for an alignment’s proposed finished pavement and ground surfaces.

The user tells the program the XC file name and centerline chain name for the alignment. The program then works from the GEOPAK cross section cells in the XC files, and with the proposed finished pavement and ground line elements in each cell, to determine the station, offset and elevation of each grade break point.

The cell file’s section cells, as generated by GEOPAK, are the key to determining a point’s station, elevation and offset, even when the cross section is at a skew to the centerline or is “kinked” at one or more offsets from the centerline.
The program takes the base elevation for the section as the value associated with the section cell’s horizontal axis line, which is written to the left of that axis. It gets the station-region value for the section’s intersection with the alignment’s centerline from the text that GEOPAK writes above the cell’s vertical axis.

The nature of the section’s pattern line is derived from the number of lines in the cell’s horizontal axis and the northing and easting values associated with the beginning/ending point of each such segment.

Within the extended bounds of a given cell, the program finds all lines on the levels for finished pavements and ground. Each unique vertex from those lines is then identified as a proposed grade break point. Each point is compared to the section’s pattern line information to determine the actual plan station and offset of the grade point. The elevation of the point is determined from the section’s base elevation and the height of the point above the section’s x-axis.

**Data Persistence**

The program stores all information associated with a project, its alignments, the cross section cells in each alignment’s XC file, the grade break points for the alignment, and any line strings the user has created from those points in an Access database. The database’s table relationships are shown in the following graphic:

The database allows the program to use SQL queries to quickly retrieve, create and update information in response to user directives (e.g. output format, point generation/editing and so forth).

Individual table structure information is provided in Appendix A
USING ODOT_XS_PTS

Before You Start

Files and Directories

There are several files that must be used with ODOT_XS_Pts.mvba.

The program’s companion Access database, XS_Grade_Pts.mdb, must exist in the project’s \admin\mdb\ subdirectory. For project directories built via ODOT_directory.exe after July 20, 2007, the database should automatically be present in the requisite directory. For project directories established by other means, or via earlier versions of the directory set-up program, you will need to create the mdb folder under the admin subdirectory and copy the database from the ODOTstd\mdb\ folder.

Geopak

Geopak should be active prior to starting the program, and its working directory must be set to the geopak folder of the project for which you will be developing grade points. The program will issue a warning to this effect prior to presenting the main form. Although the program is written to attempt to handle “after the fact” Geopak activation/directory settings, correct performance cannot be guaranteed.

Step by Step

Start-up

You may start the program from the ODOT Apps menu on your main MicroStation menu bar, if that is available to you, or you may load it into the Macro Project Manager (Utilities>Macro>Project Manager) from the vba subfolder of the ODOTstd directory.

You will see the opening form, a warning that you should make sure that Geopak is active and set to the directory of the project for which you want grade points. The form is not modal, so you do not need to close it while you activate, check or adjust your Geopak project.

Press “Quit” to exit the program or “Continue” to go on to the main user form.
User Interface: Project Info Tab

The main form now appears on your screen. At this point, only its project tab is open and available. The top frame of the Project Info page displays the county name abbreviation and PID number from the last two sub-directories in the user-set project path. To set the path, click on the browse button to bring up the directory selection dialogue.

After selecting the path to the desired project directory, click the OK button to return to the main form. If the directory path does not conform to the ODOT standard – the last two sub-directory names must be the county abbreviation and the PID number – the return will be aborted, an error message will appear and the user will be asked to reselect or cancel.

If the directory path selection does meet the ODOT CADD standard, the main form will automatically display the county abbreviation and PID and activate the remaining frames and controls on the tab. Furthermore, the program will check to see if the project is already entered in the database and, if so, it will display any County-Route-Section information it has in the designated frame on the main form. The route and milepost portions of this frame may be used to type in any edits necessary before starting the run.

Select the Geopak job number for the project from the drop-down list in the “Select the Geopak File” frame. The file selected must be named in strict accordance with the CADD standards for the program to work properly. Again, if the project already exists in the database, the .gpk file name that is found there will be displayed automatically when the user selected the county and PID.

Click on the Start button to load the design file and Geopak information from the project directory as well as any existing alignment and grade point information from the database. The frame at the bottom of the tab will keep you apprised of the program’s progress during this stage.

User Interface: Alignment Info Tab

When the program has completed loading the project information, the Alignment Info tab will be enabled and activated. This tab is used to add, delete and modify alignment information for the project. The list box in the center of the tab will be pre-loaded with any project alignments that already exist in the database, as shown on the next page.
For the purposes of this program, an alignment is defined by its cross section cell file and the Geopak centerline chain used to create the sections. For divided roads that have additional relevant chains, such as left and/or right base- or center-lines, these secondary chains may also be included in the definition. They are of use only when the user wants grade points to be exported relative to one of these chains rather than to the chain used for the sections.

Adding an Alignment to the Project

1. In the text field beneath the list box's XS cell file name column, enter the name of the cell file to use for the new alignment. To choose the name from a list of cell files in the project, merely double click to bring up a selection window.
2. In the text field beneath the list box's XS CL Chain column, enter the name of the chain used to cut the cell file's sections. Again, you may choose the chain name from a list by double-clicking in the field.
3. To add Left and Right chains where applicable and designed, use the fields beneath the remaining two columns to enter names or access a selection list.

The program will edit each entry field as you exit it. If the cell file name is not found in the project’s Geopak, an error message will be sent and the appropriate selection window will be presented for you to choose an acceptable file or chain name.

When the edit fields are correctly filled out for the alignment you wish to add, click on the Add icon to enter it into the list box.

Deleting an Alignment from the Project

1. Select the alignment you wish to delete.
2. Click on the Delete button.

Modifying an Alignment

1. Double click on the alignment you wish to modify; its information will then appear in the edit boxes below the list box.
2. Make your desired changes; the program will let you know if a file or chain name is unacceptable.
3. When the edits are complete, click on the Modify icon to enter the changes in the list box.

Note: All changes made via this tab -- additions, deletions and modifications are made in the database -- as well as the list box.

At this point, only the Alignment Info and XS Grade Points tabs are enabled. The remaining two tabs are activated when the user selects an alignment from this tab's list box, or from the XS Grade Points tab's alignment drop-down, to be the current active alignment.
User Interface: XS Grade Pts Tab

When you activate the XS Grade Points Tab, the XS cell file for the current alignment selection is automatically opened. Changing the alignment selection via the tab’s Alignment drop-down will open the XS cell file associated with the newly selected alignment.

If no cross section grade-break points exist in the database for the alignment, the tab will appear as shown to the right.

Click on the “Generate” button to have the program extract all recognizable grade break points from the cross sections’ proposed finished ground, roadway and shoulder line elements.

Once the processing from the “Generate” is complete, the Station drop down will have been populated with the station numbers for which the program found Geopak XS cells on the alignment’s chain. The first such station will be fitted to the active view, and any proposed grade breaks at that section will be displayed in the tab’s list box and in the view. The Generate button’s caption will have been changed to “Regenerate…”.

When you select a station from the Station drop-down, the grade break points found for that cross section are displayed in the drop down:

The cross section for that station will be fitted to the active view and the grade breaks will be displayed as red circles. If you select a particular grade point from the list box, its circle will be shown in yellow.
Note that the list box shows each break point’s offset from the cross section’s centerline, its elevation, its plan view station and offset (this will be different from the XS station and offset for skewed and kinked pattern lines), and a “point type” designation.

The point type designation is determined by the type of line(s) the break point represents – roadway pavement (PS), shoulder pavement (SS), finished ground (FG), shoulder-finished ground (FS) or edge of pavement (EOP). The EOP and FS designations are determined programmatically (see page 16 for additional details). Given the vagaries of criteria (or manual drawing), the EOP and FS points cannot always be identified by the program. For example, in the foregoing graphic of the XS Grade Pts tab, at station 103+00 Region 1 there are two entries for XS CL offset -16.5288 and elevation 944.3424, one marked SS and one marked PS. This would typically be the EOP line, but, since the actual elements have an elevation difference of about 0.000041, the program does not recognize them as the same point as the code uses a difference tolerance of 0.000001.

Checking the drawing accuracy of adjacent elements’ start/end points

The above condition highlights a significant secondary use for the grade points take-off automation: checking cross section drawings for accuracy. For the example situation – gaps between the end/start points of what should be adjoining elements -- the user may go through all stations’ points listings, identify such anomalies, correct the drawings, and regenerate the alignment’s grade points. With the help of the highlighting capability (the selected grade break point’s circle turns yellow), one can also easily identify elements that should be adjacent whose start/end points are “crossed” or otherwise not accurately drawn.

One may also correct inexact adjacent elements’ break points by merely deleting or adding a break point by the methods described in the next few paragraphs. However, that will not correct the drawings, and, if one regenerates the alignment’s breakpoints, these types of fixes will be lost and the adds/deletes will have to be redone.

Adding a grade break point

1. Click on the “DP” button on the lower right of the tab. This enables you to dynamically pick the point you want to add to the section’s grade break points.
2. A magenta circle will be floating on the cursor as you move it over the active view. Select the point on the cross section at which you want to add a grade break point.
3. When you select the location for the new point, the information about that point will automatically populate the text boxes below the tab’s list box. These boxes can only be directly edited.
4. Click on the “Add” icon \[\] to include the new point in the database and the list box. After inclusion, the point will be selected in the list box, its circle will be highlighted, and the new point text boxes will be cleared.
Deleting a grade break point

(1) In the tab’s list box, select the break point you wish to delete.
(2) Click on the Delete button to remove the selected point from the database and the list box. The point’s circle will also be removed from the active view’s cross section display.

Changing the ordering of the cross section grade break points

The program orders a cross section’s grade break points from left to right and, for points with the same offset, by height, as well. In this latter case -- where there are vertical “steps” in some portion of the finished surface for the section -- the ordering may not always be correct. For instance, if the surface is stepping down to from left to right, the program will put the down point ahead of the point above it. The tab allows the user to re-order a station’s sections to his/her satisfaction via the up and down arrow icons at the lower right side of the list box:

(1) In the points list box, select the break point whose order you wish to change.
(2) To move the point up one position, click on the up arrow icon; to move it down one position, click on the down arrow icon.

The points’ ordering is “remembered” by the database. A regeneration of the points does overwrite the database, however, and user defined re-orderings will need to be redone.

User Interface: Plan View Strings Tab

The Plan View Strings tab is enabled once an alignment has been selected from either the Alignment Info tab or the XS Grade Pts tab.

When the tab is first activated, the program will draw all grade point breaks for the active alignment into the active view, provided that the active design file is recognized as a roadway basemap or pattern line file. One may select a plan view type basemap file from the tab’s drop down, as shown below, within which to work with the plan view grade break information.

If the selected file is different from the currently active dgn, the program will open that file and draw grade-break points for the active alignment in it. As with the cross-section view visualizations, the circles will be red and unfilled.

The purpose of this tab is to allow the user to create and edit plan view strings of grade point breaks. The list box on the left is used to create, modify and remove string names for the active alignment. The list box on the right is used to add, remove or reorder points for the string currently selected in the String Name list.

When the tab is activated, any strings associated with the active alignment will display in the String Name box.

When a string name is selected, the points associated with it, and lines connecting them according to their user defined order, are displayed in yellow in the active view.
Adding a string name to the active alignment

1. Type the name in the edit box below the string names list.
2. Click on the Add icon 📨. The program will check to see if the name already exists for the active alignment. If not, it will be added to the list box and the database.

Removing a string name from the active alignment

1. Select the name in the string names list box.
2. Click on the Remove icon 🗑️. The string name will be removed from the database and the list box. Any visualization for it will be removed from the active view. The association with any grade break points that comprised the string will be dissolved.

NOTE: removing a string does NOT remove its grade break points from the database, only the association between the points and the deleted string name. The only way points can be removed from the database is via the XS Grade Points tab.

Modifying a string name

1. In the string names list box, double click on the name you wish to change. It will be copied to the edit field below the box.
2. Make any desired changes in the edit field.
3. Click on the Modify icon to write the changes to the database and the list box.

Once a string name has been established, it is relatively easy to associate grade break points with it. The points may be added, deleted and ordered.

Associating a grade break point with a string

1. Make sure the active dgn file is a plan view file that the program recognizes as suitable for display of grade break plan view visualizations (i.e. one of the plan views from the tab’s drop down).
2. Select the string in the string names list box. Any points already associated with it will show in the tab’s points list box.
3. Click on the DP button to the right and below the points list box.
4. With your cursor, select the desired grade break point’s visualization from the active view. If the program finds more than one break point within the MicroStation tolerance setting from your data-point, it will provide a window from which you can select the specific desired point.
5. The information for the selected point is now shown in the edit fields below the point list box.
6. Click on the Add icon to add the point to the database and the list box. The visualization will also update; the ahead point will be highlighted in magenta and all connecting lines and existing points for the string will be in yellow.
To delete a point association from a string:

1. Select the string in the string names list box.
2. Select the point you wish to delete in the points list box.
3. Click on the remove icon. The point will be removed from the database and the list box and the string’s visualization will update accordingly.

Reordering the points associated with a string

The program initially orders a string’s points from low to high station, and, for points with the same station, from closest to farthest offset. Typically, this ordering should be sufficient for users’ needs. If, for some reason, however, it does not suffice, the up and down arrow keys allow the user to alter the ordering to his/her satisfaction.

1. In the points list box, select the point whose order you wish to change.
2. To move the point up (back) one position, click on the up arrow button. To move it down (ahead) one position, click on the down arrow button.
3. The string’s visualization will change dynamically with the movement of the point in the list box.
Checking proposed plan view and proposed cross section drawing correlation

Another secondary use for the program is seeing how well the cross section proposed elements line up with their plan view representations. Over the course of a project, manual changes to such plan view elements as radius returns and transitions may not be reflected correctly in the cross sections, especially if the cross section updates are performed manually rather than by criteria. The graphic on the next page shows, in plan view, the cross section break-points for a project whose radius returns were changed in the base map but not in the cross section drawings.

User Interface: Export Tab

The Export tab is used to output grade point information for the active alignment to various electronic formats which, in turn, may be used to further prepare data for use with automated grading.

The tab’s appearance varies according to the options selected. If one chooses to output the information transversely (i.e. grouped by cross section station), the tab will appear as shown on the left, below. If one opts to output data longitudinally (i.e. by string), the tab will appear as shown on the right, below.
Exporting data by cross section grouping

Under this option, all cross section break points for the given alignment may be exported to comma delimited, text or Excel file format. If secondary chains (left or right side baseline/centerline) have been defined for the alignment, one such may be used as the reference for the export rather than the cross section centerline chain. The user may also select the starting and ending stations for the output and limit the points included to one side or the other of the reference chain, as well, if he/she so chooses.

1. Select the chain from which to reference the outputted point information. Station and offset for the points will be relative to the selected chain.
2. Select the starting and ending station for the data output. The program will check to see if the ending station is greater than the starting station. If it is not, it will swap the two.
3. Determine if you want the points to the left, the right, or both sides of the reference chain.
4. Select the type of output format.
5. To check the output content, click on the Preview button. A viewer will appear with the export information, as shown on the next page.
6. To perform the export, press the Export button. You will be asked to select a directory and file name for the output.

![Data Export Preview](image-url)
Exporting data by string

This option sets up and performs the export for a single string, as defined in the Plan View Strings tab, of the alignment’s break point information. The user may select the string name and, for text, comma delimited or Excel format output, the reference chain. The user may also export the string’s data point information to a Geopak input file that will define a chain and profile for the string.

1. Select the chain from which to reference the string’s point information. NOTE: this option is not relevant to Geopak exports; its panel is disabled when the user “Geopak chain and profile input files” for the export format.

2. Select the name of the string for which to export point information.

3. Select the output format.

4. To check the output content, click on the Preview button. A viewer will appear with the export information. For text, comma delimited, and Excel output formats, the display will be similar to that shown for the preview of transverse output. For Geopak .inp file output, however, the content will be the Geopak Cogo commands that make up the files, as shown at right.

5. To create the export file, click on the Export button. You will be asked to select a directory and file name for the output.

NOTE 1: Before previewing or exporting Geopak .inp format exports, the program will ask the user for the point, chain and profile names to use in the export file. It will check the user’s name for compliance with allowed naming conventions and for duplication of existing Cogo element names. The user will be informed of any illegal character entries, etc., and asked to make the appropriate corrections. In the case of element duplication, the user is given the option of reentering the name or allowing an overwrite.

NOTE 2: Unlike the other line-string exports, the stationing for a Geopak chain and profile export does NOT follow that of the indicated reference chain. Instead, it indicates the true plan-view distance, starting from 0 (station 0+00), along the line-string.
CAVEATS

Prototype Version

The program in its current version is considered to be more of a prototype (an example of things we can do) rather than a final product. It was initially intended to develop algorithms for identifying, ordering and outputting cross section grade break information. The work went exceptionally well; it was therefore decided to “patch on” some very basic algorithms for arranging the points into strings in order to provide additional functionality in time for the first release. This “adding on” to what was intended to be an exploratory exercise has posed considerable program structure and coding issues that need to be addressed if and when further development is undertaken.

The coding/structure issues generally do not affect the user. However, it appears that closing a secondary form will, on occasion, close the entire application. To date, the problem is not always reproducible, and when it is, traces are indicating no errors. We are continuing to address the problem. In the meantime, please report any and all such incidents to ODOT C.O. CADD Team.

Cross Section Elements Recognized

The program currently extracts cross section break points from cross section elements on the levels for proposed pavement surface, proposed shoulder surface, proposed curb surface, proposed ditch bottom, proposed seeded shoulder, and proposed finished ground. This group is thought to be sufficient for the purposes at hand.

If you find that grade-break point generation fails to produce the desired “finished” line of points across a section due to elements that are ignored by the program, your short term fix is to add/delete/modify/reorder points as needed from the XS Grade Pts tab. The longer term fix is to notify C.O. CADD Team of the additional level(s) that you would like to see the program recognize. If and when a “fix” is undertaken depends upon whether or not the levels are used correctly in the first place and how likely it is that the situation will occur on other projects.

Point Types

The “point type” that the program provides for every stored break point has been provided against possible future use; it really does not have much bearing on the current version’s processing. Three main types are currently used:

- PS for roadway pavement surface
- SS for shoulder paved/treated surface
- FG for finished ground, curb surface, ditch bottom and seeded finished grade.

These “types” are assigned to new points when they are first identified. During processing, any two points with the same physical location in the cross section, but of different types, are investigated and re-typed, if possible, to one of the following:

- FS for the location where the shoulder surface (SS) meets finished ground (FG)
- EOP for where the edge of the roadway pavement (PV) meets the shoulder surface (SS) or finished ground (FG)

The algorithms that do the re-typing are neither very robust nor very well tested. Therefore, the user should not rely on the secondary type codes for spreadsheet sorting or other post-run processing.
Contacts
If you have any questions, suggestions, or problems please contact the ODOT Office of CADD and Mapping Services CADD Support team or use the following form on the ODOT web site at:

http://www.dot.state.oh.us/Divisions/Engineering/CADDMapping/CADD/Pages/suggestions.aspx

FUTURE DEVELOPMENT

Initial improvements to the software are expected to be the result of feedback from the initial users: problem corrections and enhancements that do not require major code or interface revisions. More complex issues, especially those that improve the functionality of the application’s products, will be addressed over time.

We do hope, eventually, to be able to further develop the break point string functionality by allowing the user to connect points with curve, arc or complex elements rather than simple line elements.

Unfortunately, the original code structure and form designs do need to be re-thought and probably extensively overhauled before any major enhancements are undertaken. The ODOT CADD section’s available resources and work priorities will determine if and when significant improvements to the program are implemented.
APPENDIX A: DATABASE TABLE STRUCTURES

### Project: Table

<table>
<thead>
<tr>
<th>Field Name</th>
<th>Data Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ODOT_Id_Coll</td>
<td>Autonumber</td>
<td>the project's unique ID number</td>
</tr>
<tr>
<td>Co_PID</td>
<td>Text</td>
<td>the project's county/ID directory path</td>
</tr>
<tr>
<td>Co_Rte_Mp</td>
<td>Text</td>
<td>the project's county/route/post</td>
</tr>
</tbody>
</table>

### Alignment: Table

<table>
<thead>
<tr>
<th>Field Name</th>
<th>Data Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aln_ID</td>
<td>Autonumber</td>
<td>unique ID number for an alignment</td>
</tr>
<tr>
<td>PRI_ID</td>
<td>Number</td>
<td>the unique project ID number for the project to which the alignment belongs</td>
</tr>
<tr>
<td>YS_Spk_Chain</td>
<td>Text</td>
<td>the alignment's geospat chain name</td>
</tr>
<tr>
<td>YS_Cell_File</td>
<td>Text</td>
<td>the alignment's microstation cross section cell file</td>
</tr>
<tr>
<td>YS_Spk_Charm</td>
<td>Text</td>
<td>the name of the alignment's left centered/baseline geospat chain, if one exists</td>
</tr>
<tr>
<td>RY_Spk_Charm</td>
<td>Text</td>
<td>the name of the alignment's right centered/baseline geospat chain, if one exists</td>
</tr>
</tbody>
</table>

### Cell: Table

<table>
<thead>
<tr>
<th>Field Name</th>
<th>Data Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cell_ID</td>
<td>Autonumber</td>
<td>The XS cell's unique ID number</td>
</tr>
<tr>
<td>Aln_ID</td>
<td>Number</td>
<td>the ID number of the alignment to which the cell belongs</td>
</tr>
<tr>
<td>Cell_Section</td>
<td>Text</td>
<td>the cells station on the XS centerline</td>
</tr>
<tr>
<td>Cell_Region</td>
<td>Text</td>
<td>the cells region on the XS centerline</td>
</tr>
<tr>
<td>Cell_Abs_Sta</td>
<td>Number</td>
<td>the cells 'distance along' the XS centerline</td>
</tr>
<tr>
<td>Cell_Origin_X</td>
<td>Number</td>
<td>x coordinate of the cell's origin</td>
</tr>
<tr>
<td>Cell_Origin_Y</td>
<td>Number</td>
<td>y coordinate of the cell's origin</td>
</tr>
<tr>
<td>Cell_Origin_Elev</td>
<td>Number</td>
<td>the elevation at the cell's origin</td>
</tr>
<tr>
<td>YS_Abs_Elev</td>
<td>Number</td>
<td>x coordinate of the cell's side origin</td>
</tr>
<tr>
<td>YS_Abs_Origin_Y</td>
<td>Number</td>
<td>y coordinate of the cell's side origin</td>
</tr>
<tr>
<td>YS_MAX_Y</td>
<td>Number</td>
<td>the largest Y value for the cell's vertical range</td>
</tr>
</tbody>
</table>

### Pattern: Table

<table>
<thead>
<tr>
<th>Field Name</th>
<th>Data Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pattern_ID</td>
<td>Autonumber</td>
<td>the unique ID number for one vertex of a pattern line</td>
</tr>
<tr>
<td>Cell_ID</td>
<td>Number</td>
<td>the ID number of the XS cell with which the pattern line is associated</td>
</tr>
<tr>
<td>Pat_Abs_Sta</td>
<td>Number</td>
<td>the absolute station of the vertex relative to the XS cell's geospat chain</td>
</tr>
<tr>
<td>Pat_V_Coord</td>
<td>Number</td>
<td>the X coordinate of the vertex on the XS cell</td>
</tr>
<tr>
<td>Pat_V_Coord</td>
<td>Number</td>
<td>the Y coordinate of the vertex on the XS cell</td>
</tr>
<tr>
<td>Pat_V_Coord</td>
<td>Number</td>
<td>the plan view X coordinate of the vertex</td>
</tr>
<tr>
<td>Pat_V_Coord</td>
<td>Number</td>
<td>the plan view Y coordinate of the vertex</td>
</tr>
</tbody>
</table>

### Grade_Point: Table

<table>
<thead>
<tr>
<th>Field Name</th>
<th>Data Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade_PID</td>
<td>Autonumber</td>
<td>the grade break point's unique identification number</td>
</tr>
<tr>
<td>Cell_ID</td>
<td>Number</td>
<td>the ID number of the point's XS cell</td>
</tr>
<tr>
<td>X_Coord</td>
<td>Number</td>
<td>the point's X coordinate in the XS cell</td>
</tr>
<tr>
<td>Y_Coord</td>
<td>Number</td>
<td>the point's Y coordinate in the XS cell</td>
</tr>
<tr>
<td>Plan_Abs_Sta</td>
<td>Number</td>
<td>the point's absolute station on the XS cell's geospat chain</td>
</tr>
<tr>
<td>Plan_Offset</td>
<td>Number</td>
<td>the offset of the point from the XS cell's geospat chain</td>
</tr>
<tr>
<td>Type</td>
<td>Text</td>
<td>the point's type</td>
</tr>
<tr>
<td>Sort_Order</td>
<td>Number</td>
<td>indicates the user-defined order of this point (for the XS pts tab list, etc.)</td>
</tr>
</tbody>
</table>

### String: Table

<table>
<thead>
<tr>
<th>Field Name</th>
<th>Data Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>String_ID</td>
<td>Autonumber</td>
<td>the string's unique identification number</td>
</tr>
<tr>
<td>Aln_ID</td>
<td>Number</td>
<td>the alignment to which the string belongs</td>
</tr>
<tr>
<td>String_Name</td>
<td>Text</td>
<td>the string's name</td>
</tr>
</tbody>
</table>

### String_Point: Table

<table>
<thead>
<tr>
<th>Field Name</th>
<th>Data Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>String_PID</td>
<td>Autonumber</td>
<td>the unique ID number of a point associated with a string</td>
</tr>
<tr>
<td>String_ID</td>
<td>Number</td>
<td>the string with which the point is associated</td>
</tr>
<tr>
<td>Grade_PID</td>
<td>Number</td>
<td>the ID of the point in the grade point table</td>
</tr>
</tbody>
</table>
| Sort_Order | Number | the order of the point, relative to other points, in string