6.3   Alignment

The alignment (or alignments) of a project need to be defined before any engineering can be performed.   In the plan view, the alignments consist of straight line segments between PI points (Points of Inflection). If you start with an XYZ terrain model, the alignments are defined in the plan view by selecting the PI points (alignment corners in Fig. 6.3-1).   This is not required when using a PFL terrain model since the alignment is implied (however, the PFL model is limited to a single alignment).   All functions necessary to create or edit an alignment are available under the **Terrain/**

Fig. 6.3-1 Defining alignment

Alignment menu or by clicking on the appropriate buttons in the toolbar.

In this section we will illustrate many concepts with a simple 13 point XYZ terrain model named GRID. This example has the shape of a symmetrical pyramid as shown on the right portion of Fig. 6.3-2. It is provided in the file *Grid.xyz* included as one of the **PLS-CADD** examples. Points 1, 2, 3, 4, 6, 7, 8 and 9 are at the base of the pyramid and have an elevation of 100 ft. Point 5 is at the top with an elevation of 300 ft. Points 10, 11, 12, and 13 are at a 200 ft elevation.

6.3.1 Defining or editing alignments on terrain without existing line

The alignment functions operate somewhat differently depending on whether there is already a line on the terrain or not. In this section, we show how to create an alignment, or several alignments including branches and loops, when no line exists.

6.3.1.1   Defining or editing a single alignment

For example load the GRID terrain model. Because no alignment has yet been defined on the GRID terrain, the profile view is not yet available.   Therefore, the only window which includes useful information is the plan view which shows 13 points. Information about the terrain point closest to the mouse cursor can be seen in the lower status bar.

Our goal is to create a single alignment that starts at Point 1, goes straight to Point 8 and terminates at Point 6. We will eventually generate a centerline profile and four side profiles as shown in the left portion of Fig. 6.3-2. The process shown below is deliberately round-about to illustrate the main P.I. editing commands
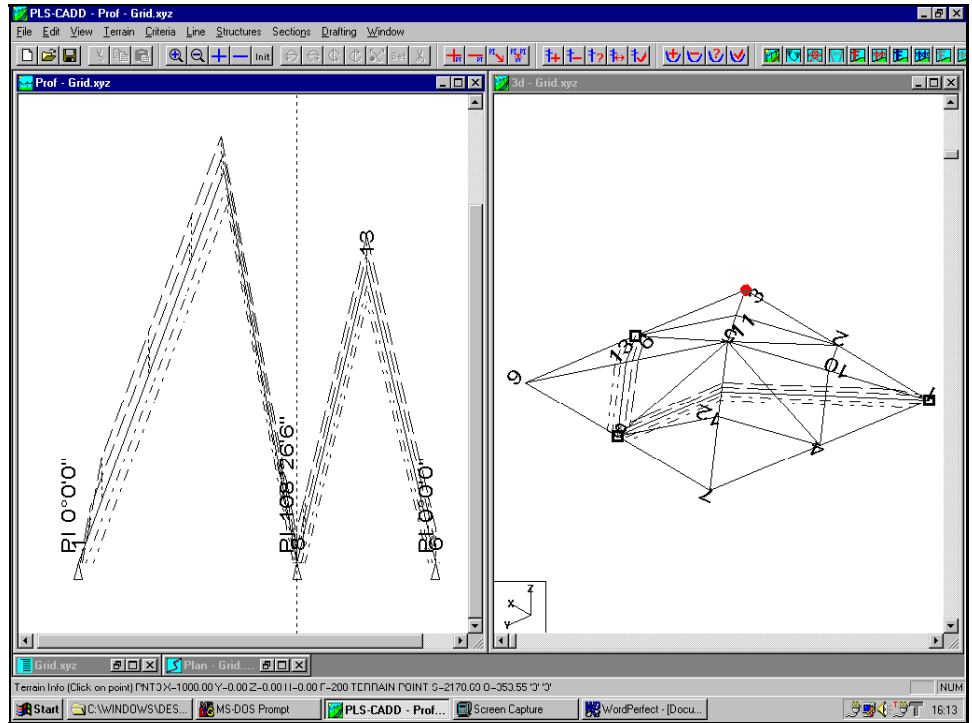

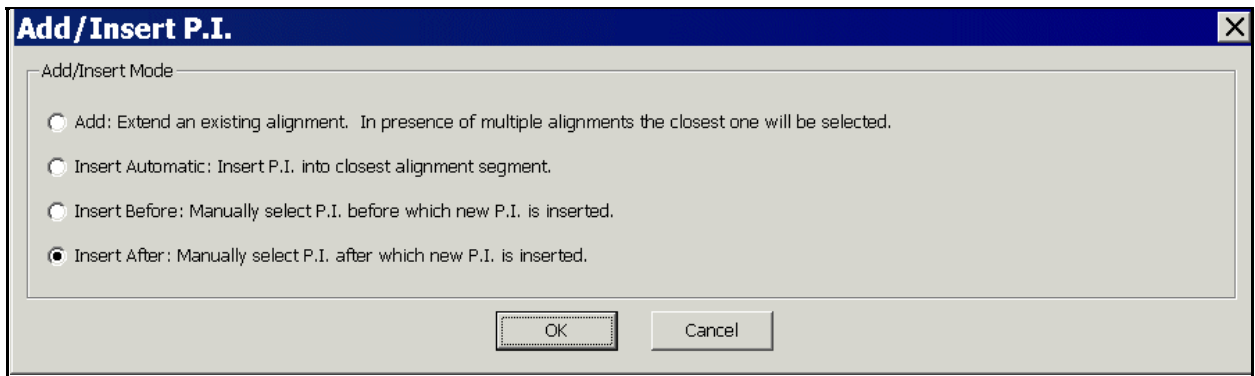**Fig. 6.3-2 Alignment 1-8-6 on GRID terrain model**

Fig. 6.3-3 Add P.I. dialog

First click on the **Add P.I.** button on the toolbar (the one with the red + sign) to start creating a new alignment. Then click on Points 1, 2, 5, and 6 until you see the GRID Aligment 1-2-5-6 of Fig. 6.3-4. Get out of the **Add P.I.** mode by clicking on the right mouse button. You now have a plan view of your entire corridor with five blue lines following the corridor. The outer pair of blue lines shows the *Maximum offset for profile view* and the inner pair shows the *Maximum offset for centerline ground profile.* Both widths are selected in the **Terrain/ Terrain widths** menu and are discussed in Section 6.3.2.

You can modify your corridor by moving, inserting or deleting alignment points. For example, click on the **Move P.I.** button, click and hold the mouse button on the third alignment point (Point 5) and drag it to Point 8. Get out of **Move P.I.** mode by right-clicking the mouse. Now click on the **Delete P.I.** button and click on Point 2 to get the alignment shown in Fig. 6.3-5. Click the right mouse button to get out of **Delete P.I.** mode.
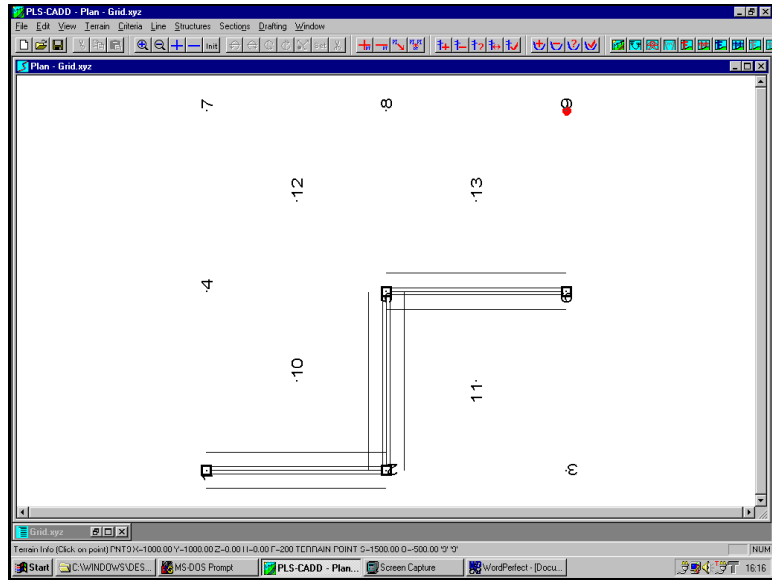

Fig. 6.3-4 GRID alignment 1-2-5-6

Now, click on the **Add P.I.** button again. Note that this time, the **Add P.I.** command brings up the **Add/ Insert P.I.** dialog box shown in Fig. 6.3-3. This is different from when we clicked on **Add P.I.** the first time because the existence of an alignment gives us some options we did not have before. You can try adding or inserting a P.I. with each of the options to see the behavior. You can undo the addition/ insertion by selecting **Edit/ Undo Terrain/ Alignment/ Add P.I.** Again, click the right mouse button to get out of **Insert P.I.** mode.
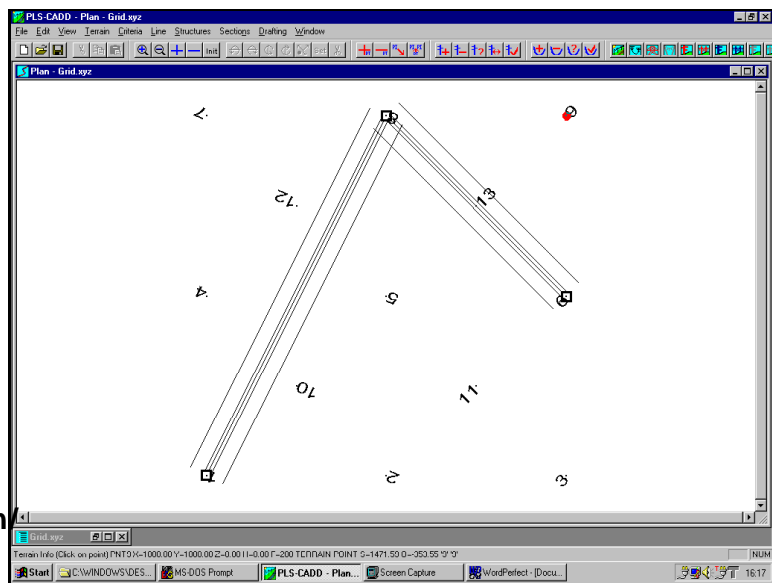

Fig. 6.3-5 GRID alignment 1-8-6

When you are done working with the GRID Example, make sure that you do not save it when you quit **PLS-CADD** as we will re-use the virgin terrain (without any alignment) again with the examples of Section 6.3.1.2.

As an alternate to the manual definition of an alignment using the alignment functions defined above, you can automatically create an alignment through points having specified feature codes with **Terrain/ Alignment/ Automatic Alignment**.

You can reverse the direction of your alignment, that is flip the corresponding **Profile** view left to right, with **Terrain/ Alignment/ Reverse Alignment**.

Whether you create an alignment manually or have one generated automatically through a list of surveyed points, you have the ability to remove PI's with small angle values with **Terrain/ Alignment/ Delete Small Angle PI**. You enter the maximum angle value and the maximum allowed distance for a structure to move.

6.3.1.2   Defining or editing additional alignments

Once you have at least one alignment defined, you can create: 1) other independent (unconnected) alignments, 2) alignment branches, or 3) alignment loops. These are discussed in the following examples. When you have multiple alignments you can build lines on all of them. These lines will be displayed simultaneously in the **3-D** views. Structures at the junctions of several lines will be loaded by all wires attached to them. Additionally, clearances can be measured between all wires regardless of the alignment they are on..

To create an independent alignment, branches or loops, click on the **New Alignment** button to take you to the **New Alignment** dialog box of Fig. 6.3-6.
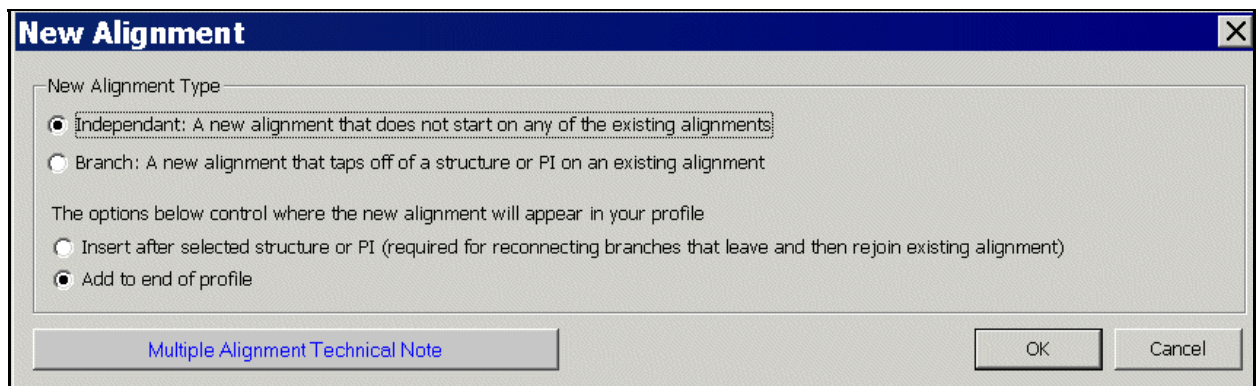

Fig. 6.3-6 New Alignment box

Independent Alignment:

For example, load again the GRID terrain model: make sure it is the original terrain model without any alignment on it. Create first the alignment 1-2-5-9 following the procedure described in Section 6.3.1.1. That alignment will be shown in the **Plan** window (see right of Fig. 6.3-7). Then click on the **New Alignment** button and select *Independent* and *Add to End of Profile* in the **New Alignment** dialog box. Clicking consecutively on points 4, 12 and 8 will create the additional independent alignment 4-12-8.

Once you have defined at least one alignment, you can open a **Profile** window with **Windows/ New Window/ Profile View**. You can center the profiles in that view by clicking on the **Init** button in the tool bar. You will be able to see both the **Profile** and the **Plan** windows as displayed in Fig. 6.3-7 with **Windows/ Tile Vertical**.

You will note in the **Profile** window that the profile of the original alignment (1-2-5-9) is shown first. After a short gap, it is followed by the profile of the second independent

Fig. 6.3-7 Unconneted alignments

alignment (4-12-8). The length of the gap between the two profiles is the *Station Gap to Insert Between Alignments* selected in the dialog box reached **with Terrain/ Alignment/ Multiple Alignment Options**.
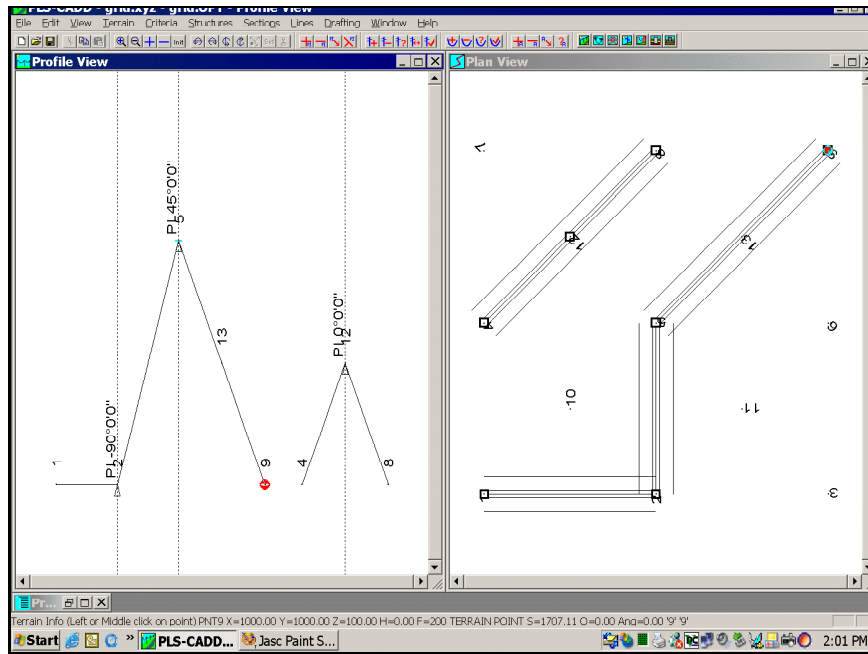
Open branch:

For this example, load again the GRID terrain model (without any alignment on it). Create first the main alignment 1-2-5-13-9 following the procedure described in Section 6.3.1.1 (make sure you click on Point 13 this time). That alignment will appear as shown in the **Plan** window at the right of Fig. 6.3-8. Then click on the **New Alignment** button and select *Branch* and *Add to End of Profile* in the **New Alignment** dialog box. Clicking consecutively on points 5 and 8 will create the additional
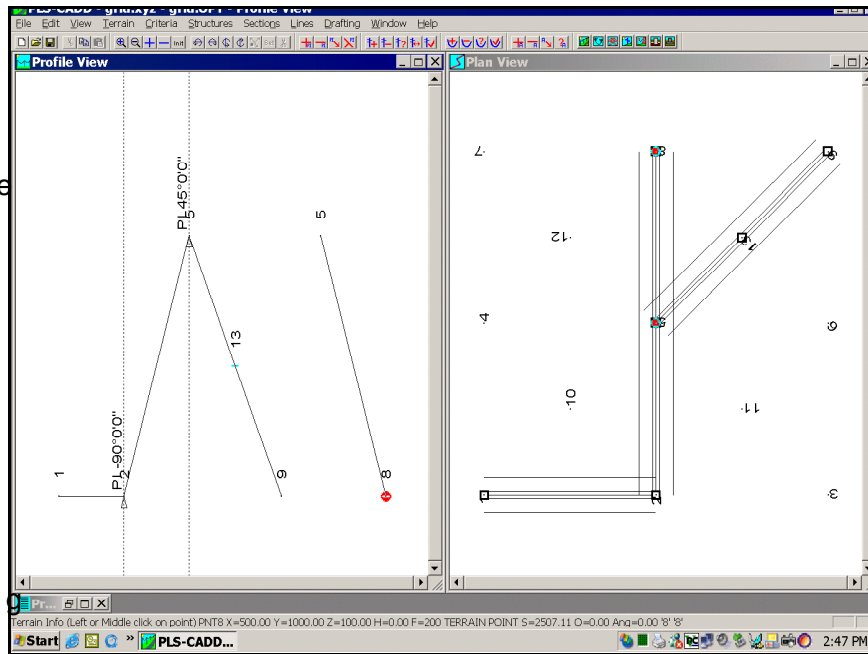
Fig. 6.3-8 Open branch

branch 5-8.

After you open a **Profile** window, you will note that the profile for the additional branch follows, after the specified gap, that of the original alignment because you had selected *Add to End of Profile* in the **New Alignment** dialog box.

Loop:

Now continue with the open branch example, click on the **Add P.I.** button, select *Insert After* in the **Add/ Insert P.I.** dialog box, click sequentially on Points 8 and 13, and **OK** snapping on the existing P.I. at Point 13. You have effectively closed the branch and made a loop out of it. This is shown in Fig. 6.3-9.

You will note that the Profile window in Fig. 6.3-9 is identical to that in Fig. 6.3-8, except that you have added one straight line segment 8-13 to the profile of the branch. Actually, the

Fig. 6.3-9 Making a loop out of branch in Fig. 6.3-8

profile continues in a straight line beyond Point 13. Profiles are always extended for some distance beyond the last alignment point if terrain points exist in that region.
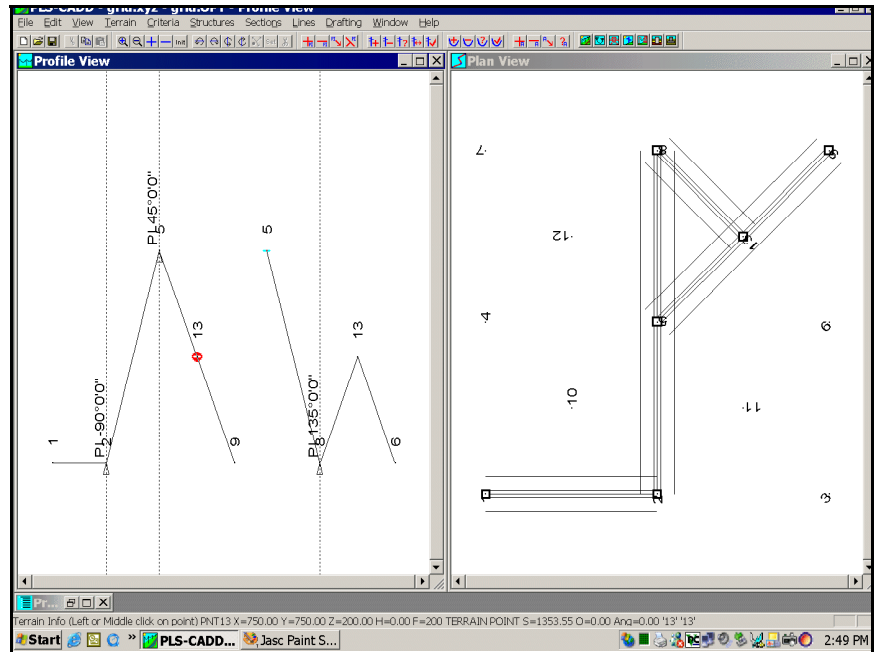
However, for reasons which will be explained later in this Section, creating a loop by closing an open branch at the end of the profile should be avoided as it may cause some stringing problems. Instead, the entire loop should be created from its departure point on an existing alignment to its reconnecting point using the procedure described in the following example.

Load again the GRID terrain model (making sure again that there is no alignment on it). Create first the main alignment 1-2-5-13-9 following the procedure described in Section 6.3.1.1 (make sure you also click on Point 13 this time). That alignment will appear as shown in the **Plan** window at the right of Fig. 6.3-10. Then click on the **New Alignment** button and select *Branch* and *Insert After Selected Structure or PI* in the **New Alignment** dialog box. Clicking consecutively on points 5, 8 and 13, and OK'ing snapping on the existing P.I. at Point 13 will create the loop 5-8-13. This is shown in Fig. 6.3-10.

If you compare the **Plan** windows in Figs. 6.3-9 and 6.3-10, they are identical. However, the **Profile** windows are quite different. In Fig. 6.3-9, the profile of Loop 5-8-13 is displayed entirely after the gap that follows the profile of the main alignment. In Fig. 6.3-10, the profile of Loop 5-8-13 taken over the position of the profile of the main alignment between Points 5 and 13, and the profile of the main alignment after Point 5 has been moved over to the end of the **Profile** window. This is because of one imperative rule

Fig. 6.3-10 Creating a complete loop

that you will need to observe for loops because of the way you will string cables to structures in the **Profile** window (stringing is discussed in Section 10.3).
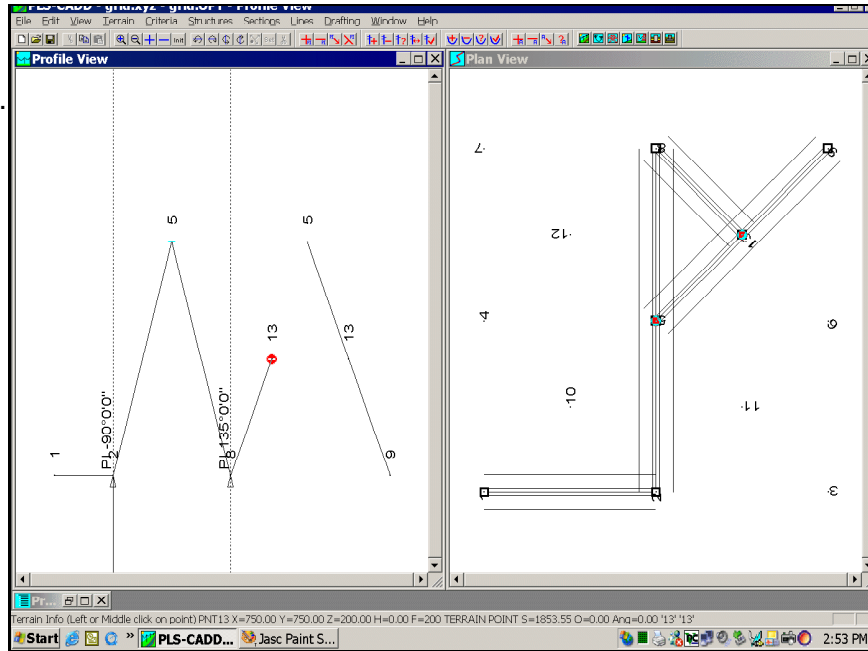
The rule is: when a loop rejoins an existing alignment at a particular P.I., the profiles of all the paths leading to that P.I. must be displayed before continuing with the display of any profile beyond the P.I. (remember that alignments are directional, i.e. they have stations that increase in the direction in which you have created them). For example, in Fig. 6.3-9, the profile of Segment 13-9 is displayed before the profile of the Loop 5-8-13, which is unacceptable and will cause stringing problems later on. However, in Fig. 6.3-10, the profile of Segment 13-9 is shown at the end of the Profile window following all branches leading to P.I. 13, which is necessary to avoid future stringing problems.

You will understand the need for the rule once you will have learned that structures are spotted in the **Profile** window and then cables are attached (strung) to the appropriate structures in that **Profile** window. You always string a tension section by starting at a dead end structure and then you move progressively to the right (you cannot move to the left) in the **Profile** window in search of intermediate supports, eventually terminating the stringing at another dead end structure. When you have a single alignment, the profile displayed in the **Profile** window is that of that alignment. When you have more than one alignment, the profiles of all created alignments are displayed in the **Profile** window as the profile of a single virtual alignment which is used for spotting and stringing structures. In Fig. 6.3-7, the virtual alignment is 1-2-5-9-gap-4-12-8 (the portion 9-4 is not real and is represented by a gap). In Fig. 6.3-8, the virtual alignment is 1-2-5-13-9-gap-5-8 (with a gap between points 9 and 5). In Fig. 6.3-9, the virtual alignment is 1-2-5-13-9-gap-5-8-13. Finally, in Fig. 6.3-10, the virtual alignment is 1-2-5-8-13-gap-5-13-9.

To summarize what we have learned about branches and loops, we will look at three more examples in Fig. 6.3-11. The squares (or pairs of squares) in the figure represent structures at the end of tension sections (dead ends) and the open circles represent intermediate structures (not dead ends). The numbers shown (ignore the numbers in parentheses at this time) are the internal structure numbers,

Fig. 6.3-11 Spotted structures on various alignments

numbers automatically assigned by **PLS-CADD** in the order in which the structures appear in the **Profile** window, i.e on the profile of the virtual alignment.
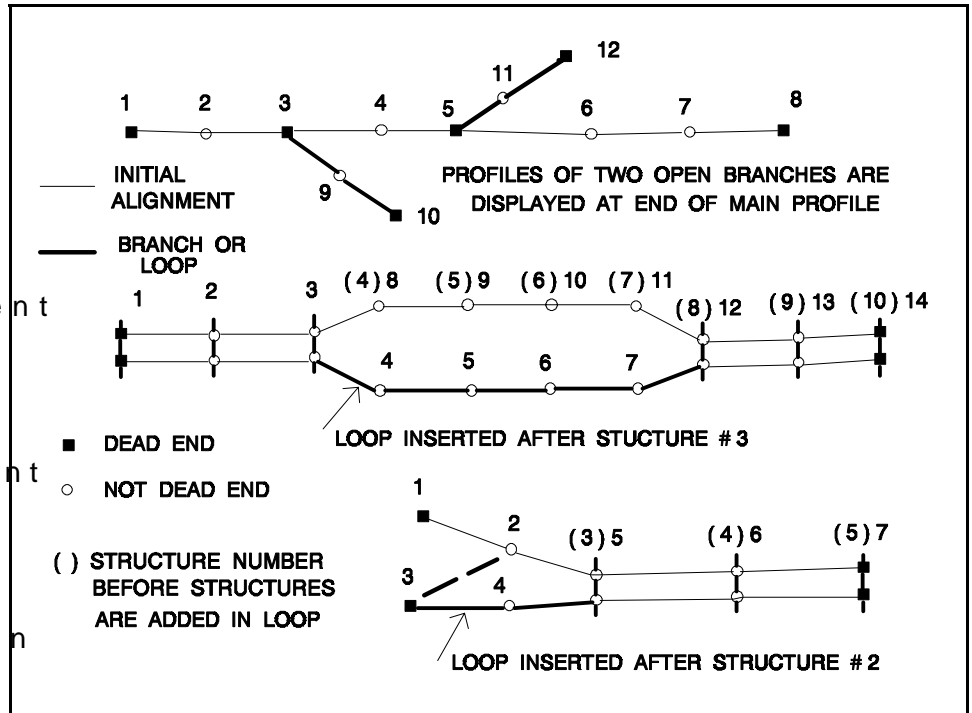
The sketch at the top of Fig. 6.3-11 represents a main line with two taps. The alignment of the main line was created first (initial alignment), and then two open branches were added (and displayed at the end of the main line profile) as was done with the example of Fig. 6.3-8.

The sketch in the middle of Fig. 6.3-11 represents a double circuit line with its cicruits split on separate alignments at Structure # 3 and then rejoined them again at Structure # 12 (in the following discussion we will use the notation # i to denote Structure # i). A main alignment was created first (following the top branch). In this example, ten structures (# ' s 1, 2, 3, (4), (5), (6), (7), (8), (9), and (10)) were first spotted on that main alignment before the bottom loop was added. Then the alignment for the bottom loop was created as was illustrated with the example of Fig. 6.3-10. This bottom loop was automatically inserted before the top branch in the virtual alignment. Therefore, as structures were added to the bottom loop, their numbering system started with the number 4. Each time one structure was added to that bottom loop, the internal number of the structures in the top branch and all the strucures to the end of the line were automatically incremented by one. Once all four structures were spotted in the bottom loop, the numbering scheme for all structures in the tension sections became those shown without parentheses in the figure. It was then possible to string each circuit separately. For example, the top circuit was strung from # 1, attaching at # 2 and #3 , passing over # 4 to # 7, attaching at # 8 to # 13 and ending at # 14. The bottom circuit was started at #1, attaching at # 2 to # 7, passing over # 8 to # 11, attaching at # 12 to 13 and ending at # 14. Note

that the sequence of structures which are attached or by-passed is complete and in ascending order.

The sketch in the bottom part of Fig. 6.3-11 represents a tension section in a main line initially defined along the alignment following # ' s 1, 2, (3), (4) and (5). A distribution tension section that starts on a different alignment somewhere to the left of # (3) and joins the main line as underbuild at # (3) needs to be strung. If the distribution circuit were dead-ended at # (3), then we could simply create an open branch to the left of # (3) and string one tension section along that branch through structures that would be numbered 6 and 7. Another tension section would be strung from # 3 to # (5). However, because the distribution is not dead ended at # (3), it is necessary to make the distribution branch part of a loop that starts somewhere before # (3). We arbitrarily started the loop at # 2 and closed it at # (3). As the two distribution structures # 3 and # 4 were added, the structures in the main line were renumbered 5 to 7 as shown. Then the distribution could be strung from # 3, attaching to # 4, #6, # 7 and ending at # 7.

6.3.2   Maximum offsets and center line profile

Values for the *Maximum Offset for Profile View (MOPV)* and the *Maximum Offset for Centerline Ground Profile (MOCGP)* are selected with **Terrain/ Terrain widths**.

All ground or obstacle points within the *MOPV* (measured from the center-line) are displayed with the appropriate symbols in the various profile views, whether on screen or on a sheet of paper. Points outside the *MOPV* are not displayed in the **Profile** views. In addition, any structure or wire with an offset greater than *MOPV* will not be shown in the profile view. Once you have an alignment defined on an XYZ terrain model, you can create an equivalent PFL model by using the **File/ Save as** command and specifying a *.pfl* extension that tells the program that model should be saved as a PFL file. If you create a PFL model this way, points that cannot be projected on the alignement will be lost. These points are located inside the angle formed by the two lines perpendicular to the alignment at a P.I. and on one side of the alignment. We generally do not recommend that you save an XYZ file with its alignment as a PFL file.

The center-line is defined in the plan view as the collection of straight line segments connecting alignment corners. The center-line ground profile is theoretically the intersection of vertical planes going through the center-line and the ground. However, because the terrain data are only defined at discrete points within the line corridor, there is a need for rules to define how the profile is displayed on the screen and on drawings. The ground profile line displayed by **PLS-CADD** is a line that joins all ground points within a specified offset from the center-line. That offset (*MOCGP*), is shown in Fig. 6-8 for two widths. The points are joined in ascending order of stations. For example, if one selects a *MOCGP* of 10 ft, then the profile line will pass through all the points within 10 ft of the center-line. If there is significant side slope (perpendicular to the line) the line profile may look jagged when it joins points of significantly different elevations on alternate sides of the center-line.