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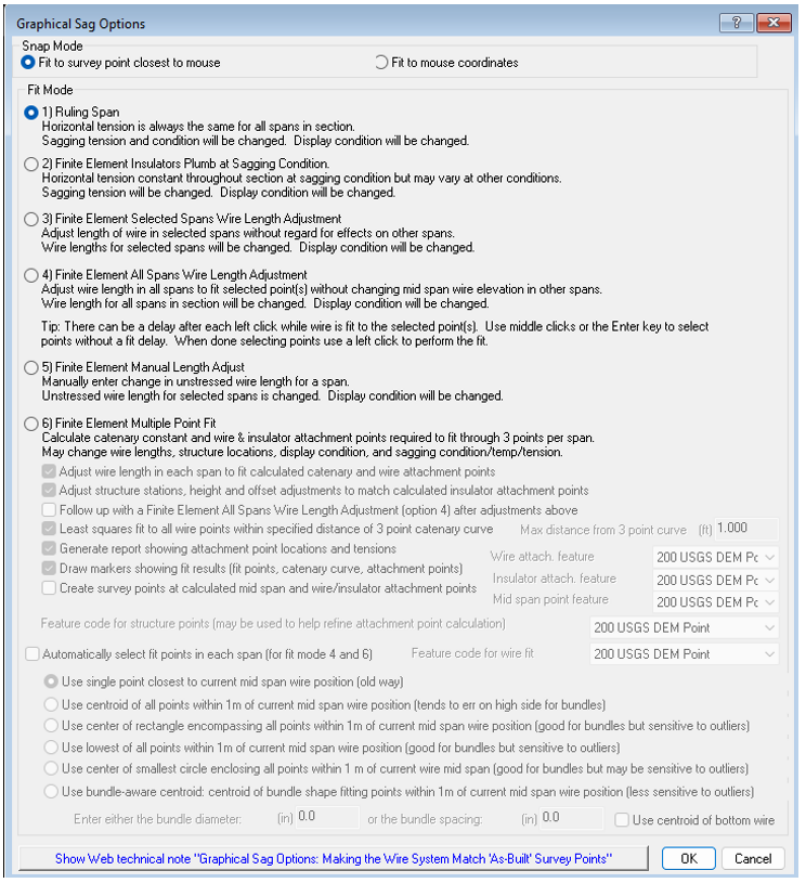
Graphical Sag Options: Making the Wire System Match "As-Built" Survey Points

Introduction

The PLS-CADD **Sections/Graphical Sag** command has several options to help you fit wire through survey points. It is most frequently used to make a PLS-CADD wire sag match surveyed wire points in an as-built, field condition. It can also be used as a design tool to determine what must be done to a line to meet certain clearance requirements. The various graphical sag options are discussed below.



For the Snap Mode settings; if you select *Fit to survey point closest to mouse* in the **Graphical Sag Options** box, you will be able to make the cable pass through the surveyed point closest to the mouse cursor. If you select *Fit to mouse coordinates*, you will be able to drag the selected cable with the mouse.

Figure 1: Graphical Sag Options

Fit Mode Options

1) Ruling Span

This mode operates under the ruling span assumption that for any given temperature, all spans within a tension section have the same horizontal component of tension. This assumption is generally considered acceptable provided the spans are fairly level, span lengths are fairly similar, the line was correctly strung, and nothing unusual has happened to the line that would cause unbalanced tensions (no structure/foundation movement, no changes to structures after construction, no cutting/splicing wire, etc....)

To sag in this mode, start by specifying the wire condition (**Initial/Creep/Load**) and weather case for the wire you've selected. Then click on a survey point in one of the spans of the wire you originally selected (either freehand or snapped based on your original selection as described in Figure 1 above) that the wire should pass through. PLS-CADD will determine the horizontal tension that is required to fit through the point and will sag all the spans within the tension section accordingly.

This mode can be used to match a surveyed sag or to determine the tension that would be required to have the wire clear the selected point. When using this mode to as-built a wire it is a good idea to check the fit in any other spans you have surveyed wire points in to make sure you have a good fit. If you do not get a good fit, you may have to consider one of the more advanced modes below. Getting a good approximate fit before making wire length adjustments is critical for getting accurate wire tensions (and sags). It is recommended to always use the Ruling Span method to obtain a close fit before considering one of the Finite Element methods when performing graphical sag operations on an existing wire.

2) Finite Element with Insulators Plumb at Sagging Condition (requires FE sag-tension plug-in)

In this mode the program assumes that all spans within the tension section had the same horizontal component of tension when the line was sagged. The program does not rely on ruling span approximations other than for determining the initial length of wire in each span. Once these lengths are known they are fed through a finite element sag-tension calculation to predict where the wire should be under other conditions. This method is capable of dealing with large variations in span length and severely inclined spans where the ruling span approximation may not work well. Like the ruling span method, this method is unable to handle changes in wire length or structure position that occurred after the line was sagged.

Sagging a wire using this mode is the same as for the ruling span mode except that you should first use **Section/Modify** to set the sagging temperature and wire condition to values where the insulators were plumb (constant horizontal component of tension). This method will not clip in wires or adjust wire lengths, but it will change the display wire condition to a Finite Element condition (**Initial/Creep/Load**).

3) Finite Element with Wire Length Adjustment in Selected Span (requires FE sag-tension plug-in)

In this mode, after you've set the wire condition and weather case, you click on a survey point and the program adjusts the length of the wire in the span crossing that point to fit. For this command, the wires will be clipped in and the wire length in each span will be determined prior to the length of wire adjustment in the selected span. This mode is most useful when you have a clearance problem in one span and want the computer to tell you how much wire to cut out to meet clearance. Please note that length changes in one span will impact sags and longitudinal loads throughout the tension section. Care must be taken when doing this to ensure that the structures can handle the induced loads. Prior to using this mode, it is recommended to get an approximate sag for your tension section using a ruling span method.

4) Finite Element with Wire Length Adjustments in All Spans (requires FE sag-tension plug-in)

This is the mode to use if you don't have a good fit after using one of the previous modes. Best results are obtained if you first use the ruling span method to get a close fit before using this finite element method. In this mode the program will adjust the length of wire in every span of the tension section to simultaneously fit through a selected point in each span.

When starting a graphical sag in this mode the program can automatically pick a default point in each span to fit through if the selection at the bottom of the dialog "Automatically select fit points in each span (for fit mode 4 and 6)" is selected. If that option is not selected, you will need to manually select the fit point for each span. If using the automatic option, the point the program selects is at the current mid span wire elevation (*this is why first getting a close fit with one of the earlier modes is a good idea*). Unless you change these automatically selected points, the program will in effect lock the spans at their current mid span elevations. You can change the selected point in each span by simply clicking on a different point.

The main advantage of this mode over the earlier ones is that it is completely immune to ruling span approximation errors, sloppy stringing technique or anything that may have happened after construction (structure movement, wire length changes, structure changes…). If you know where your structure to insulator attachment points are and know points along the wire, this mode will allow you to obtain a good fit.

5) Finite Element with Manual Length Adjustment (requires FE sag-tension plug-in)

In this mode, after selecting the wire condition and weather case, you click on a span and then key in how much wire you want to add or subtract from that span and its adjacent spans. Through trial and error, you can determine how much change in wire length is needed to obtain the desired clearance. It can be used to experiment with cutting out wire length or shifting slack from one span to an adjacent one (reclipping insulators) as solutions to clearance problems. As is the case with any adjustment in wire length, sags and tensions throughout the section are affected so you need to make sure the structural analysis is still sufficient.

6) Finite Element Multiple Point Fit (requires FE sag-tension plug-in)

This is the mode to use when the locations of your insulator attachment points (insulator to structure connection) are questionable. The other graphical sag modes assume the insulator attachment points are correct and will not produce good results if they are in error. This mode is different in that it can calculate where the insulator attachment points should be and can even move your structures to match these points.

The program searches for points of a designated feature code close to the currently displayed wire position. It will automatically pick three points in each span, one near the left end, one in the center and one near the right. It will then fit a catenary curve through these three points. There's an option to refine this catenary by doing a least squares curve fit through all points within a certain distance of this catenary. You could also choose to use the Method 4 graphical sag option after the Method 6 option is complete for an even closer fit. The least squares curve and Method 4 fit are both optional selections.

Once the program has the catenary curve in each span it can calculate the wire attachment points from the intersection of these curves and then from these it can determine the insulator attachment points. Options are provided for adjusting wire length to match the arc length along the catenary between wire attachment points and to adjust structure positions to get the attachment points in the right place. You can also choose to generate a report or draw markers to show the fit results. There are also options to create survey points at the calculated wire and insulator attachment points.