AutoCAD Civil 3D 2010
Education Curriculum Instructor Guide
Unit 3: Land Development

Lesson

4

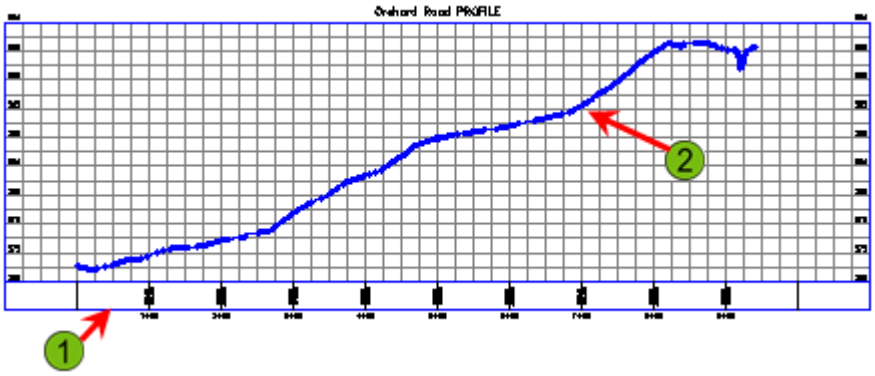
Profiles

Overview

In this lesson, students learn to create surface profiles and profile views. Surface profiles are created for alignments and typically show the nature of the existing terrain along the alignment. Profile views are the grid objects that show surface profile and other types of profile data.

Surface profiles are dynamic objects that automatically update if either the horizontal alignment geometry changes or the surface changes. This makes it very easy to adjust the horizontal alignment to best match the existing terrain.

A profile view with a surface profile is shown in the following illustration.



1. Profile view
2. Surface Profile

After the designer creates a surface profile, the next step in the road design process is to create a layout profile. The layout profile represents the design profiles and consists of tangents and vertical curves. You create layout profiles by using commands on the Profile Layout Tools toolbar. You can edit layout profiles graphically, using the table in Panorama, or by using profile creation tools on the Profile Layout Tools toolbar.

Objectives

After completing this lesson, students will be able to:

- Create a profile from a surface and create a profile view.
- Create a layout profile.
- Edit a layout profile using graphical and tabular methods.
- Label profiles and profile views.

Exercises

The following exercises are provided in a step by step format in this lesson:

1. Create a Surface Profile and a Profile View
2. Create a Layout Profile
3. Edit Profile Geometry
4. Label Profiles and Profile Views

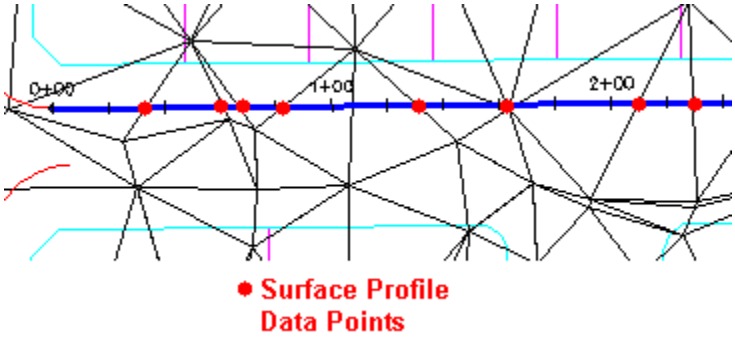
About Surface Profiles

Surface profiles are objects used to represent terrain data along a horizontal alignment. Surface profiles are displayed in profile views.

After you create an alignment, the next step in the road design process is to generate the surface profile. The surface profile helps the designer determine the layout of the design profile. In many instances, engineers strive to design road profiles to match the surface profiles as closely as possible to minimize the amount of earthwork on a project. Surface profiles are dynamic profiles and automatically update when you edit the alignment geometry or station data, or change the surface.

Data Points

Surface profile data points are generated wherever the alignment intersects a TIN line. The following illustration shows the locations where the data points are sampled when a surface profile is created for an edge of pavement alignment.

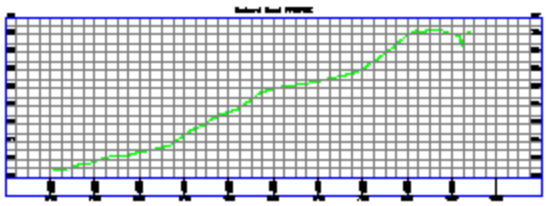


Profile Editor

Profile data is displayed in the Profile Editor. The surface profile data station and elevation pairs are shown in the following illustration. These are the locations where the alignment intersects a surface triangulation line.

3	0+82.98'	272.123'	-0.26%
4	1+07.34'	272.251'	0.53%
5	1+30.00'	272.896'	2.85%
6	1+58.17'	274.311'	5.02%

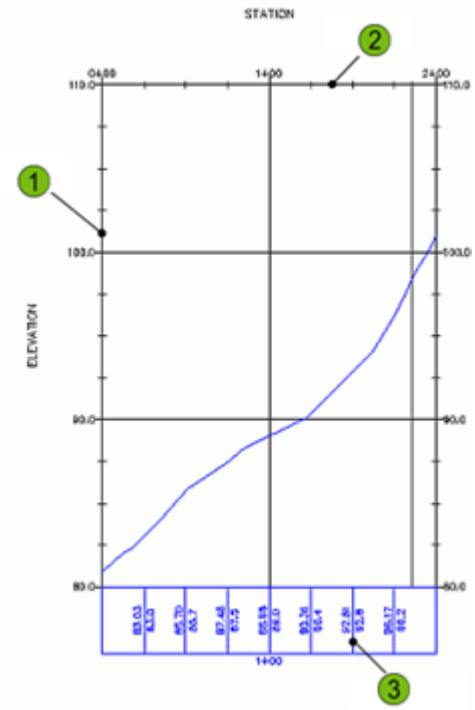
The following illustration shows a surface profile with an existing elevation change from west to east along the centerline of an alignment.



About Profile Views

A profile view is a graph that includes a grid, X and Y axes, and data bands that displays profile view data. The X axis represents horizontal distance along the selected horizontal alignment or

other linear feature. The Y axis represents elevations. You can configure data bands to contain annotations such as elevation data, stations, and cut/fill depths.



1. Y axis
2. X axis
3. Data bands

You control the appearance of a profile view using profile view styles. The profile view style also controls the following:

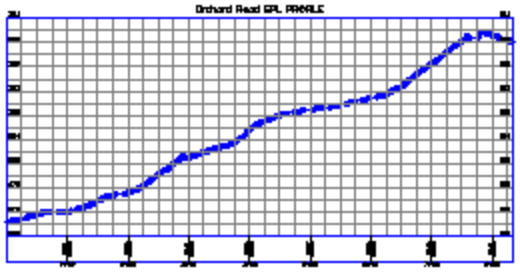
- Vertical exaggeration of the profile view object.
- Major and minor grid spacing.
- Axes labeling.
- Profile view title annotation.
- Colors, linetypes, and lineweights of profile view components.

You can customize the components and appearance of the graph. You can change the display elements of a profile view such as title format, axis annotation, and grid appearance. You can set the view to clip grid lines above the profile line or to hide grid lines.

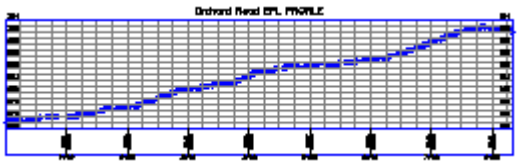
Examples

In the first illustration, notice that the surface profile is at a significant grade. The profile view style shows the profile data at a 10:1 vertical exaggeration. This may result in difficulties fitting the profile data in the profile portion of a plan and profile construction drawing.

For steep terrain, a 10:1 vertically exaggerated profile view does not show the entire profile within a paper space viewport. To address this issue, the designer creates and assigns a profile view style that reduces the vertical exaggeration to 5:1. The profile view with the new profile style assigned is shown in the second illustration.



Profile view with 10:1 vertical exaggeration



Profile view with 5:1 vertical exaggeration

Keep the following guidelines in mind when creating profiles:

- For surface profiles to be accurate, you must ensure that the surface is accurate. This means using breaklines and excluding points that do not represent the lay of the land from the surface.
- When you move the profile view, profile data in the profile view moves with the profile view.

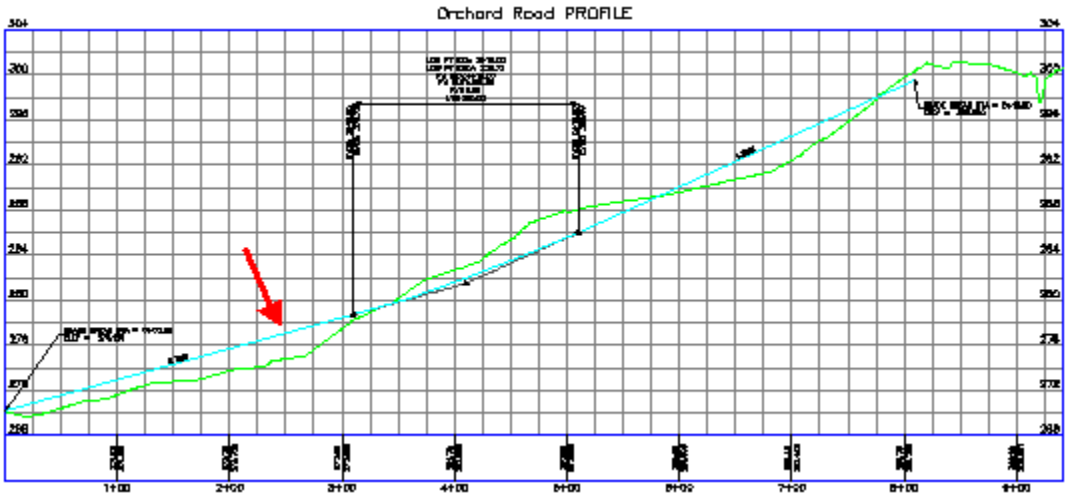
- If you change the vertical exaggeration of a profile view by assigning a new profile view style, profile data in the profile view updates accordingly.

About Layout Profiles

Layout profiles represent the finished vertical alignment that final road construction and grading is based on. The layout profile is also known as the vertical alignment or design profile and consists of tangents and vertical curves. After you create and display the surface profile in the profile view, you then create the layout profile, which represents the design of the vertical alignment for the road.

Unlike dynamic surface profiles, layout profiles are static and do not update with changes to the alignment. You can create layout profile geometry by converting existing AutoCAD® lines and splines. You can also create layout profiles by inputting stations, elevations, and vertical curve data in a tabular editor. There are a number of useful commands available on the Profile Layout Tools toolbar to help you create a layout profile.

The following illustration shows a layout profile in the profile view. The surface profile is also present in the profile view.



You define your layout by selecting points of vertical intersection (PVIs), which are connected using tangents either with or without curves. If you are drawing tangents with curves, you can choose standard curve settings to create an initial curve design. You can edit the curve values and other profile layout properties later to generate a more precise design.

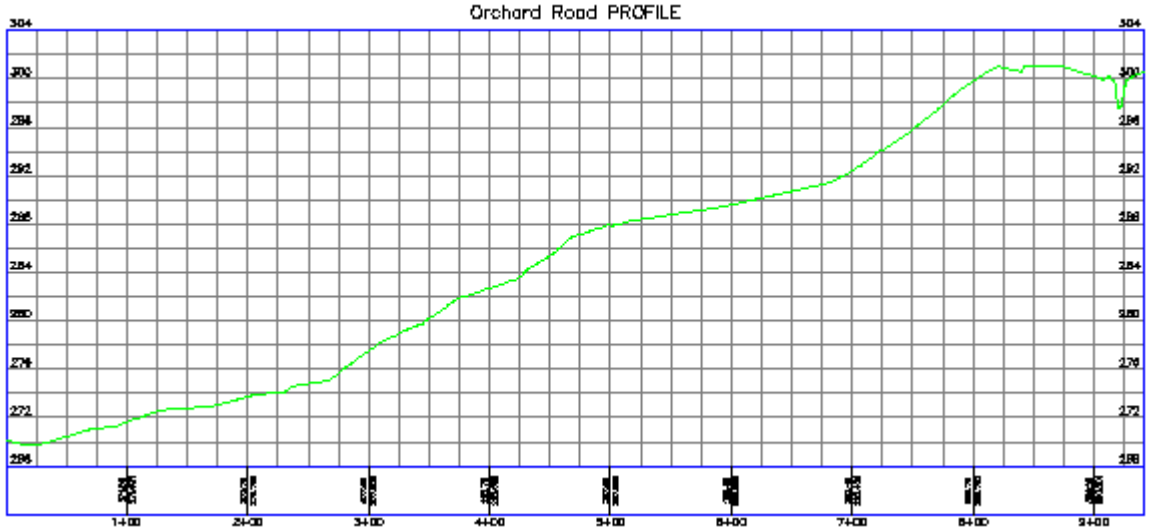
You can lock a PVI at a specific station and elevation so that it cannot be moved by edits to adjacent entities. This is often done in intersections, where a side road profile is locked to the

crown and edge of pavement elevations of the main road. If you unlock a dynamic PVI for one road in an intersection, you break the link to the profile of the other road.

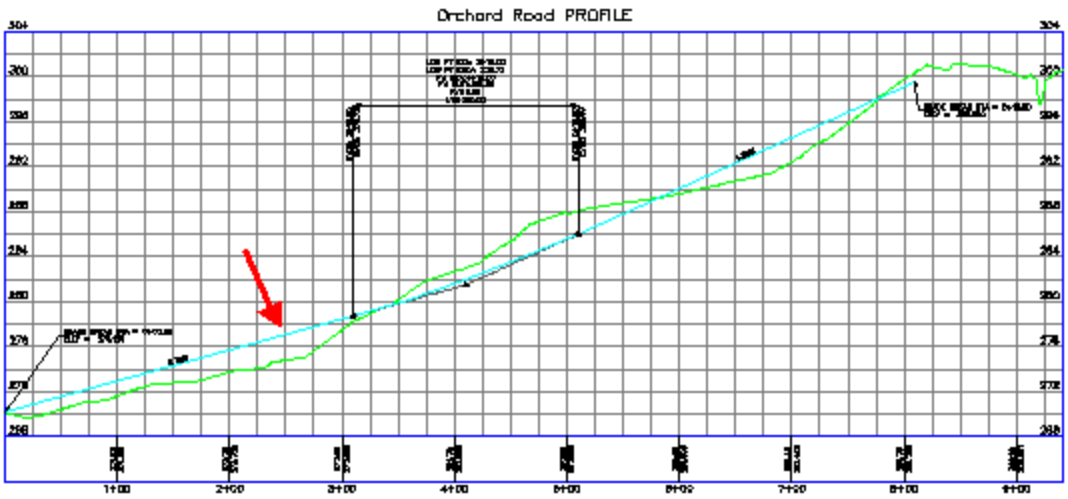
When you create a layout profile, you select a profile style and label set. You can later change the profile style and label set to suit the phase of the road design. For example, you may want fewer labels as you lay out the profile and more labels when you are preparing the design for construction documents.

In many instances, a designer needs to reproduce design profile data that already exists on a hard-copy plan. The hard-copy plan would show PVI stations, PVI elevations, vertical curve lengths, and tangent grades.

The following examples show a profile view and surface profile before and after the layout profile is created. The first illustration shows a profile view with a surface profile. When you create the layout profile, you can reference stations, elevations, and grades in the profile view using the commands on the Transparent Commands toolbar.



In this illustration, the layout profile is drawn in the profile view with PVIs and vertical curves. You can configure the profile to automatically place labels at standard points of reference as you create it.



Keep the following guidelines in mind when you create layout profiles:

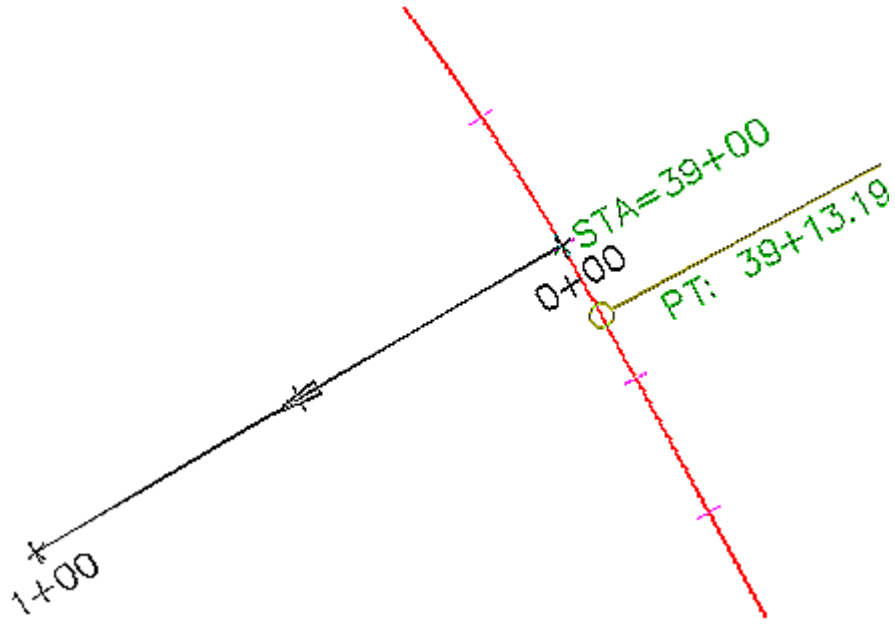
- Layout profiles are static, not dynamic; therefore, when you edit horizontal alignment geometry, you also need to edit the layout profile.
- Layout profiles must be created in the direction of increasing change.

About Transparent Commands

Transparent commands are designed to simplify drawing tasks. Transparent commands can be used to reference locations in both plan and profile views. You use the profile transparent commands to create profile geometry by referencing stations, elevations, and grades.

Transparent commands are commands that are issued from within another command. You can use transparent commands to locate objects based on known information. These locations are usually identified in the context of a larger operation, such as while drawing a line within a parcel. You can use transparent commands when creating any type of Civil 3D object such as points, parcels, profiles, or alignments.

For example, you can use the Profile Station Elevation Transparent command to create or move a PVI to a known station and elevation in a profile view.

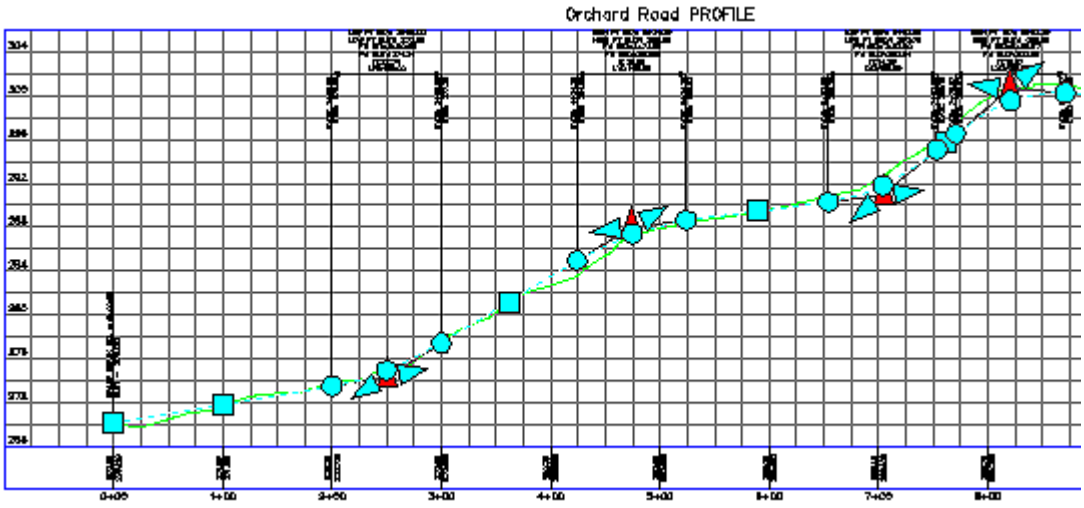


For more information, see "Civil Transparent Commands" in Help.

Editing Profile Geometry

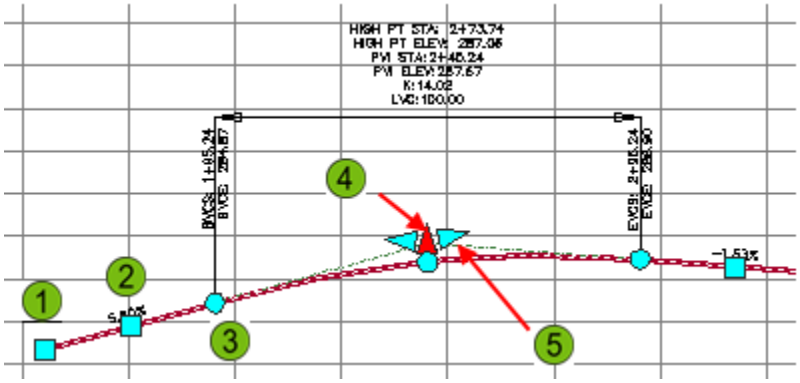
You edit a layout profile graphically using tools such as grips and transparent commands. You can also make more precise edits to the layout profile geometry by changing data in a table such as grades, elevations, stations, and vertical curve design parameters.

The following illustration shows the grips that are displayed on a layout profile when you select it. You use the grips to move PVIs, move PVIs and maintain the entering or existing grade, change tangent locations, and change vertical curve lengths. When you move a PVI or tangent locations, connected vertical curves maintain their tangency.



You use grips to graphically edit a layout profile. When you edit a layout profile with grips, you are editing the profile object; therefore, any associated annotation and tabular data automatically updates. You click the layout profile to show the graphical editing grips.

Grips are displayed in the following illustration.



1 Square grip at profile beginning and end tangents: change tangent grade.

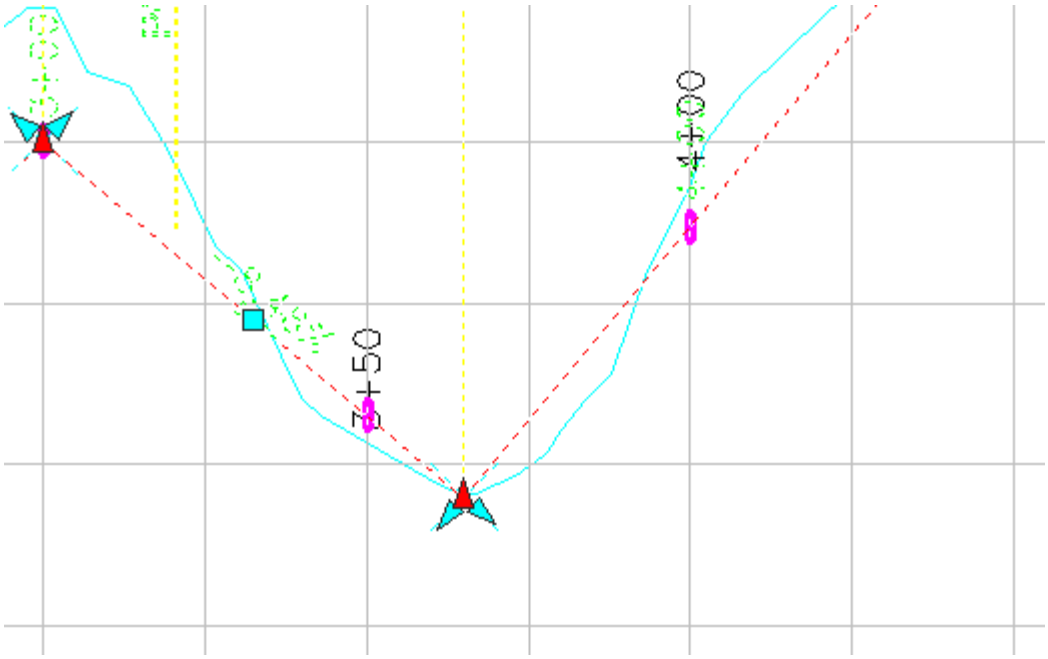
2 Square grip at tangent midpoints: move tangent and maintain grade.

3 Circular grips on vertical curves: resize vertical curves.

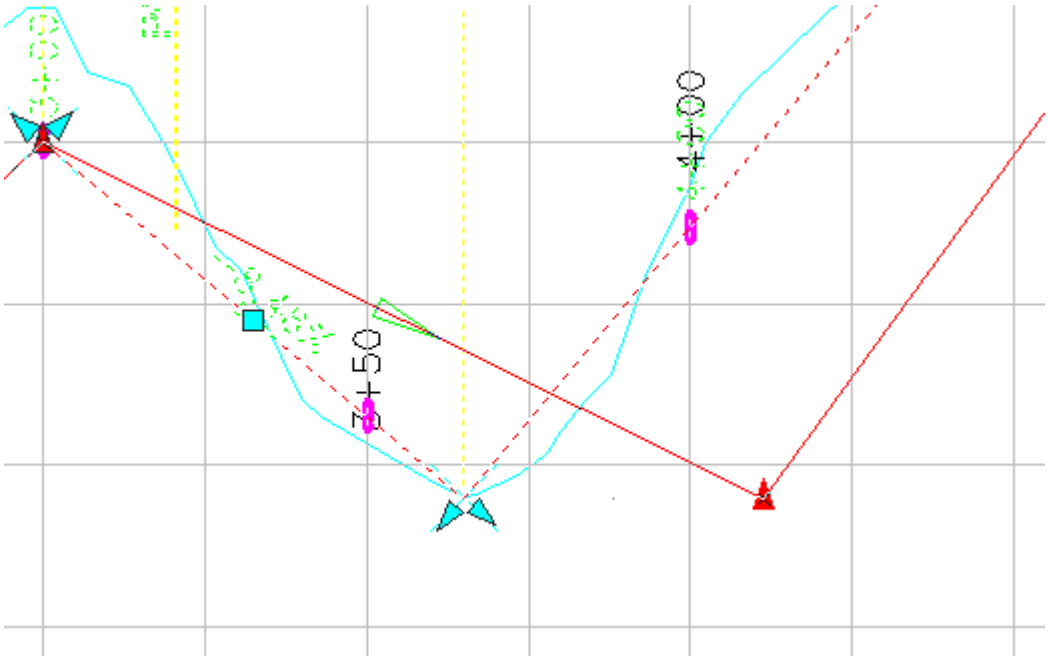
4 Red triangle grip on PVI: move the PVI.

5 Cyan triangle grips on PVI: move PVI and maintain grade of either incoming or outgoing tangent.

The following illustrations show you how to use grips to change the location of a PVI. Click a grip to make it active, as shown in the following illustration.



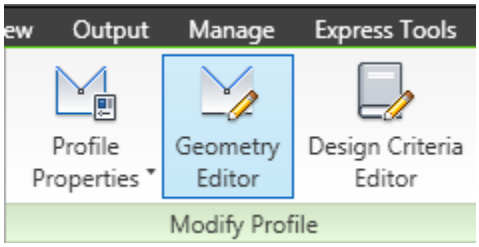
When the grip is active, you can move it to a new location, as shown. You can also select a new location more precisely using Object Snap or Profile Transparent commands.



You can also edit a layout profile by using commands on the Profile Layout Tools toolbar. In the drawing area, select the layout profile, right-click, and click Edit Profile Geometry to show

the Profile Layout Tools toolbar. You have a number of layout profile editing tools on this toolbar. You can use any of the tangent and vertical curve commands to add profile entities. You can also use the Delete Entity button to remove profile entities. When you edit a profile with commands on the Profile Layout Tools toolbar, the graphical display of the profile and associated annotation automatically update.

From the Profile Layout Tools toolbar, you can also access the Panorama window to edit layout profile data in a table. You can view data in the table as either PVI-based or entity-based. The Profile Geometry Editor command is available on the ribbon when the layout profile is selected. This is shown in the following illustration.



Keep the following guidelines in mind when editing profile layouts:

- Layout profile grips work exactly the same as grips on all AutoCAD entities. Graphically editing a profile with grips is a three-step process:
    - First click: select the layout profile.
    - Second click: select the grip.
    - Third click: reposition the grip.
- You can use transparent commands to help you graphically edit the profile.
- Use the Tabular Editor in the Panorama window to round profile tangent grades, vertical curve lengths, and vertical curve K values.

Labeling Profiles and Profile Views

Much of the labeling on a profile view is generated directly from the profile view style. The profile view style displays labeling on both axes and on the profile view title. You can also add station/elevation and depth labels to the profile view as an independent operation.

You label surface profile data after the surface profile has been created. Layout profiles are labeled when the profile is created, or after the profile has been created. When you create a layout profile, you can automatically label it using label styles. Profile label styles can be configured to mark any of the following standard points along the profile:

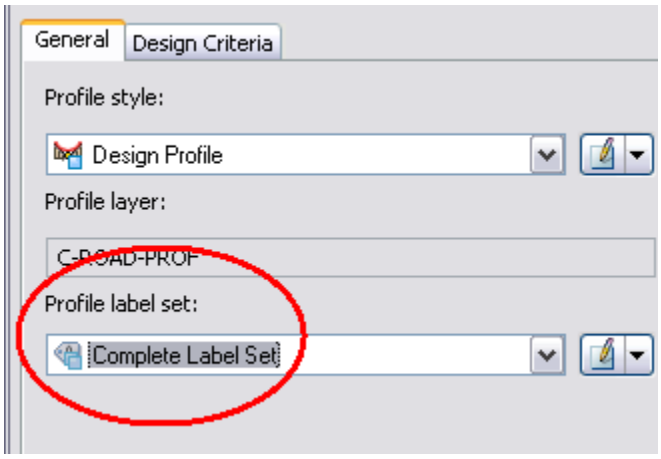
- Major and minor stations of the parent horizontal alignment
- Horizontal geometry points
- Grade breaklines
- Sag curves
- Crest curves

Definition of Label Sets

Profile label sets are the collection of individual profile label types. On the Settings tab of the Toolspace window, you can find the profile label sets by expanding the Profile, Label Styles, and Label Sets trees. You combine vertical curve, tangent, grade break, station, and horizontal alignment geometry labels in a label set. When you create a layout profile, you can apply the label set to the profile. The label set can also be applied to the profile afterward.

Individual label types can be applied to a layout profile. Alternatively, if the layout profile has already been created, you can add profile labels. A common method is to combine individual label types into a label set and apply the label set to the layout profile. This enables you to standardize on collections of labels that you would regularly apply to profiles.

When you create a layout profile, you select a label set to apply to the profile, as shown in the following illustration.



Editing Profile Labels

You can change the position of the profile labels after they are created. You either edit the position of the labels graphically using grips, or you edit the position of the profile labels in a table. The latter option displays a dialog box similar to the Profile Label Set dialog box, where you change the Dimension Anchor option and Dimension Anchor value in a table.

You can use the following Dimension Anchor options:

- Distance Above and Below PVI
- Fixed (Absolute) Elevation
- Distance Relative to the Profile View Top and Profile View Bottom

When you use grips to modify the position of the labels, drag the labels to their new locations. The Label Dimension Anchor grip enables you to move the entire vertical curve up and down. The square grip is used to move the profile label so that it adopts its dragged state display property.

Keep the following guidelines in mind when creating profile labels and label sets.

- You can create a profile label set called None, which can be applied to a layout profile when you first create it. This action makes it easier to visualize your design geometry.
- Profile styles and label styles should be created and stored in your drawing template. All new drawings created with the drawing template carry the styles forward.
- You can set the default profile view, and profile styles and label styles, by modifying the command settings.

Profile View Labels

The profile view style accounts for much of the labeling on a profile view. With the profile view style, you can label the horizontal axes, the vertical axes, and the title. Once you change a profile view style, all profiles view that reference that style automatically update to reflect the new display parameters. Use the Display tab on the Profile View Style dialog box to determine which labeling components of the profile view are displayed, as shown in the following illustration.

Component Type	Visible	Layer
Graph Title		C-ROAD-PROF-TITL
Left Axis		C-ROAD-PROF-TTLB
Left Axis Title		C-ROAD-PROF-TITL
Left Axis Annotation Major		C-ROAD-PROF-TEXT
Left Axis Annotation Minor		C-ROAD-PROF-TEXT
Left Axis Ticks Major		C-ROAD-PROF-TEXT
Left Axis Ticks Minor		C-ROAD-PROF-TEXT
Right Axis		C-ROAD-PROF-TTLB
Right Axis Title		C-ROAD-PROF-TITL

Data bands refer to the information displayed above or below the profile view. Data bands can show many different types of data including profile, alignment, pipe network, and superelevation. A band set is a collection of label style settings for a profile view, specifically for the band of labels marking the x axis.

Key Terms

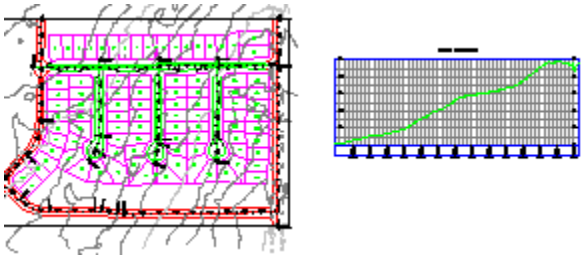
Existing Profile	An existing profile is the intersection of a horizontal alignment and an existing surface. It is a perpendicular view of the terrain surface sliced along the alignment. In Civil 3D, the existing profile is referred to as a surface profile.
Design Profile	A design profile is the finished vertical alignment that contains the final vertical tangents and vertical curves for the road. The designer creates the vertical tangents and vertical curves in accordance with standard design criteria for sight and stopping distance and slope. In Civil 3D, the design profile is referred to as the layout profile.
Surface Profile	Also known as an existing ground profile. Surface profiles are dynamic and react to changes made to the horizontal alignment and the surface.
Layout Profile	Also known as a design profile. Layout profiles represent the finished design and are nonreactive, or static.
Profile View	The profile view is the grid object, or plot, that contains the profile data. Surface profiles and layout profiles are displayed in a profile view.
Tangent	For a profile, a tangent is a straight section of roadway that has a constant slope, or grade. A positive tangent moves upward while a negative tangent moves downward.
Vertical Curve	A vertical curve connects to tangents. A vertical curve with an incoming tangent grade greater than the outgoing tangent grade is called a *crest*. A vertical curve with an incoming tangent grade less than the outgoing tangent grade is called a *sag*. Vertical curves are most often represented with parabolas.
Station	Stationing is a form of linear referencing of distance along an alignment. A station is a value of distance from the start point added to the starting station value. The base value for imperial stationing is 100 feet, designated as 1+00. The base value for metric stationing is 1000 meters, designated 1+000.
Station Elevation	Along a profile, station elevation is a method for identifying the location of a point based on the alignment station and the elevation.

PVI	Point of Vertical Intersection is the intersection point of two profile tangents, typically marking the center of a symmetrical parabolic vertical curve.
BVC	Beginning of a Vertical Curve is the transition point from a constant grade line (tangent) to a vertical curve.
EVC	End of a Vertical Curve is the transition point from a vertical curve to a constant grade line (tangent).
Label Sets	A label set is a collection of profile label styles for a profile. When you create a profile, you apply a label set as opposed to selecting individual label styles.
Band Sets	A band set is a collection of label style settings for a profile view, specifically for the band of labels marking the x axis.

Exercise 1: Create a Surface Profile and a Profile View

In this exercise, students create a surface profile using an alignment and an existing surface. Students also create a profile view.

The completed drawing is as shown.



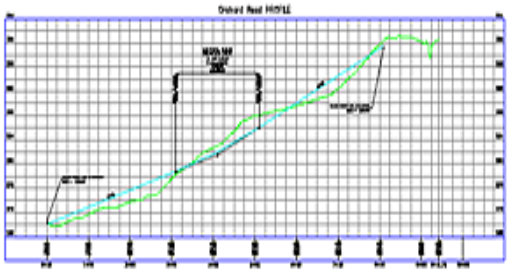
For this exercise, open …*I_Profiles-EX1.dwg (M_Profiles-EX1.dwg).*

First, students display the existing ground surface as contours.

Exercise 2: Create a Layout Profile

In this exercise, students create a layout profile.

The completed drawing is as shown.

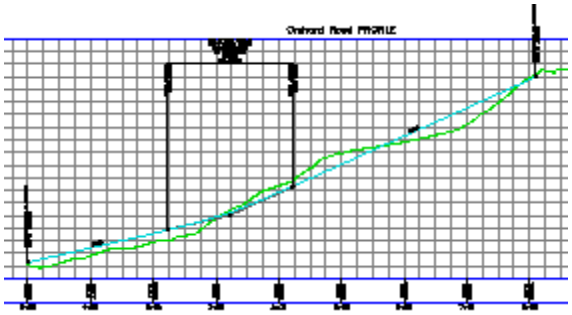


For this exercise, open …*I_Profiles-EX2.dwg (M_Profiles-EX2.dwg).*

Exercise 3: Edit Profile Geometry

In this exercise, students edit a layout profile using graphical and tabular methods.

The completed drawing is as shown.

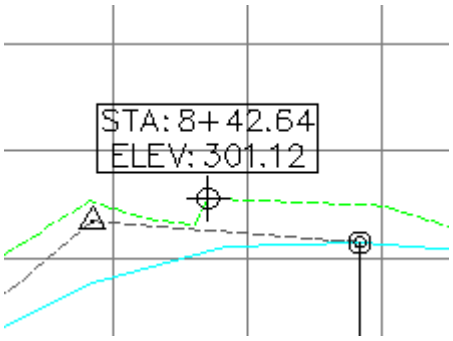


For this exercise, open …*I_Profiles-EX3.dwg (M_Profiles-EX3.dwg).*

Exercise 4: Label Profiles and Profile Views

In this exercise, students add labels to profiles and profile views. Students also modify label styles for both objects.

The completed drawing is as shown.



For this exercise, open …*I_Profiles-EX4.dwg (M_Profiles-EX4.dwg).*

Assessment

Challenge Exercise

Instructors provide a master or challenge exercise for students to do based on this lesson.

Questions

1. What is the difference between an existing profile and a design profile?
2. If the design profile needs to be raised by 0.5 feet (0.2 m) along its entire length, what method should you use?
3. Which grip should you use to move a PVI laterally, along the incoming tangent grade?
4. How do you change the color of the design profile line?
5. Are the grid lines part of the profile style or the profile view style?
6. What is a band set?

Answers

1. An existing profile is the current elevation of the terrain along the alignment. A design profile is the proposed road finished surface using tangents of constant grade connected by vertical curves. Differences in grade between the existing and design profile represent areas of cut or fill.
2. In the Profile Layout Tools toolbar, use the Raise/Lower PVI button to enter the elevation change.
3. Use the arrowhead grip to the left of the PVI arrowhead grip. Click the grip and move the PVI to the left along the incoming tangent grade.
4. Click the profile, right-click, and click Edit Profile Style. On the Display tab, click the Color property for the line component and change the color in the Select Color dialog box.
5. The grid lines are part of the profile view style.
6. A band set is a collection of label style settings for a profile view, specifically for the band of labels marking the x axis.

Lesson Summary

In this module, students learned how to work with profiles and profile views. First, an existing profile was created using the existing surface and an alignment. A profile view was created in the drawing area. The Layout tools were used to add a layout profile to the profile view. Several methods were used to edit the design profile, including profile grips, the Grid View Panorama window, and powerful tools on the Layout toolbar. Finally, the profiles and profile view labels were added and modified using styles, label sets, and band sets.