AutoCAD Civil 3D 2010

Education Curriculum Instructor Guide, Unit Overview

Unit 5: Transportation Design

Unit 5 – Transportation Design

Unit 5 addresses corridor design as it applies to transportation engineering projects. Transportation corridors are usually more involved, and more complex than corridors used for subdivision and other types of corridor designs. Transportation design projects typically involve road reconstruction, interchanges, intersection improvements and sometimes involved new roads and highways. Features typical of these types of projects are daylighting, varying lane widths for acceleration and deceleration lanes, overlay and milling and superelevation. There is a wide range of functionality in AutoCAD Civil 3D that can be applied to transportation corridor projects.

The lessons contained in Unit 5 include the following:

- Lesson 1 – Roadway Alignments
- Lesson 2 – Roadway Profiles
- Lesson 3 – Assemblies and Corridors
- Lesson 4 – Cross Sections and Quantities
- Lesson 5 – Plan Production

Lesson 1 introduces the student to creating and editing roadway alignments for transportation projects. Commands on the alignment layout tools toolbar are used to create alignments using tangents, curves and spirals. In Lesson 2 both surface and layout profiles are discussed. Lesson 3 addresses the creation of assemblies and corridor models for transportation projects. In Lesson 4, students learn how to create sample lines, generate cross sections and calculate quantities. Finally, in Lesson 5, students learn how to create plan and profiles sheets using the plan production tools available in AutoCAD Civil 3D.

A detailed summary of the lessons in Unit 5 follows:

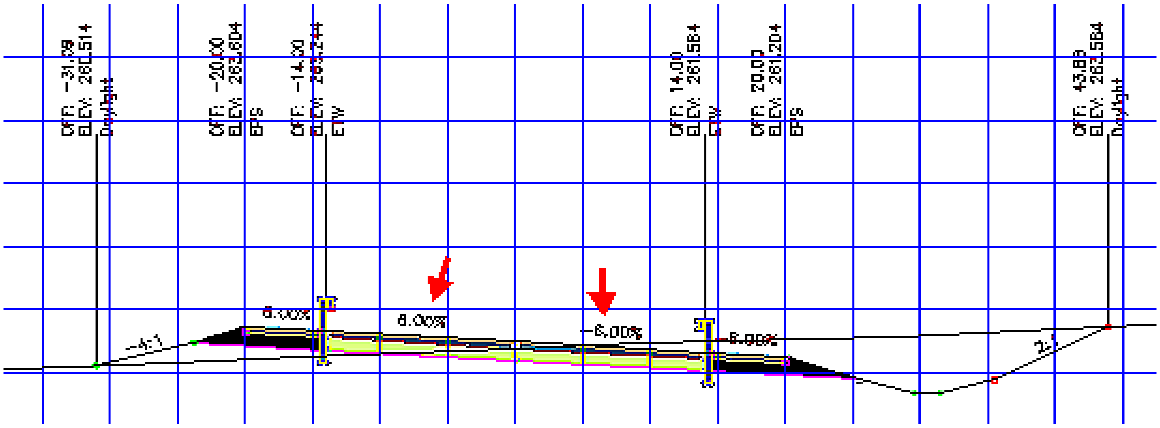
Lesson 1 – Roadway Alignments

In this lesson, students learn how to work with alignments specifically intended for transportation projects. These are typically more advanced designs than those used for subdivision design. Alignments are frequently criteria-based and may include superelevation and offset alignments.

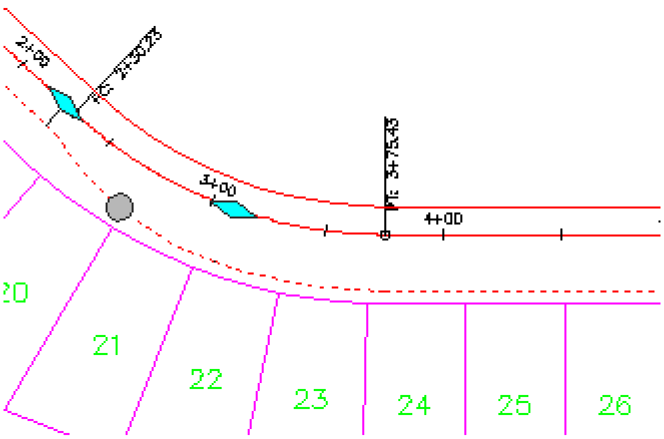
When engineers plan and design transportation facilities for both new construction and road reconstruction projects, they must create and then edit the alignments used to control the design of the road. You create tangent, curve, and spiral alignment components with layout tools, and you can edit alignments both graphically and in a table. When you edit alignment data in a table, the graphical display of the geometry and associated annotation is automatically updated. When you edit alignment data graphically, curves maintain tangency to the lines. When you edit alignment geometry, surface profile data also automatically updates. The following illustration shows two intersecting alignments:

Superelevation is the purposeful canting of road or railway cross sections within spiral and curve alignment components. The intent is to counteract centrifugal forces to allow for higher design speeds and safer passage through alignment spirals and curves. To calculate superelevation values for an alignment, you modify alignment properties to assign a design speed. The superelevation values are referenced from a rate table in a design criteria file. Each curve is a superelevation region, and for each superelevation region, you can assign independent superelevation properties. You can also apply the superelevation properties of one superelevation region to the other superelevation regions in the alignment.

When you use alignment design criteria and superelevation, you associate standard imperial and metric superelevation tables with the alignment to calculate minimum curve radii and superelevation critical values for assigned design speeds. The superelevation values assigned to an alignment are referenced when you create the corridor model for the transportation facility.



Offset alignments are directly related to the centerline alignment. When you change the geometry of the centerline alignment, the geometry of the offset alignment automatically recalculates based on the offset parameters.



Objectives

After completing this lesson, students will be able to:

- Describe alignments and their properties.
- Create alignments using objects.
- Describe alignment tag labels.
- Label alignments and create a table.
- Explain criteria-based design.
- Create alignments using layout tools.
- Calculate and apply superelevation to a horizontal alignment.
- Create offset alignments and widenings.

Exercises

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

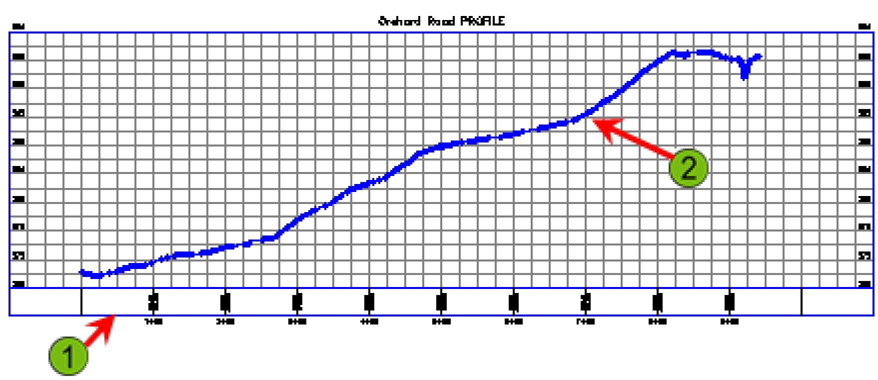
1. Create an Alignment Using Objects
2. Label an Alignment
3. Create an Alignment Using Layout Tools
4. Edit an Alignment
5. Apply Superelevation
6. Create Offset Alignments and Widenings

Lesson 2 - Roadway Profiles

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

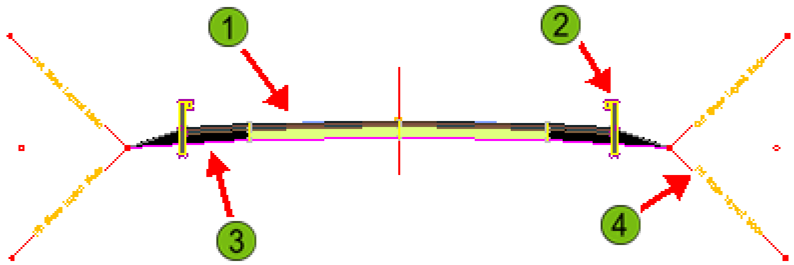
The following exercises are provided in a step by step format in this lesson:

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

Lesson 3 - Roadway Assemblies and Corridors

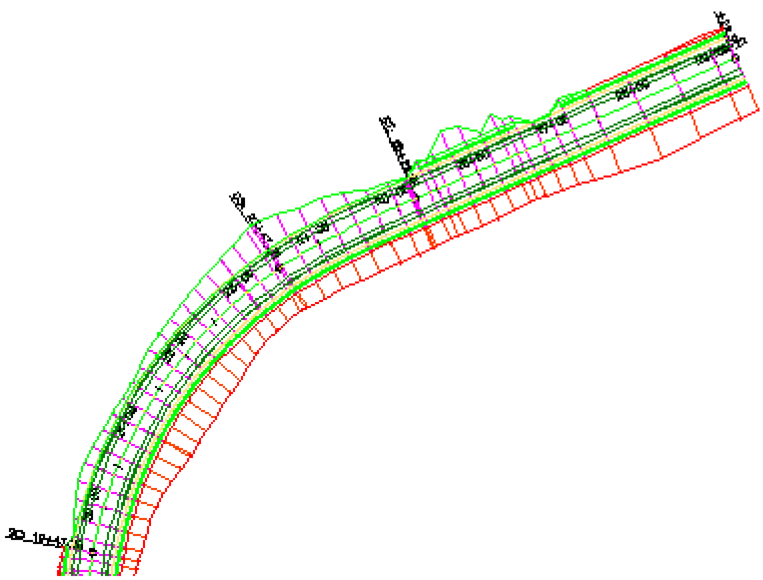
This lesson describes how you create and modify assemblies and create transportation corridors for arterials and freeways. Students also create transportation corridor surfaces and create a four-way intersection using the Create Intersection wizard. In addition, this lesson describes how you create a model that combines an existing surface and a corridor model. It also describes how you view and render a model with photorealistic materials in 3D.

Assemblies for transportation road and highway corridor models are usually more complex than assemblies used for subdivision road corridor models. An assembly for a transportation corridor model involves the application of alignment superelevation and the use of other alignments and profiles to control how you generate the corridor model. Also, assemblies for transportation corridor models usually incorporate daylighting subassemblies, which project match slopes to a target surface in cut and fill conditions. The following illustration shows the subassemblies in a transportation corridor assembly that daylights to a surface and reads the alignment superelevation parameters.

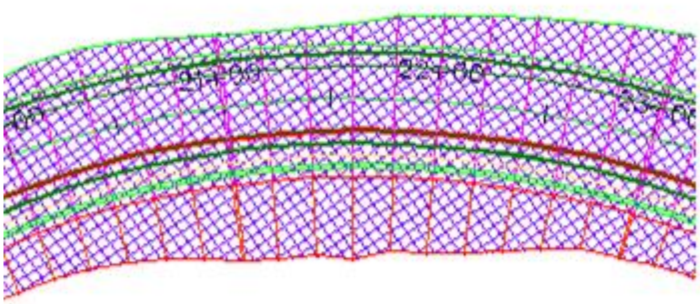
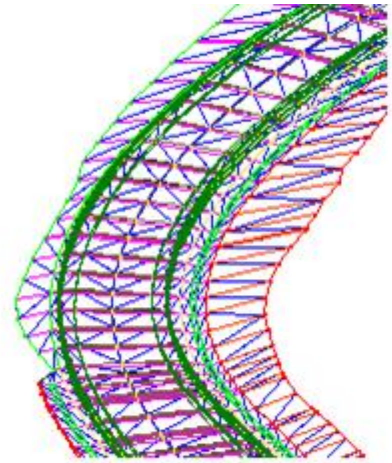


1. Lane
2. Guardrail
3. Shoulder
4. Daylight

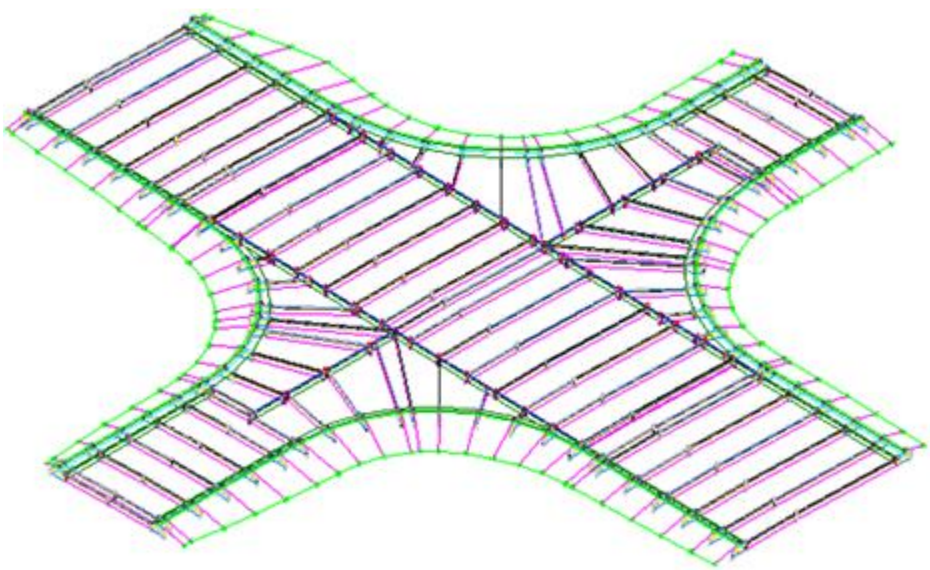
Transportation corridor models are usually more complicated than subdivision corridor models because they often include more complex subassemblies, daylighting to a surface, and modeling lanes with varying widths and including superelevation. A corridor model for an arterial roadway is shown in the following illustration:



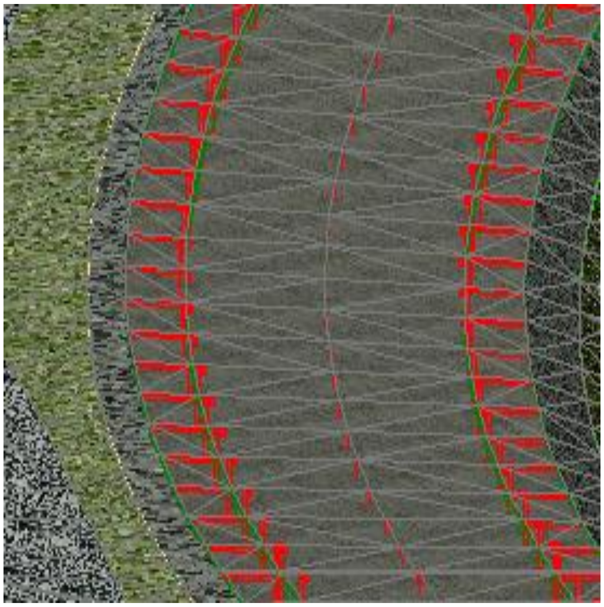
Corridor surfaces can be used for earth cut and fill volume calculations, labeling finished design grades and slopes, and calculating pipe network rim and invert elevations. A corridor surface is shown in 2D and 3D views in the following illustration.

Intersection modeling can be very complex. Horizontal alignments, profiles, and assembly cross falls all require spatial coordination to correctly model an intersection. The Create Intersection wizard automatically generates and coordinates the alignments, profiles, corridor regions, and assemblies required to model the intersection and the entrances and exits. The end result is the creation of a corridor model and intersection object that are directly related to one another. The following illustration shows an intersection with curb returns, viewed in Object Viewer.



Three-dimensional models of a proposed design are very effective when you need to communicate the plan or the design to both the general public and approving agencies. You can easily apply photorealistic materials to corridors that are rendered in 3D for presentation purposes. Furthermore, you can merge the corridor model with the existing ground surface model to enhance the effect. The following illustration shows a 3D view of a road design.



Objectives

After completing this lesson, students will be able to:

- Describe how daylighting is used for matching slopes to surfaces.
- Describe assemblies and subassemblies.
- Create an assembly that consists of lanes, shoulders, guardrails, and match slopes.
- Describe a corridor model and list its components.
- Create a corridor model.
- Map corridor targets.
- View and edit corridor sections.
- Create corridor top and datum surfaces.
- Create an intersection.
- Describe how a code set style assigns rendered material styles to corridor links.
- Create a 3D road design model.

Exercises

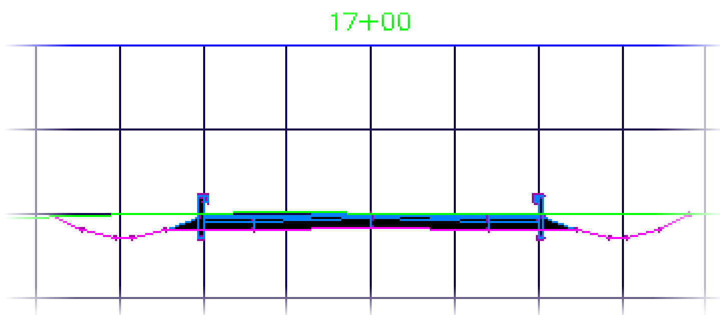
The following exercises are provided in a step-by-step format in this lesson:

1. Create and Modify a Transportation Assembly
2. Create a Corridor Model

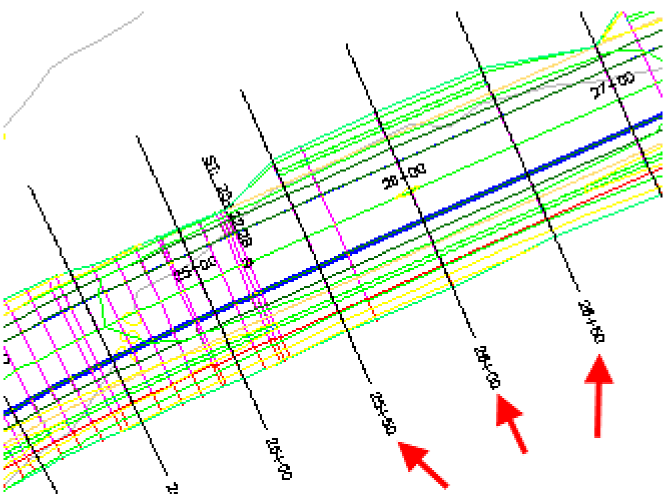
3. Map Corridor Targets
4. View and Edit Corridor Sections
5. Create Corridor Surfaces
6. Create an Intersection
7. Create a 3D Road Design Model

Lesson 4 - Cross Sections and Quantities

In this lesson, students work with cross sections, sample lines, corridor quantities, and quantity reports. Cross-section views are inserted at sample line locations along the alignment and illustrate the materials to be used at that particular location. Section views display surface, corridor surface, corridor, pipe network, and material section data at the sample line locations. Section data in the section views is automatically updated when the corridor recalculates or section data changes. A section view is shown in the following illustration.

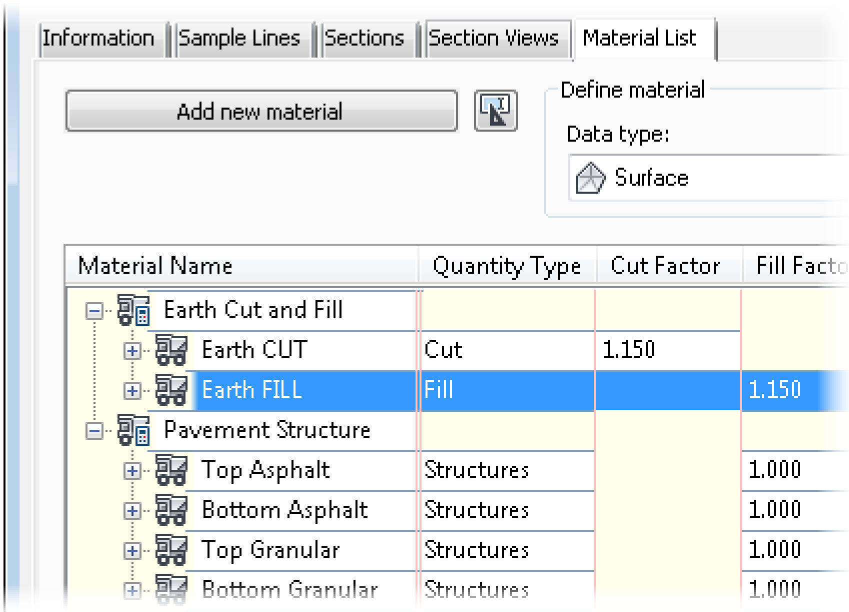


Sample lines are required to calculate quantities and to create section views that display section data. Sample lines are attached to an alignment, as shown in the following illustration.



Earth cut and fill, and pavement structure quantities, are calculated from data associated with cross sections at the sample lines in order to estimate the amount of earth to be moved and the required materials for construction. Earth cut and fill volumes are calculated by comparing the corridor datum surface section data with the existing ground surface section data. Pavement and base material volumes necessary to construct the roadway are calculated directly from the corridor section data.

The following illustration shows a material list for corridor quantities. The material list is assigned to a sample line group.



Quantity reports are created from a sample line group and can be inserted in a drawing as a table, or extracted to an external file. After a quantity report is created, if the corridor model changes, the section data attached to the sample lines also updates. When the section data attached to the sample lines updates, the quantity table in the drawing also updates. This makes it very easy to quickly analyze quantities and adjust corridor models to balance earth cut and fill volumes.

The following illustration shows a portion of a quantity report in a table in a drawing area.

Total Volume Table						
Station	Fill Area	Cut Area	Fill Volume	Cut Volume	Cumulative Fill Vol	Cumulative Cut Vol
22+00.00	22.49	132.73	31.34	325.98	125.78	3360.02
22+50.00	44.54	84.68	74.13	219.93	199.91	3579.96
23+00.00	89.36	54.86	147.60	140.70	347.50	3720.66
23+50.00	173.73	11.25	288.62	66.40	636.13	3787.06
24+00.00	196.97	0.00	402.83	11.36	1038.96	3798.41
24+50.00	190.12	0.00	416.84	0.00	1455.80	3798.41
25+00.00	100.86	17.09	311.71	17.90	1767.51	3816.31
25+50.00	46.68	38.46	157.09	59.15	1924.61	3875.46
26+00.00	14.99	60.49	65.66	105.36	1990.27	3980.83
26+50.00	1.18	95.42	17.22	166.02	2007.49	4146.85

Objectives

After completing this lesson, students will be able to:

- Describe sample lines and how they are used in cross sections.
- Create and edit sample lines.
- Modify the sample line group properties and add additional section data.
- Describe criteria used in quantity takeoff calculations.
- Calculate the earth cut and fill and pavement structure quantities for a corridor model.
- Create quantity reports that display quantity calculations.
- Create a quantity report in a table and a quantity report in a web browser.
- Create section views from sample lines.
- Create multiple section views.

Exercises

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

1. Create and Edit Sample Lines
2. Modify Sample Line Group Properties
3. Calculate Corridor Quantities
4. Create Quantity Reports
5. Create Multiple Section Views

Lesson 5 - Roadway Plan Production

This lesson describes how to automate the generation of plan and profile design and construction sheets using the plan production tools. These tools, the Create View Frames wizard and Create Sheets wizard, eliminate the repetitive tasks associated with orienting and scaling viewports to show alignment and profile data.

Using the wizards, you can quickly create sheets that display segments of alignments and profiles in your design and construction plans. Instead of having to manually create viewports for alignments and profile views, and manually recreate sheets each time your data changes, you can now create sheets from dynamic view frame groups that automatically capture predefined areas along an alignment and a profile view.

Objectives

After completing this lesson, students will be able to:

- Create view frames in a view frame group.
- Create all plan and profile sheets in the current drawing.
- Create all plan and profile sheets in a new drawing.
- Create all plan and profile sheets in individual drawings.
- Use the AutoCAD Sheet Set Manager to manage the sheets.

Exercises

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

1. Create View Frames
2. Create Sheets