



**W17**

# **Exploring Template Points and Constraints**

**XM Edition**

  
**Bentley Institute**

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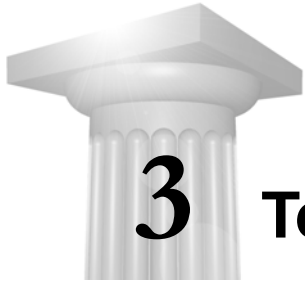
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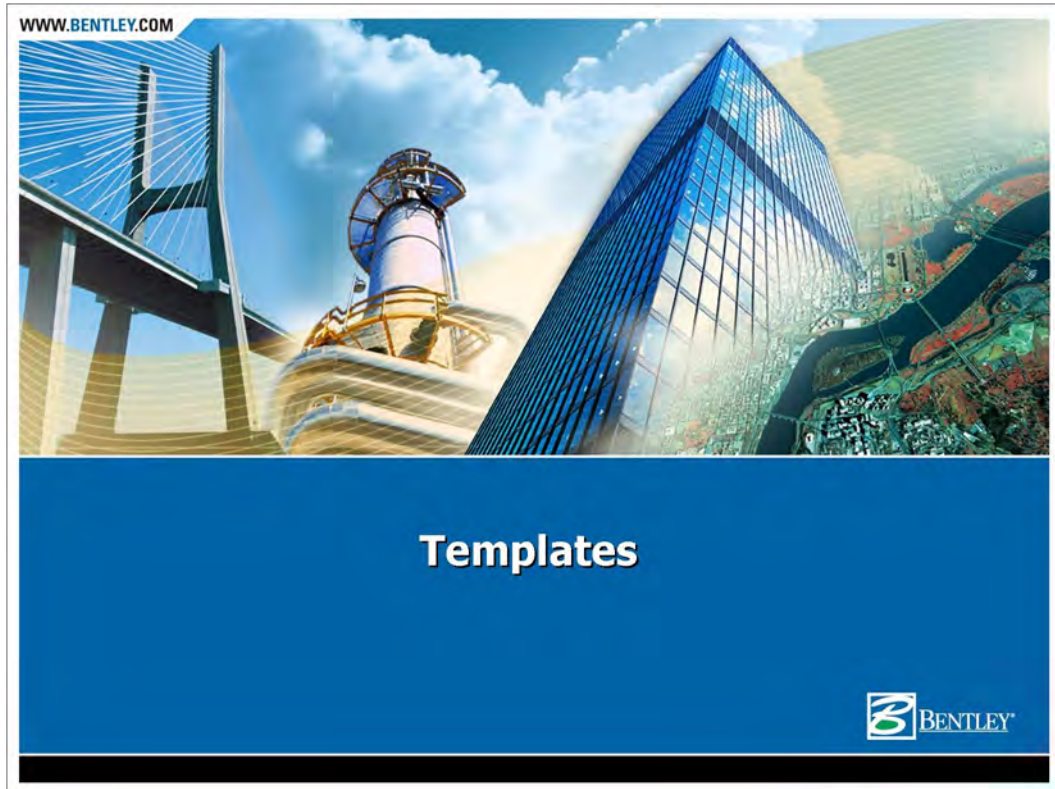
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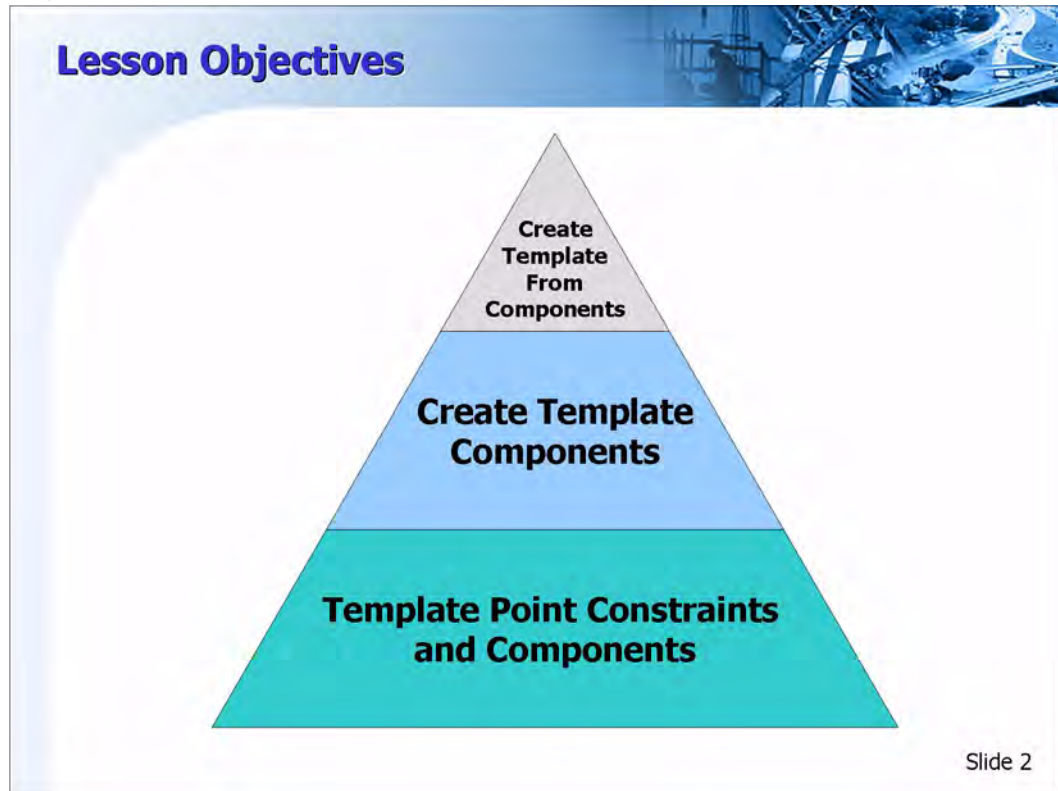
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# 3 Templates



## Lesson Objectives



### Lesson Objectives

In this lesson we will...

- Learn about template point constraints and components
- Create template components
- Create a complete template from the components

### Starting Clean

- 1 Close MicroStation and InRoads.

### Starting InRoads

- 1 Double-click the InRoads icon.

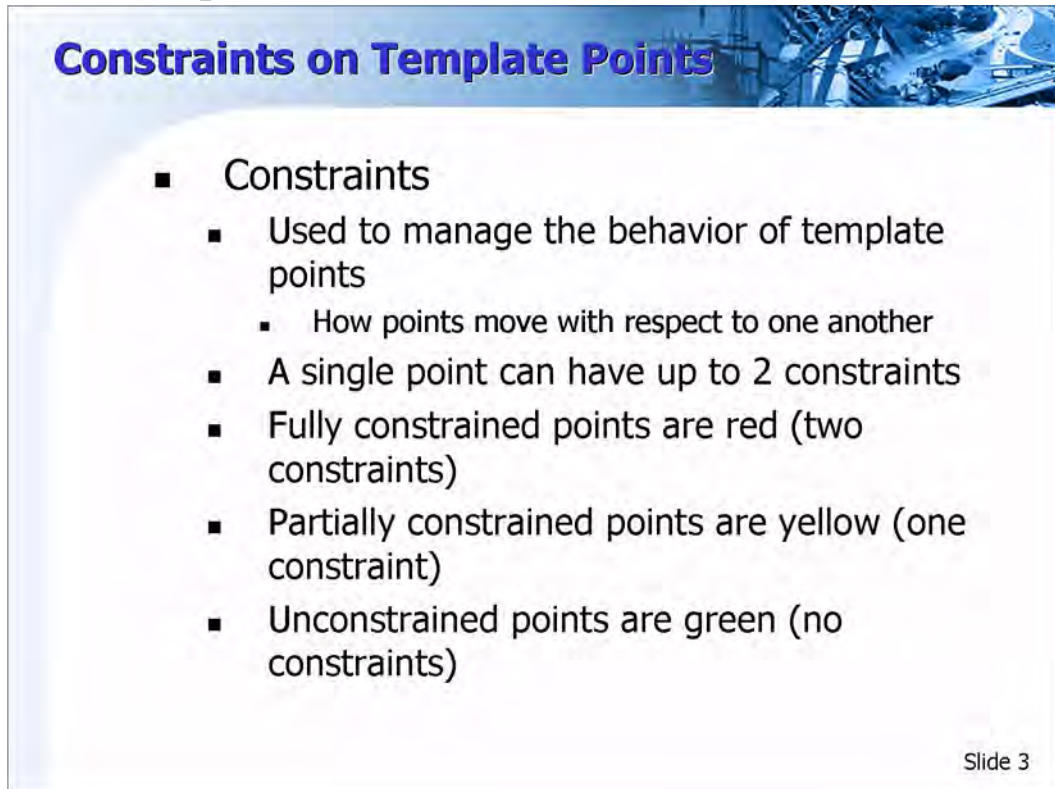
The MicroStation Manager appears.

An alternate path for launching InRoads is **Start > Programs > Bentley > InRoads Group XM > InRoads**.

**Open a CAD File**

- 1 Set the directory to *C:\InRoads Training\InRoads 201\Practice\Practice Lesson 03*.
- 2 Open the CAD file *SR 2067 Bypass.dgn*.

## Constraints on Template Points



The slide features a blue header with the title "Constraints on Template Points" in white text. The main content is a bulleted list on a white background. The list is structured as follows:

- Constraints
  - Used to manage the behavior of template points
    - How points move with respect to one another
  - A single point can have up to 2 constraints
  - Fully constrained points are red (two constraints)
  - Partially constrained points are yellow (one constraint)
  - Unconstrained points are green (no constraints)

Slide 3

### Constraints on Points

Point constraints are used to manage the behavior of template points. They are used so that if a point is moved in a template, either by the user editing the template or by the application of point controls during design processing, all the points related to the point being moved will behave in a predictable manner.

- A template point can have a maximum of two constraints on it. A point with two constraints is considered “fully constrained.” A point that is fully constrained is represented by a red plus sign.
- A point that has only one constraint on it is considered “partially constrained” and is shown as a yellow plus sign.
- A point with no constraints (unconstrained) is shown as a green plus sign.

Constraints can also be labeled so that during the design process the value of labeled constraints may be changed. For example, the template may have a constraint label called Thickness that controls the thickness of the asphalt wearing surface. This thickness can be changed so that one template can be used for different asphalt depths, without having to edit the template.

## Types of Constraints

InRoads provides a variety of constraint types for roadway template design as described below:

### Horizontal

The child point remains at the given horizontal distance from the parent point.

### Vertical

The child point remains at the given vertical distance from the parent point.

### Slope

The child point will maintain the given slope from the parent point. Slope constraints can, additionally, have rollover values assigned to them. Rollover values are used to set the slope constraint based on a high side slope difference and a low side slope difference, and a reference point which defines the controlling slope to the parent point. Slope constraints are absolute. Slopes going from lower-left to upper-right are positive regardless of whether the child point is to the left or right of the parent.

### Horizontal Maximum

The child point has two parent points and remains at the given horizontal distance from the parent point that is farthest to the right (has the maximum horizontal or X value).

### Horizontal Minimum

The child point has two parent points and remains at the given horizontal distance from the parent point that is farthest to the left (has the minimum horizontal or X value).

### Vertical Maximum

The child point has two parent points and remains at the given vertical distance from the parent point that is highest (has the maximum vertical or Y value).

### Vertical Minimum

The child point has two parent points and remains at the given vertical distance from the parent point that is lowest (has the minimum vertical or Y value).

### **Vector Offset**

The child point has two parent points and will be projected onto the vector defined by the two parents. If the offset is not zero, then the child point will maintain a perpendicular offset from the parent vector at the specified offset value. Negative values indicate an offset to the left of the vector defined by the parent points. Positive values indicate an offset to the right.

### **Project to Surface**

This constraint must be used in conjunction with one of the previously defined constraints. The other constraint will define the projection direction. The child point will then be projected to the surface with the name given when the design is processed. If the surface does not exist, or no solution is found, the point will remain where it is placed in the template.

### **Project to Design**


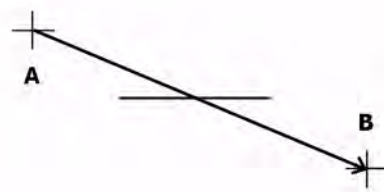
This constraint is similar to Project to Surface, except that the point is projected to the design surface of the template. A projection value is given to indicate whether the projection is to be to the left or to the right. Again, the point must also be constrained by one of the previous constraints, excluding the Project to Surface, so that a direction for the projection may be determined. Again, if no solution is found, then the point will remain where it is placed in the template.



## Visual Indicators for Parent-Child Relationship and Horizontal Constraint

### Constraints on Template Points

- Parent-Child point relationship
  - Point B is the Child of Parent point A
  - Arrow points from Parent point to Child point
  
- Horizontal Constraint
  - Child is horizontally constrained to parent

Slide 4

### Parent-Child Point Relationship

When a point is constrained, it is constrained by either one or two points. Points are constrained in a two dimensional plane. Constraints can affect only the point's offset and elevation, which is the X and Y coordinates in a cross section view. Point constraints are also directional. The direction forms a parent-child relationship between points. If point B is constrained by point A, point A is said to be the parent of point B. When viewing the constraints, the parent point has a blue arrow pointing to the child point. To see the constraints in a template, enable the Constraints radio button located in the Display portion of the Create Template dialog.

### Horizontal Constraint

A horizontal constraint is when a child is horizontally constrained to the parent. When you move the parent point, the child point moves at a constant horizontal distance from that point, which is specified when the constraint is established. A white horizontal line crossing over the blue arrow indicates a horizontal constraint.

## Visual Indicators for Vertical, Horizontal, and Slope Constraints

**Constraints on Template Points**

- **Vertical Constraint**
  - Child is vertically constrained to Parent
- **Horizontal and Vertical Constraint**
  - Child is horizontally and vertically constrained to Parent
- **Slope Constraint**
  - Child and Parent are constrained by slope

Slide 5

### Vertical Constraint

A vertical constraint is when a child is vertically constrained to the parent. When you move the parent point, the child point moves at a constant vertical distance to that point, which is specified when the constraint is established. A white vertical line crossing over the blue arrow indicates a vertical constraint.

### Horizontal and Vertical Constraint

A horizontal and vertical constraint is when a child is horizontally and vertically constrained to the parent. When you move the parent point, the child point moves at a constant horizontal and vertical distance to that point, which is specified when the constraint is established. A white horizontal and vertical line crossing over the blue arrow indicates a horizontal and vertical constraint. When a point has two constraints, such as horizontal and vertical constraints, that point is fully constrained and is shown in red.

## Slope Constraint

A slope constraint is when a child is constrained to the parent by the slope between the two points. When you move the parent point, the child point moves at a constant slope with respect to the parent point, which is specified when the constraint is established. A white diagonal line crossing over the blue arrow indicates a slope constraint. When a point has only one constraint, such as a slope constraint, it is called a partially constrained point and is shown in yellow.

## Practice - Observe Template Constraints Behavior

**Follow Me...**

- Observe Template Constraints Behavior
  - Open Template Library
  - Select ***Constraints Behavior*** template
  - Move template points and observe the behavior
  - Change the point constraints
  - Move template points again and observe the behavior
  - Delete a component

Slide 6

### Open Project File

- 1 Select **File > Open**.
- 2 Open the Project File *C:\InRoads Training\InRoads 201\RWK\Practice Lesson 03.rwk*.

### Select Template

- 1 Select **Modeler > Create Template**.
- 2 Double-click the Template named *Constraints Behavior* from the *Constraints* folder.

This makes the template *Constraints Behavior* the current template.

- 3 Enable the *Constraints* and *Display Point Names* in the *Display* portion of the Create Template dialog.
  - Point 1 is the parent of Point 2.
  - Point 2 is the child of Point 1.
  - Point 2 is horizontally and vertically constrained to Point 1.
  - Point 2 is the parent of Point 3.
  - Point 3 is the child of Point 2.
  - Point 3 is horizontally and vertically constrained to Point 2.

### Move Template Points

- 1 Right-click on *Point 1* and select **Move Point**.  
Observe how the Points 1, 2 and 3 move as a rigid body.
- 2 Right-click to exit **Move Point**.
- 3 Right-click on *Point 2* and notice that **Move Point** is no longer available.  
It is not possible to move a point that has 2 constraints.  
Let's see what happens when we remove the vertical constraint from Point 2.

### Change Point Constraints

- 1 Double-click *Point 2*.  
This will bring up the Point Properties dialog.
- 2 Change *Constraint 2* from *Vertical* to *None* and click **Apply**, then **Close**.  
Notice the color of the point turned from red to yellow.

### Move Template Points

- 1 Move *Point 1*.  
Notice the horizontal distance between Points 1 and 2 remains the same.
- 2 Move *Point 2*.  
Notice the horizontal distance between Points 1 and 2 remain the same.  
Also notice that the horizontal and vertical distance remains the same between Points 2 and 3.

### Change Point Constraints

- 1 Double-click *Point 2* again.
- 2 Change *Constraint 1* from *Horizontal* to *Slope* and click **Apply**, then **Close**.

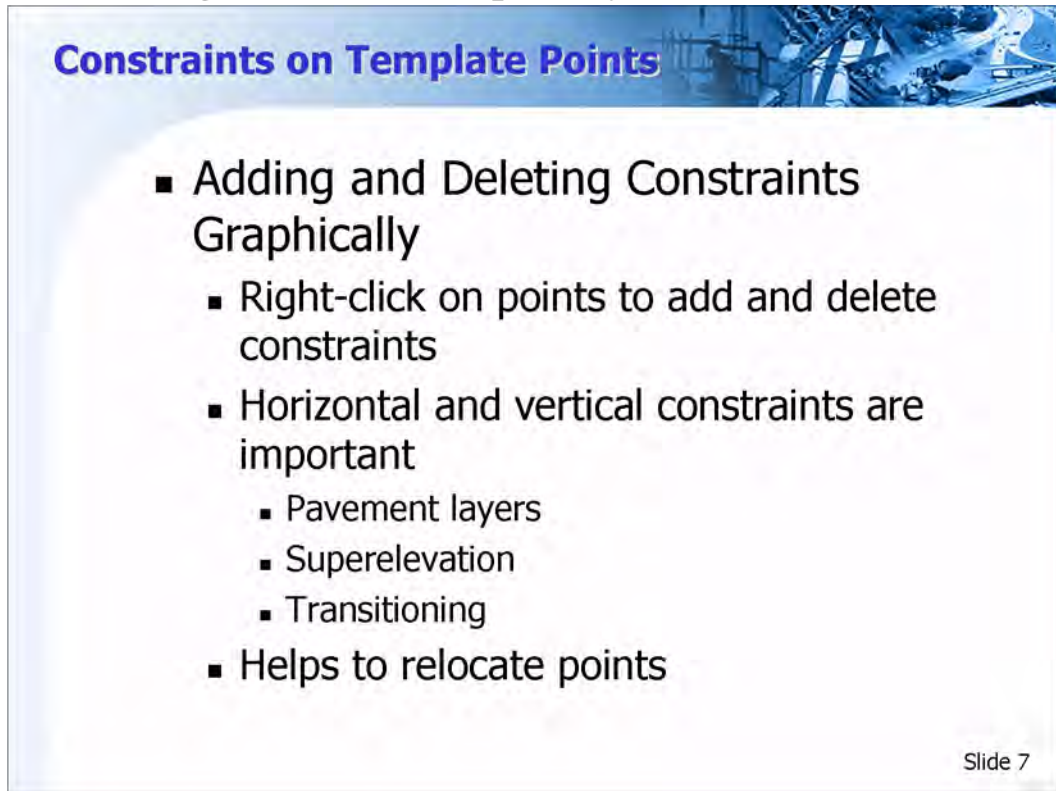
### Move Template Points

- 1 Move *Points 1 and 2*.

### Delete Component

- 1 Delete the component by right-clicking with your cursor directly over the component and selecting **Delete Component**.  
Notice there is also a **Delete Components** command that is used to delete multiple components.

## Adding and Deleting Constrains Graphically



The slide features a blue header with the title "Constraints on Template Points" and a background image of a road construction site. The main content is a bulleted list of instructions for adding and deleting constraints graphically. The slide is labeled "Slide 7" in the bottom right corner.

- **Adding and Deleting Constraints Graphically**
  - Right-click on points to add and delete constraints
  - Horizontal and vertical constraints are important
    - Pavement layers
    - Superelevation
    - Transitioning
  - Helps to relocate points

Slide 7

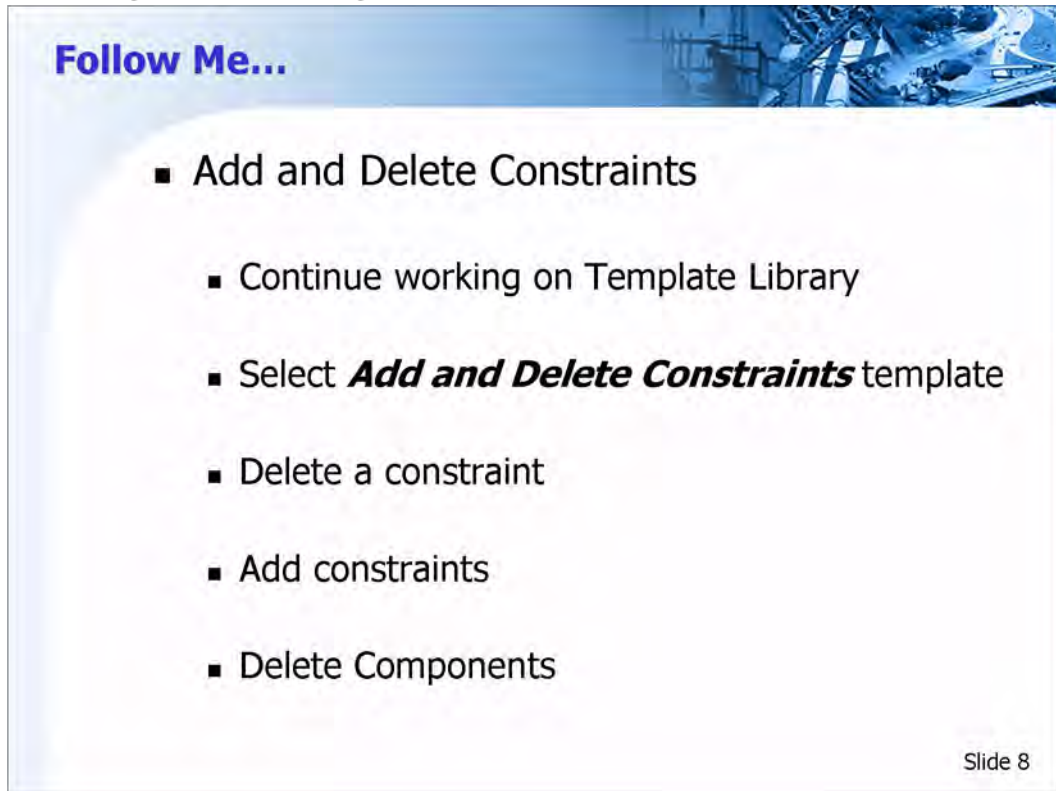
### Adding and Deleting Constraints

In addition to editing the template point constraints using the Point Properties dialog, you can right-click on any point to access **Add Constraint** or **Delete Constraints**. This is very handy for making quick adjustments to the template constraints.

**Delete Constraints** removes all constraints from the point. **Add Constraint** lets you pick the type of constraint you want to add to the point. **Full Constraint** adds both horizontal and vertical constraints to a point.

Right-click on the child point you want to constrain, select **Add Constraint**, and select the point constraint you want to add. Then click the parent point and key in the offsets or slope values of the child point from the parent. Setting the appropriate constraints on points is important to achieve the desired results when pavement layers, superelevation, and transitioning are introduced to the design. Using the Point Properties dialog is helpful for adjusting point constraints after initial point placement.

## Practice - Adding and Deleting Constraints



**Follow Me...**

- Add and Delete Constraints
  - Continue working on Template Library
  - Select **Add and Delete Constraints** template
  - Delete a constraint
  - Add constraints
  - Delete Components

Slide 8

Continue working on the template library used in the last practice activity.

### Delete Constraint

- 1 Select the *Add and Delete Constraints* template and make it the current template.
- 2 Enable the *Components* and *Display Point Names* options in the *Display* area of the Create Template dialog.
- 3 Right-click on the *CL\_AGGR\_B\_BOT* point and select **Delete Constraints**.  
Notice the color of the point turn from red to green.
- 4 Delete the constraints on the *EOP\_AGGR\_B\_BOT* and *SHDR\_AGGR\_B\_BOT* points.

### Add Constraints

- 1 Right-click on the *CL\_AGGR\_B\_BOT* point and select **Add Constraint > Full Constraint**.
- 2 Click on the *CL\_AGGR\_A\_BOT* point.  
This will bring up the Add Horizontal Constraint dialog.
- 3 Key-in a *Horizontal Offset* of 0.0 and a *Vertical Offset* of -1.0 and click **OK**.
- 4 Right-click on the *EOP\_AGGR\_B\_BOT* point and select **Add Constraint > Full Constraint**.
- 5 Click on the *EOP\_AGGR\_A\_BOT* point.  
This will bring up the Add Horizontal Constraint dialog.
- 6 Key-in a *Horizontal Offset* of 0.0 and a *Vertical Offset* of -1.0 and click **OK**.
- 7 Right-click on the *SHDR\_AGGR\_B\_BOT* point and select **Add Constraint > Slope**.
- 8 Click on the *EOP\_AGGR\_B\_BOT* point.  
This will bring up the Add Slope Constraint dialog.
- 9 Key-in a *Slope* of -6.0% and click **OK**.
- 10 Right-click on the *SHDR\_AGGR\_B\_BOT* point again and select **Add Constraint > Slope**.
- 11 Click on the *SHDR\_AGGR\_A\_BOT* point.
- 12 Key-in a *Slope* of -25.0% and click **OK**.

### Delete Components

- 1 Right-click on the Current Template Window and select **Delete Components**.
- 2 Hold down the left mouse button and draw a line across a few components.  
Release the left mouse button when done.  
To undo the deletion, press the CTRL+Z buttons on the keyboard.



## The Sign of the Distance and Slope

**Add New Component Commands**

- **Component Slopes and Distances**
  - Parent point is placed first
    - Child placed to the right (x) of Parent is positive distance
    - Child placed to the left (x) of Parent is negative distance
  - Slope is algebraic slope

Slide 9

### Component Slopes and Distances

When defining components with precision input, the sign of the distance is dependent on the parent-child relationship. The parent is always the first point placed when creating template components. The distance is positive if the parent has a lower X value than the child. The distance is negative if the parent has a higher X value than the child. The sign of the component slope is based on the mathematical slope.

## Simple Component

### Add New Component Commands

- Simple Component
  - Creates constrained parallelogram for pavement layers and sidewalks
  - Provide the following data:
    - Component Name and Style
    - Slope, Thickness and Width

Slide 10

### Template Components

A component is a set of points that define an open or closed shape. Each component, whether open or closed, can represent a different material or area of interest.

Components are saved in the template library and are normally stored in a separate folder in the *Template Library* folder structure.

To create a component, first select **File > New Template** and name the template component. Then, use **Add > Simple** or **Add > Constrained** to build the component. Each component has a name and an assigned feature style.

There are five types of components created in InRoads:

- Simple
- Constrained
- Unconstrained
- Null Point
- End Condition

As you add template components, the area under the graph changes to allow for different types of component input. This is called the Current Component area.

### **Simple Component**

A simple component typically represents a section of pavement or sidewalk. It is a closed parallelogram that is defined by slope, thickness, and width. The top points are constrained by horizontal and slope constraints. The lower points are constrained to the points directly above them by horizontal and vertical constraints.

## Pratice - Creating a Template of Simple Components



**Follow Me...**

- Create a pavement section
  - Create Template named ***12' Concrete Pavement w/8' Shoulder***
  - Start Dynamic Settings
  - Add Simple Components
  - Save Template Library

Slide 11

### Create a Template Name

- 1 Browse to the folder named *Components* in the Create Templates dialog.
- 2 Create a template named *12' Concrete Pavement w/8' Shoulder*.

### Start Dynamic Settings

- 1 Select **Tools > Dynamic Settings**.
- 2 Disable the *Apply Affixes* option in the Dynamic Settings dialog.

### Add Simple Component

- 1 Right-click on the Current Template window and select **Add New Component > Simple**.
- 2 Setup the *Current Component* portion of the Create Template dialog as follows:
  - Component Name:* CONCRETE
  - Style:* P\_ROAD\_Concrete
  - Slope:* -2.000%
  - Thickness:* 1.000
  - Width:* 12.000

- 3 Place the component at the origin of the Current Template window.
- 4 Right-click again on the Current Template window and select **Add New Component > Simple**.
- 5 Setup the *Current Component* portion of the Create Template dialog as follows:  
Component Name: CONCRETE

① Note: Since this is the same name as the first component created, the name will automatically be appended with a 1 resulting in Concrete1 as the component name.

*Style: P\_ROAD\_Concrete*

*Slope: -6.000%*

*Thickness: 1.000*

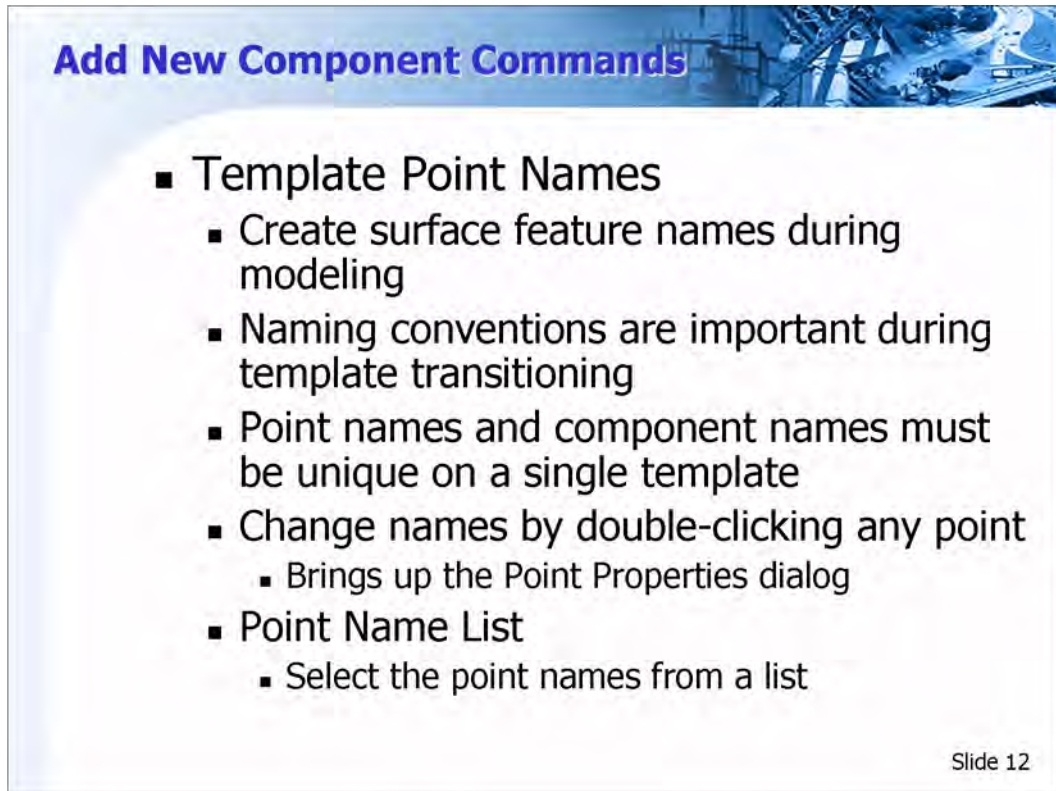
*Width: 8.000*

- 6 Place the component at the right edge of pavement point of the Current Template window.

### Save Template Library

- 1 Select **File > Save** in the Create Template dialog.

## Template Point Names



**Add New Component Commands**

- **Template Point Names**
  - Create surface feature names during modeling
  - Naming conventions are important during template transitioning
  - Point names and component names must be unique on a single template
  - Change names by double-clicking any point
    - Brings up the Point Properties dialog
  - Point Name List
    - Select the point names from a list

Slide 12

### Template Point Names

Templates are used by the Roadway Designer to create surfaces of the proposed roadway. Each template point will be connected longitudinally to the next template drop, based on the interval, to form longitudinal breakline surface features. The names of those features will be the name of the template points. Therefore, establishing a standard naming convention for template points is important to the quality of the proposed surface.

Likewise, individual component names will also appear in the ensuing surfaces. These components will be used for volume calculations, so standard naming conventions should be applied to ensure consistent results.

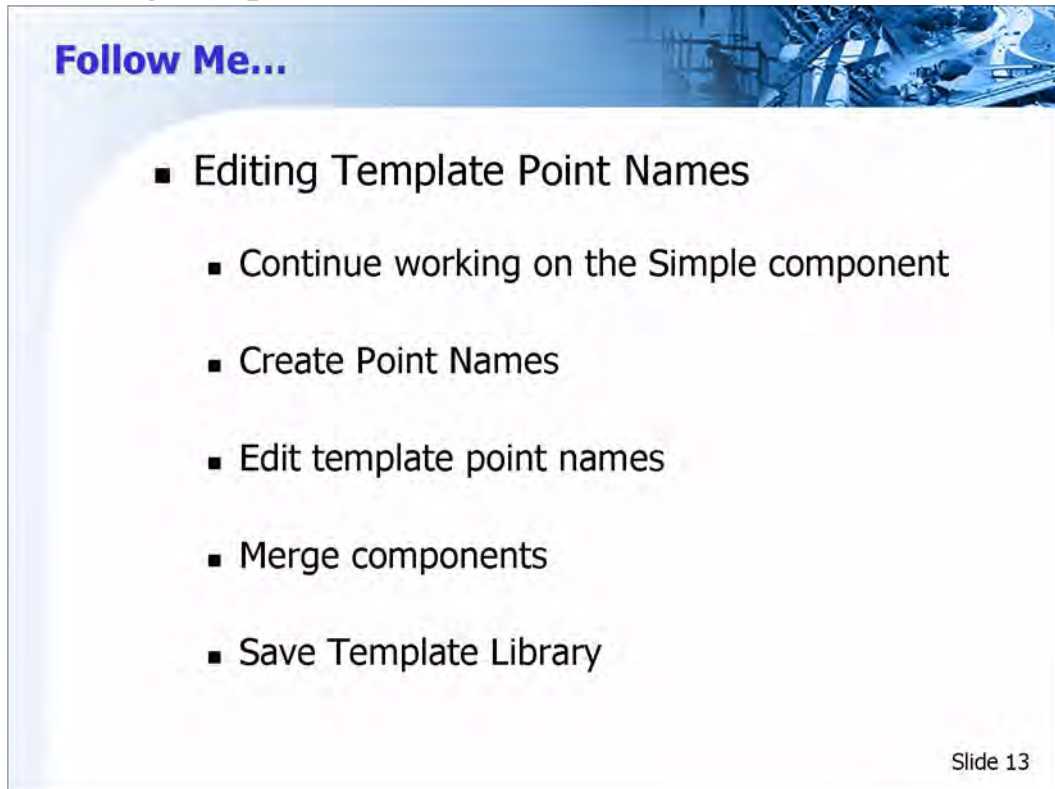
When transitioning between two templates (going from a two-lane to a four-lane roadway, for example), the Roadway Designer will attempt to connect template points of the same name to model the transition. Template transitioning makes consistent template component and template point naming even more important.

Each template point name and component name must be unique within a template. For accurate volume calculations and surface creation (especially during template transition), different templates should use consistent component and template point names. InRoads automatically appends the names if the same name is chosen during template creation. Also, InRoads provides for automatic prefixes and suffixes (such as LT\_ and RT\_) when components are created or added to the left or right side of the origin point. Prefixes and suffixes for template point names can be defined using **Tools > Options** in the Create Template dialog.

Editing template point names can be easily accomplished by right-clicking on a template point and selecting **Edit Point**. Double-clicking the point also invokes **Edit Point**. This brings up the Point Properties dialog, where the point name and surface feature style can be changed. After you change the point name, click **Apply**. The **Next >** and **< Previous** buttons help to change multiple points by moving from point to point within the same template. Enabling the *Display Points Names* option in the *Display* portion of the Create Template dialog will allow you to visually verify the point names.

The Point Name List is used to create template point names. These names are then selected during component creation or editing to reduce time spent keying in the names. To add names to the Point Name List, right-click on Point Name List in the Template folders and select **Edit**, or double-click on Point Name List.

## Practice - Editing Template Point Names



The slide features a blue header with the text "Follow Me..." in white. Below the header is a white rounded rectangle containing a bulleted list of tasks. The background of the slide is a blue-tinted image of a road construction site.

- Editing Template Point Names
  - Continue working on the Simple component
  - Create Point Names
  - Edit template point names
  - Merge components
  - Save Template Library

Slide 13

Continue to work on the template named *12' Concrete Pavement w/8' Shoulder*.

The template components have been added, but the names should be changed to reflect a standard naming convention.

### Create Point Names

- 1 Right-click on the *Point Names List* and select **Edit**.  
This will bring up the Point Name List dialog.
- 2 Key-in CL\_CONC\_BOT in the *Name* field.
- 3 Select the Style *P\_COGO\_MainCL* and click **Add**.
- 4 Key-in EOP\_CONC\_BOT in the *Name* field.
- 5 Select the Style *P\_ROAD\_EdgeOfPavement* and click **Add**.
- 6 Key-in SHDR\_CONC\_BOT in the *Name* field.
- 7 Select the Style *P\_ROAD\_Shoulder* and click **Add**, then **Close**.



**Edit Template Points**

- 1 Double-click the point located at the template origin.  
This will bring up the Point Properties dialog.
- 2 Change the point *Name* to **CL** and click **Apply**.
- 3 Click the **Next >** button which will move you down one point.
- 4 Change the Name as follows: Click **Apply**, then **Next >** and repeat.

Name :

*CL\_CONC\_BOT*

*EOP*

*EOP\_CONC\_BOT*

*SHDR*

*SHDR\_CONC\_BOT*

- 5 Close the Point Properties dialog.

**Merge Components**

- 1 Right-click on the vertical segment separating the road and shoulder and select the **Merge Components** command.

Now the name of the merged component is called *CONCRETE*.

- 2 Double-click on the component to verify the name.

**Save the Template Library**

- 1 Select **File > Save** in the Create Template dialog.

## Constrained and Unconstrained Components



- **Add New Component Commands**
- **Constrained**
  - Creates any component
    - Median barrier, curb and gutter, complex pavement sections, retaining walls, etc.
  - Points are automatically constrained horizontally and vertically
- **Unconstrained**
  - Creates any component
  - No points are constrained
  - Constraints are added manually

Slide 14

### **Add New Component > Constrained**

**Add New Component > Constrained** is used to create open and closed shaped template components using precision input. You can access this command by either right-clicking on the Current Template window or selecting it from the pull-down menus.

Examples of constrained components include median barriers, curb and gutter sections, retaining walls, and complex pavement sections.

Constrained components are created with horizontal and vertical constraints already applied to each point.

Both closed and open shaped components can be created. The option to make the component closed or open is selected by right-clicking on the Current Template window during component creation.

When creating template points, the Dynamic Settings dialog is used to define point names and styles. The Dynamic Settings dialog can also be used to enter the precise location for the points.

The basic workflow for creating constrained components is to:

- Select **Add New Component > Constrained**.
- Key-in the *Component Name* and select the *Style* in the Current Component area.
- Key-in the *Point Name* and select the *Style* in the Dynamics Settings dialog.
- Select the key-in type (hs= for example) and key-in the precision value (12.0,2.0% for example) in the Dynamics Settings dialog.
- Press the Enter or Tab key on the keyboard.
- Repeat these steps until the last template point is placed.
- Right-click on the Current Template window and select **Finish**.

### **Add New Component Unconstrained**

**Add New Component > Unconstrained** is also used to create open and closed shape template components using precision input. You can access this command by either right-clicking on the Current Template window or selecting it from the pull-down menus.

This command works the same as using **Add New Component > Constrained** except the components are created without any constraints on the points. The constraints are added manually using **Edit Point** or **Add Constraint**, accessed by right-clicking on any template point

## Practice - Adding a Constrained Component



**Follow Me...**

- Create a concrete curb
  - Create a New Template named ***Curb***
  - Start the Dynamic Settings
  - Create a Constrained Component
  - Save the Template Library

Slide 15

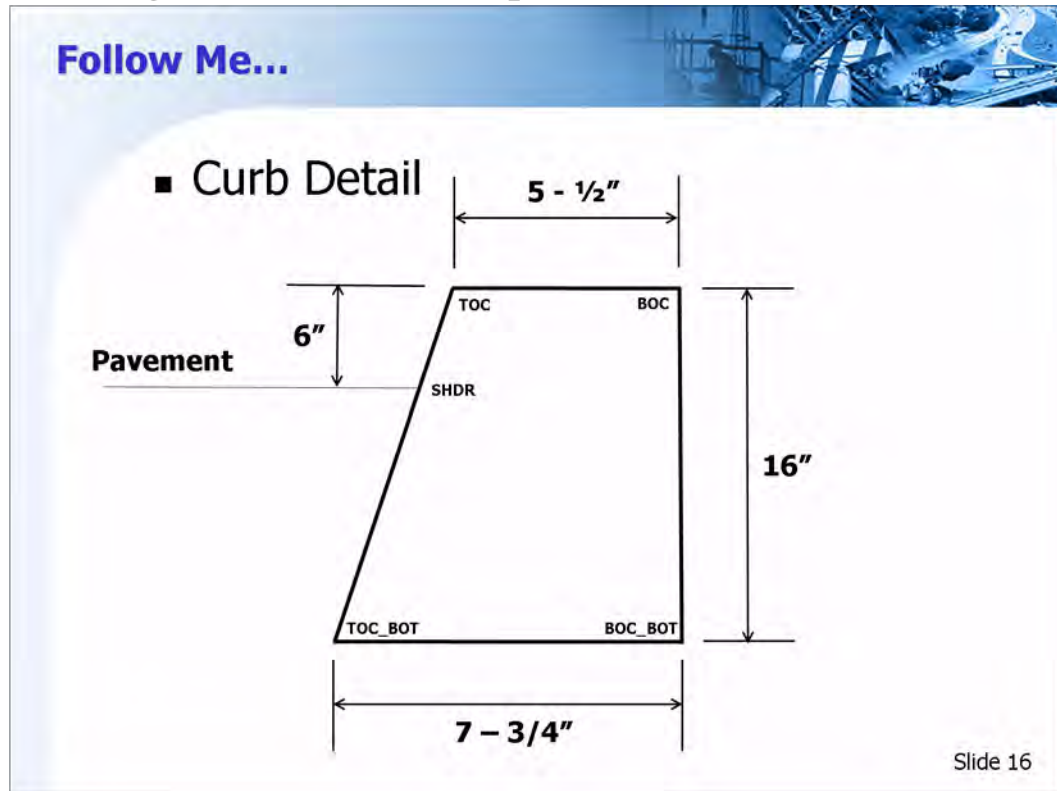
### Create a Template Name

- 1 Browse to the folder named *Components* in the Create Templates dialog.
- 2 Create a template named *Curb*.

### Preparing Settings Before Component Creation

- 1 If the Dynamic Settings dialog is not displayed, select **Tools > Dynamic Settings**.
- 2 Toggle *Display Point Names* to desired settings.

## Practice - Adding a Constrained Component (continued)



### Creating a Constrained Component

- 1 Right-click on the Current Template window and select **Add New Component > Constrained**.
  - 2 Setup the *Current Component* portion of the Create Template dialog as follows:  
*Component Name:* CONCRETE CURB  
*Style:* P\_ROAD\_ConcreteCurb
  - 3 Setup the Dynamic Settings dialog as follows:  
*Point Name:* SHDR (Select from the list)  
*Apply Affixes:* disabled  
*Precision Input:* xy = 0,0  
 Press the Enter key
- ❶ The default units for precision input are feet. You can enter other units with the proper specification, such as 6'' instead of 0.5.
- ❶ Watch the prompts in the lower left corner of the Create Template dialog. When creating a component using precision key-in, an ESC allows you to go back.

- 4 Set up the Dynamic Settings dialog as follows:  
*Point Name: TOC*  
*Apply Affixes: disabled*  
*Precision Input:  $xy = 0.07, 0.5$  (from similar triangles)*  
Press the Enter key.
- 5 Set up the Dynamic Settings dialog as follows:  
*Point Name: BOC*  
*Apply Affixes: disabled*  
*Precision Input:  $hs = 5.5'', 0.0$*   
Press the Enter key.
- 6 Set up the Dynamic Settings dialog as follows:  
*Point Name: BOC\_BOT*  
*Apply Affixes: disabled*  
*Precision Input:  $dl = 0.0, -16''$*   
Press the Enter key.
- 7 Set up the Dynamic Settings dialog as follows:  
*Point Name: TOC\_BOT*  
*Apply Affixes: disabled*  
*Precision Input:  $dl = -7.75'', 0$*   
Press the Enter key.
- 8 Right-click on the Current Template Window and select **Finish**.
- 9 Enable the *Display Point Names* option.

### Save the Template Library

- 1 Select **File > Save** in the Create Template dialog.

## Basic Component Creation Workflow

Creating Components

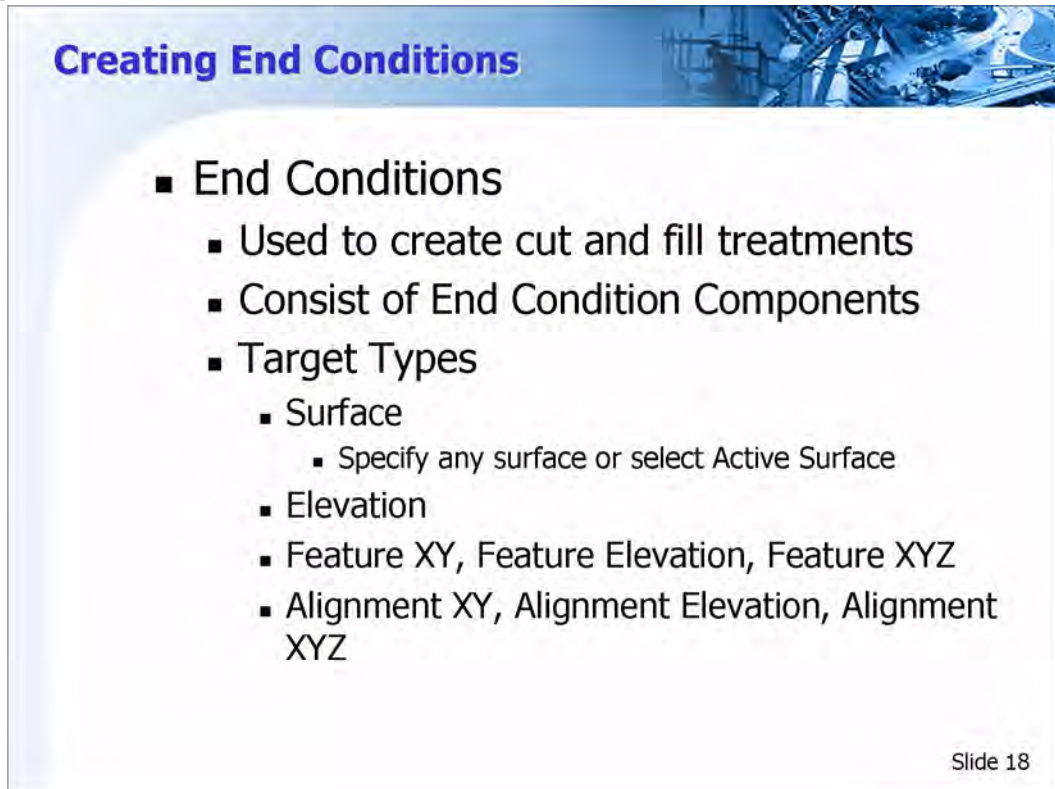
- **Basic Component Creation Workflow**
  - Select File > Open and open a Template Library
  - Select Modeler > Create Template command
  - Navigate to appropriate template folder used for components
  - Select File > New > Template command to create new template name
  - Select the Tools > Dynamic Settings
  - Select Add > Simple or Add > Constrained commands to create components
  - Save the Template Library

Slide 17

### Basic Component Creation Workflow

- Open the *Template Library* by selecting **File > Open**.
- Select **Modeler > Create Template**. This will bring up the Create Template dialog.
- Navigate to the template folder used for components.
- Select **File > New > Template** from the Create Template dialog. Name the new template, which is a component.
- Select **Tools > Dynamic Settings** if the Dynamic Settings dialog is not open.
- Select **Add > Simple** or **Add > Constrained** from the Create Template dialog.
- Add template components by using the Dynamic Settings dialog to specify the *Point Name* and *Style*, and the point locations.
- Select **File > Save** from the Create Template dialog to save the template library.

## Creating End Conditions

A presentation slide titled "Creating End Conditions" with a blue header and a background image of a road construction site. The slide contains a bulleted list of information about end conditions.

**Creating End Conditions**

- End Conditions
  - Used to create cut and fill treatments
  - Consist of End Condition Components
  - Target Types
    - Surface
      - Specify any surface or select Active Surface
    - Elevation
    - Feature XY, Feature Elevation, Feature XYZ
    - Alignment XY, Alignment Elevation, Alignment XYZ

Slide 18

### End Conditions

End conditions are template components which are used to model cut and fill treatments. They are added to the end of simple, constrained, and unconstrained components.

End conditions are created like other template components. End conditions consist of template points and individual components, and appear as line segments. They are different than simple and constrained components because they have the ability to target surfaces, elevations, alignments and surface features.

An example of this targeting is a design criteria which specifies a 4:1 fill slope if a fill height under 6 feet is encountered and the target type would be the original ground surface.

To create an end condition, first select **File > New Template** and name the template. Then use **Add New Component > End Condition** to build the end conditions. End conditions are stored in the template library and normally are created in a separate folder in the template library.



## Target Types

Target types are specified in the Current Component portion of the Create Template dialog, which appears below the Current Template window during end condition creation.

Target types are defined only for end condition components, and are a property of that component. To edit a target type, open the Component Properties dialog by double-clicking on the component or by right-clicking on the component and selecting Edit Component.

A solution can intercept multiple targets and target types. A ditch design, for example, may intercept an alignment that represents the bottom of the ditch and then intercept the original ground surface to form the backslope of the ditch.

**Surface** – targets the active surface or any specified surface. Using the active surface as the target helps when you are applying the end conditions to different projects. This is because the end condition will still work even though the target surface name may be different, so long as it is designated as the active surface.

**Elevation** – targets any specified elevation.

**Feature XY** – targets the horizontal offset of any specified surface feature.

**Feature Elevation** - targets the vertical elevation of any specified surface feature.

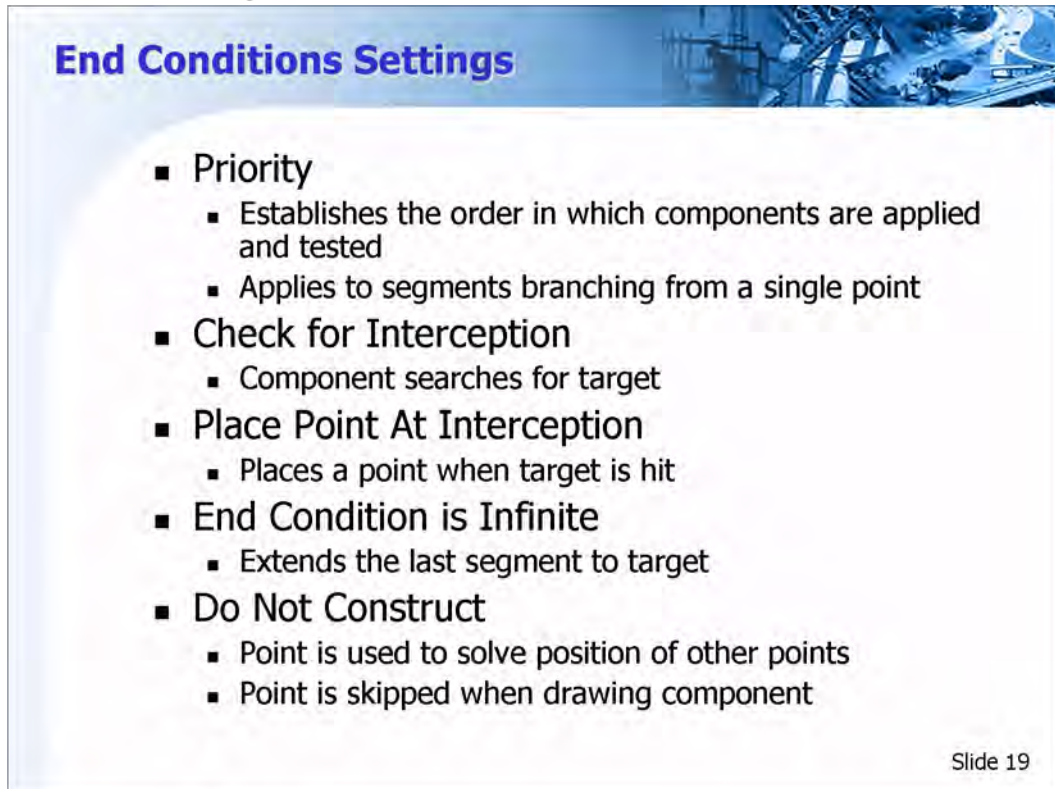
**Feature XYZ** - targets the horizontal offset and vertical elevation of any specified surface feature.

**Alignment XY** – targets the horizontal offset of any specified alignment.

**Alignment Elevation** - targets the vertical elevation of any specified alignment.

**Alignment XYZ** - targets the horizontal offset and vertical elevation of any specified alignment.

## End Conditions Settings

A presentation slide titled "End Conditions Settings" with a blue header and a background image of a road construction site. The slide contains a bulleted list of settings and their descriptions. The text is as follows:

- **Priority**
  - Establishes the order in which components are applied and tested
  - Applies to segments branching from a single point
- **Check for Interception**
  - Component searches for target
- **Place Point At Interception**
  - Places a point when target is hit
- **End Condition is Infinite**
  - Extends the last segment to target
- **Do Not Construct**
  - Point is used to solve position of other points
  - Point is skipped when drawing component

Slide 19

### End Condition Priority

Simple end conditions consist of cut and fill segments. When creating the roadway design, each condition will be tested in a specific order. That order is called the priority, which is numeric, and is assigned during end condition creation. The most desirable conditions are assigned the lowest priority numbers. The most desirable condition, and the first condition to be tested, is a priority of 1. The next condition to be tested will have a priority of 2, and so on.

For example, a design criteria calls for two fill conditions; 4:1 fill slope for an 8 foot fill height and a 3:1 fill slope for a 10 foot fill height. In this example, the target of each condition is the original ground surface. Each condition will be tested starting with lowest priority number. The first condition to successfully intersect the target, which is the original ground surface in this example, will be applied.

Priority is used when more than one end condition starts at the same point. In order for an end condition segment to be placed and used in the design, a segment or one of the segments connected to that segment must successfully intercept its target. If a segment or its connected segments do not intercept their targets, that group of segments fails and the next group of segments, with the next higher priority, are tested. It is important that end conditions have at least one solution that will not fail to intercept their targets.

## End Condition Settings

As you create the end conditions, there are several settings that will have to be considered to obtain the desired results. These settings are enabled or disabled and are set using the Dynamic Settings dialog during end condition point creation. To edit end condition settings, open the Point Properties dialog by double-clicking on the end condition point or by right-clicking on the point and selecting **Edit Point**.

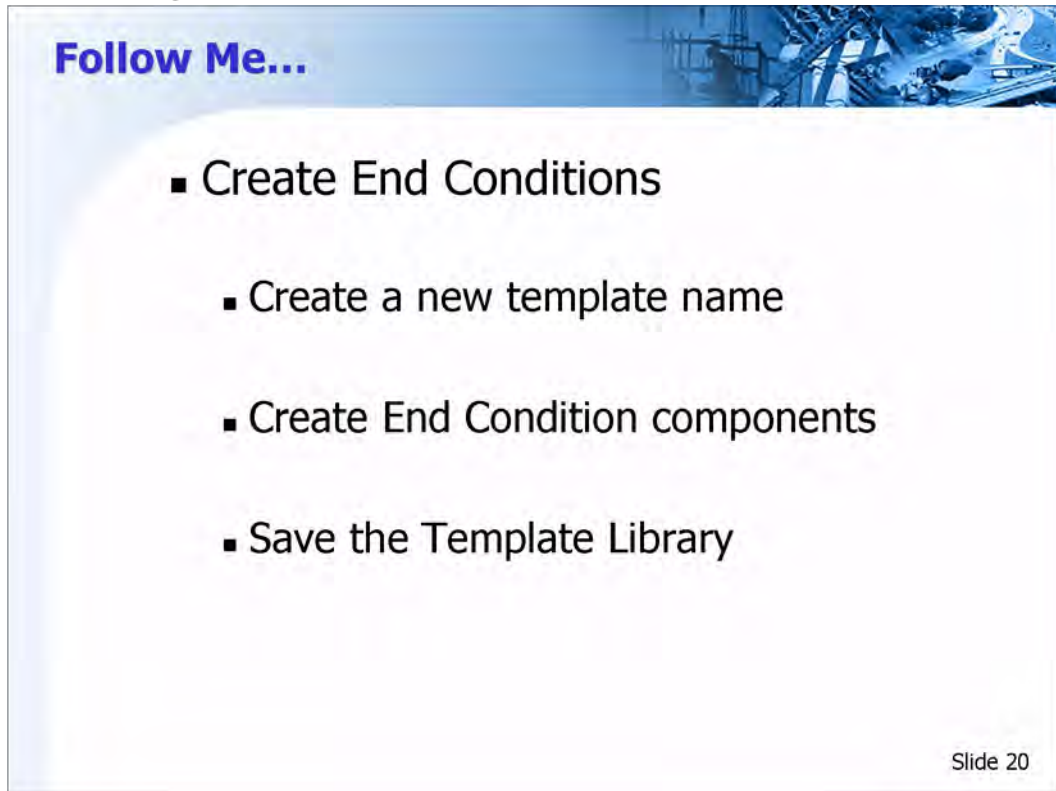
**Check for Interception** – when checked on, the line segment will search for the specified target. If checked off, the line segment will be created at its full width regardless of whether it intersects the target, provided that one of the segments connected to this segment successfully intersects the target.

**Place Point at Interception** – when checked on, a point will be placed at the location of the interception. If checked off, the line segment will be created at its full width, provided that one of the segments connected to this segment successfully intersects the target.

**End Condition is Infinite** – when checked on, the line segment will automatically be extended to intercept the target. If checked off, the line segment will only extend to its maximum constraint to meet its target. This applies only to the last line segment in an end condition.

**Do Not Construct** – If checked on, the end point of the line segment will be used as a reference point to find a subsequent point. The point will be solved like any other end condition point, but that point will be skipped when drawing the final component segments. This is normally checked off and is used only for more complex condition testing.

## Practice - Creating End Conditions



The slide features a blue header with the text "Follow Me..." in white. Below the header is a white rounded rectangle containing a bulleted list of four items. The background of the slide is a blue-tinted image of a road construction site.

- **Create End Conditions**
  - Create a new template name
  - Create End Condition components
  - Save the Template Library

Slide 20

### **Create a New Template Name**

- 1 Browse to the folder named *End Conditions* in the Create Templates dialog.
- 2 Create a template named *Simple Cut and Fill*.

### **Starting Dynamic Settings and Point Names**

- 1 Select **Tools > Dynamic Settings**, if not already displayed.
- 2 Enable the *Display Point Names* option.

## Create End Condition Components

- 1 Right-click on the Current Template Window and select **Add New Component > End Condition**.

The example design criteria calls for a 6:1 fill slope at fill heights between 0' to 5'.

- 2 Setup the *Current Component* portion of the Create Template dialog as follows:

*Name:* 6:1 FILL FOR 30'

*Style:* P\_ROAD\_FillLine

*Target Type:* Surface

*Priority:* 1

*Surface:* <Active>

- 3 Setup the Dynamic Settings dialog as follows:

*Point Name:* BOC (select from list)

*Apply Affixes:* Disabled

*Precision Input:* xy = 0,0

- 4 With your cursor in the xy=0,0 field, press the Enter key on your keyboard.

- 5 Setup the Dynamic Settings dialog as follows:

*Check for Interception:* Enable

*Place Point at Interception:* Enable

*End Condition is Infinite:* Disabled

*Do Not Construct:* Disabled

*Point Name:* 6:1 FILL (key-in the name)

*Point Style:* P\_ROAD\_FillLine

*Apply Affixes:* Disabled

*Precision Input:* hs = 30.0,-1:6

- 6 With your cursor in the hs = 30.0,-1:6 field, press the Enter key on your keyboard.

- 7 Right-click on the Current Template window and select **Finish**.

- 8 Right-click on the *BOC* point on the Current Template Window and select **Add New Component > End Condition**.

The example design criteria calls for a 3:1 fill slope for fill heights greater than 5'.

- 9 Setup the *Current Component* portion of the Create Template dialog as follows:

*Name:* 3:1 FILL

*Style:* P\_ROAD\_FillLine

*Target Type:* Surface

*Priority:* 1

*Surface:* <Active>

- 10 Setup the Dynamic Settings dialog as follows:

*Check for Interception:* Enable

*Place Point at Interception:* Enable

*End Condition is Infinite:* Enable

*Do Not Construct:* Disabled

*Point Name:* 3:1 FILL

*Point Style:* P\_ROAD\_FillLine

*Apply Affixes:* Disabled

*Precision Input:*  $hs = 40.0, -1:3$

- 11 With your cursor in the  $hs = 40.0, -1:3$  field, press the Enter key on your keyboard.

- 12 Right-click on the Current Template Window and select **Finish**.

- 13 Right-click on the *BOC* point in the Current Template window and select **Add New Component > End Condition**.

The example design criteria calls for a 3:1 cut slope for all cut conditions.

- 14 Setup the *Current Component* portion of the Create Template dialog as follows:

*Name:* 3:1 CUT

*Style:* P\_ROAD\_CutLine

*Target Type:* Surface

*Priority:* 1

*Surface:* <Active>

15 Setup the Dynamic Settings dialog as follows:

*Check for Interception: Enable*

*Place Point at Interception: Enable*

*End Condition is Infinite: Enable*

*Do Not Construct: Disabled*

*Point Name: 3:1 CUT*

*Point Style: P\_ROAD\_CutLine*

*Apply Affixes: Disabled*

*Precision Input: hs = 40.0,33.3%*


16 With your cursor in the *hs = 40.0,33.3%* field, press the Enter key on your keyboard.

17 Right-click on the Current Template Window and select **Finish**.

### **Save the Template Library**

1 Select **File > Save** in the Create Template dialog.

## Practice - Adding a Ditch End Component



**Follow Me...**

- Add a Fill Ditch
  - Continue working on Simple Cut and Fill
  - Create ditch End Condition components
  - Save the Template Library

Slide 21

Continue to work on the end condition template named *Simple Cut and Fill*.

### Create Ditch End Components

- 1 Right-click on the *3:1 FILL* point in the Current Template window and select **Add New Component > End Condition**.
- 2 Setup the Current Component portion of the Create Template dialog as follows:
  - Name:* DITCH
  - Style:* *P\_ROAD\_Ditch*
  - Target Type:* *Surface*
  - Priority:* 1
  - Surface:* <Active>



- 3 To place the second point, set up the Dynamic Settings dialog as follows:

*Point Name: DITCH BOTTOM* (select from list)

*Check for Interception: Disabled*

- ① This forces this line segment to be placed.

*End Condition is Infinite: Disabled*

*Do Not Construct: Disabled*

*Apply Affixes: Disabled*

*Precision Input: hs = 5,-1:4*

- 4 With your cursor in the *hs = 5,-1:4* field, press the Enter key.

- 5 Setup the Dynamic Settings dialog as follows:

*Point Name: DITCH BACKSLOPE* (select from list)

*Check for Interception: Disabled*

- ① This forces this line segment to be placed.

*End Condition is Infinite: Disabled*

*Do Not Construct: Disabled*

*Apply Affixes: Disabled*

*Precision Input: hs = 5,0*

- 6 With your cursor in the *hs = 5,0* field, press the Enter key.

- 7 Setup the Dynamic Settings dialog as follows:

*Point Name: DAYLIGHT* (select from list)

*Check for Interception: Enable*

*Place Point at Interception: Enable*

*End Condition is Infinite: Enable*

*Do Not Construct: Disabled*

*Apply Affixes: Disabled*

*Precision Input: hs = 5,25%*

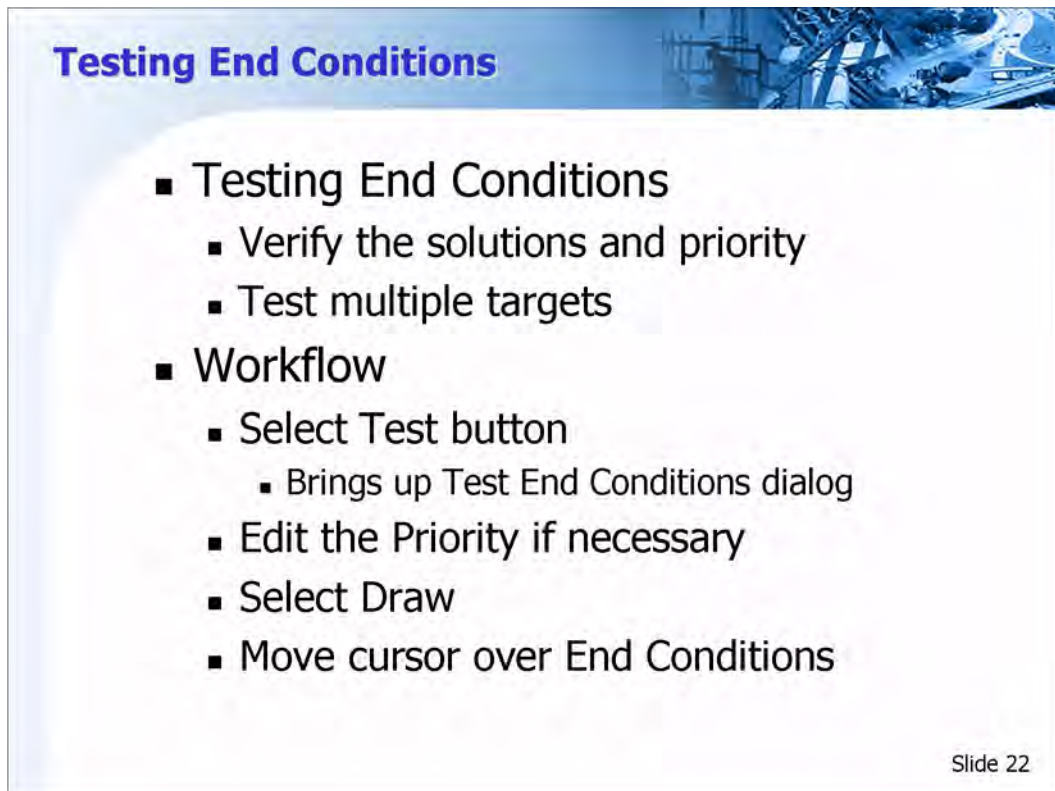
- 8 With your cursor in the *hs = 5,25.0%* field, press the Enter key.

- 9 Right-click on the Current Template window and select **Finish**.

### Save the Template Library

- 1 Select **File > Save** to save the template library.

## Testing the End Conditions



**Testing End Conditions**

- Testing End Conditions
  - Verify the solutions and priority
  - Test multiple targets
- Workflow
  - Select Test button
    - Brings up Test End Conditions dialog
  - Edit the Priority if necessary
  - Select Draw
  - Move cursor over End Conditions

Slide 22

### Testing End Conditions

End Conditions can be tested prior to and during during end condition creation. Testing will simulate how the end conditions will behave during modeling, without using the Roadway Designer.

To test that the end conditions produce the desired results, select the Test button located under the Current Template window. This brings up the Test End Conditions dialog. The window in the Test End Conditions dialog displays non-end-condition components as solid lines and end conditions as dotted lines. The scale of this window is dynamic and view controls are located at the bottom.

To test the end conditions, select one of the available targets and select the Draw button located on the right side of the dialog. Move your cursor over the testing window. The end conditions will change from a dotted line to a solid line, revealing the final solution for the proposed target intercept. If there are any priority conflicts, you will receive a warning message. Select the Check Priorities button to review and edit the priority of each end condition.

## Practice - Testing the End Conditions

Follow Me...

- Testing the End Conditions
  - Continue working on Simple Cut and Fill template
  - Test the End Conditions
  - Change the Priority

Slide 23

Continue to work on the end condition template named *Simple Cut and Fill*.

### Test the End Conditions and Change the Priority

- 1 Select **Test** located under the Current Template window.  
A warning will be given about the template having end condition priority conflicts.
- 2 Select **Check Priorities** on the right side of the Test End Conditions window.  
Notice that *BOC* point is a bold white color, which is an indicator of the point that has the priority conflicts.
- 3 Select **Edit**.  
Notice that all the end conditions have the same priority number.
- 4 Put your cursor in each of the fields and notice the segments highlighting.
- 5 Assume that fill is the most desirable condition and change the *Priority* of the *3:1 CUT* to 3 and the *Priority* of the *3:1 FILL* to 2.
- 6 Click **OK**, then **Close**.
- 7 Click **Draw** on the right side of the Test End Conditions window.
- 8 Move your cursor over the end conditions.

- 9 Change the *Use Surface Slope* to 10.00% and click **Draw** again.
- 10 Move your cursor over the end conditions.
- 11 Close the Test End Conditions dialog.

**Save the Template Library**

- 1 Select **File > Save** to save the template library.
- 2 Exit MicroStation and InRoads.

## Basic End Condition Component Creation Workflow

### Creating End Conditions

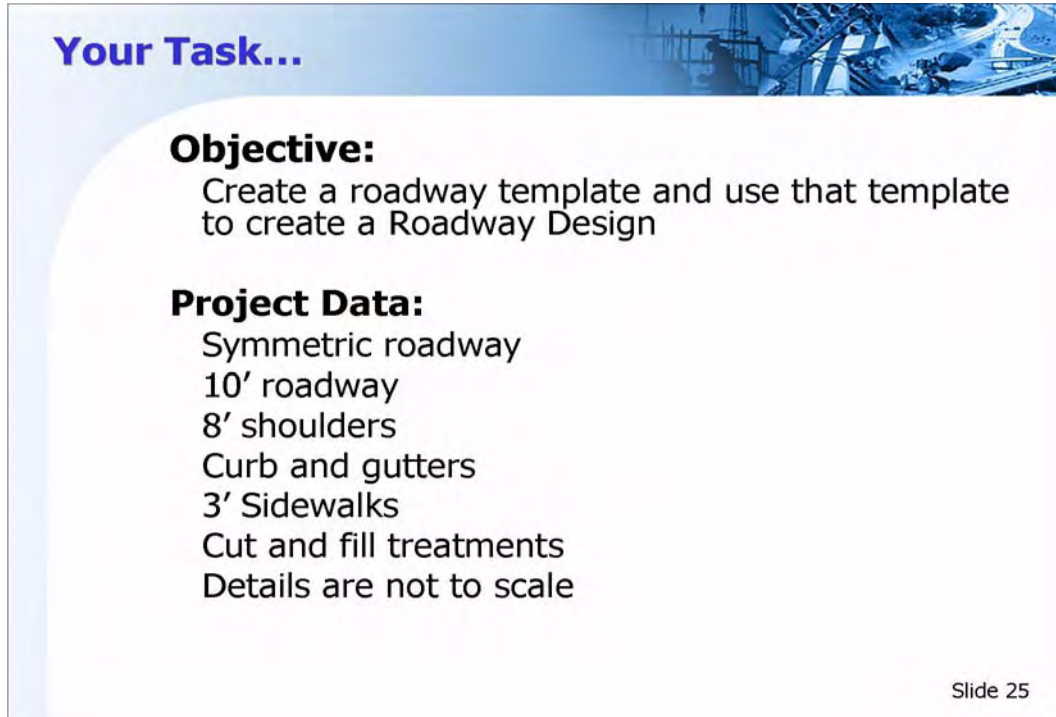
- Basic End Condition Component Creation Workflow
  - Select File > Open and open a Template Library
  - Select Modeler > Create Template command
  - Navigate to appropriate template folder used for End Condition components
  - Select File > New > Template command to create new template name
  - Select Add > End Conditions to create End Condition components
  - Test the End Conditions
  - Save the Template Library

Slide 24

### Basic End Condition Component Creation Workflow

- Open the *Template Library* using **File > Open**.
- Select **Modeler > Create Template**. This will bring up the Create Template dialog.
- Navigate to the template folder used for *End Condition* components.
- Select **File > New > Template** from the Create Template dialog. Name the new template, which is an end condition component.
- Select **Tools > Dynamic Settings** if the Dynamic Settings dialog is not open.
- Select **Add > End Condition** from the Create Template dialog.
- Add end condition components by using the Dynamic Settings dialog to specify the *Point Name* and *Style*, and the point locations.
- Select **File > Save** from the Create Template dialog to save the template library.

## Project Task



**Your Task...**

**Objective:**  
Create a roadway template and use that template to create a Roadway Design

**Project Data:**  
Symmetric roadway  
10' roadway  
8' shoulders  
Curb and gutters  
3' Sidewalks  
Cut and fill treatments  
Details are not to scale

Slide 25

### Task Objective

Create a roadway template from scratch and use that template to create a roadway design.

### Given Data

#### Working MicroStation File

- *C:\InRoads Training\InRoads 201\Firethorn Road\Firethorn Road.dgn*

#### Project File

- *C:\InRoads Training\InRoads 201\RWK\Firethorn Road Task.rwk*

The project file will load the correct preferences, geometry, and existing ground surface file. The individual files are listed below but do not need to be loaded individually if you load the project file.

#### Preference File

- *C:\InRoads Training\InRoads 201\Standards\Preferences\InRoads Training.xin*

#### Geometry Project

- *C:\InRoads Training\InRoads 201\Firethorn Road\Firethorn Road.alg*

### Existing Ground Surface

- *C:\InRoads Training\InRoads 201\Firethorn Road\Existing Ground Survey.dtm*

### Template Library

- *C:\InRoads Training\InRoads 201\Firethorn Road\Template Standards.itl*

### Additional Project Data

Detail Sketches (located on the following pages)

- Roadway Detail
- Curb and Gutter Detail
- Cut and Fill Detail

### Requirements

- Close and restart MicroStation and InRoads if they are running from a previous exercise.
- Open the “working” CAD file.
- Open the Project File (.rwk).
- Create a complete template using the provided details.
- Create a roadway design and design surface.
- Create cross sections and run **End-Area Volumes**.
- Save all new or modified files.

### Tips

- Create components separately.
- Toggle off Apply Affixes when creating components.
- Drag and drop completed components with Apply Affixes toggled on.
- Adjust template point locations or constraints using the **Edit Point** command if necessary.
- Test the end conditions prior to creating the surface model
- Use the Point Names List to create any missing point names and associated styles (most point names have already been created).

### Questions

What is the total cut and fill based on the End-Area volume computation?

End-Area Cut Volume \_\_\_\_\_

End-Area Fill volume \_\_\_\_\_

How many components make up the final template? \_\_\_\_\_

### Assistance Video

Videos demonstrating how to complete this project are available if you need assistance.

- 1 From the InRoads menu, select Help > Training.
- 2 Select InRoads 201 for the Learning Module.
- 3 Select the Task 03 folder.
- 4 Double-click on the video to view.

**Time Allowed**

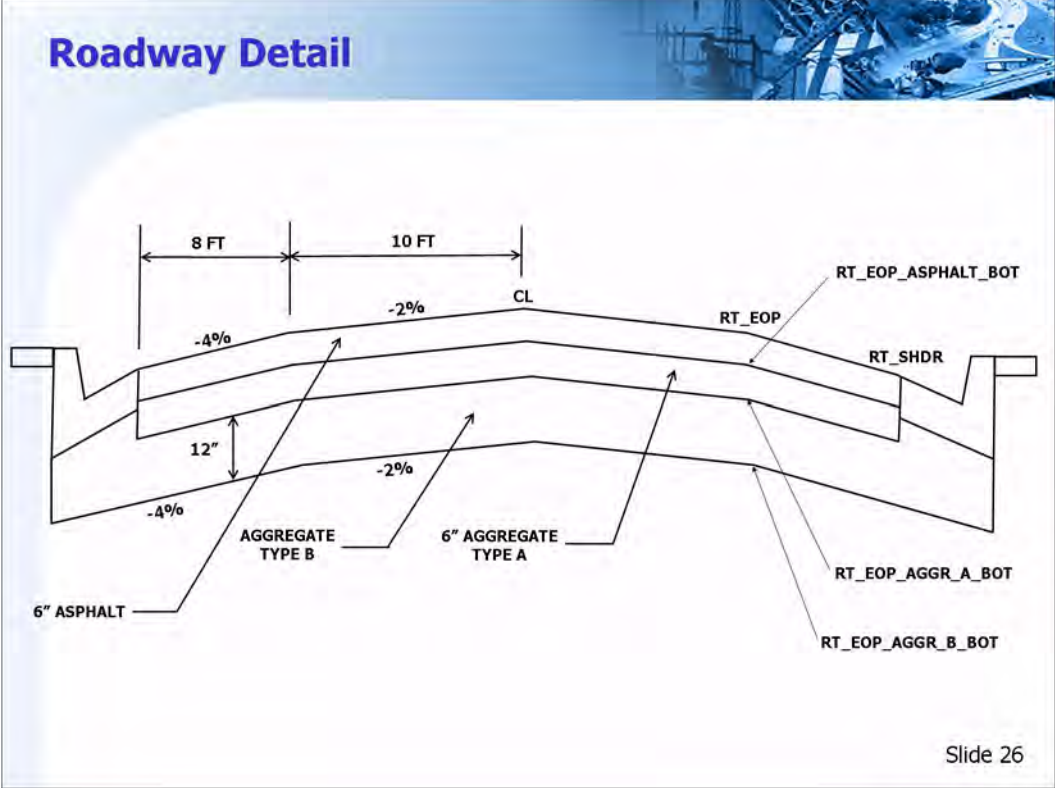
2 hours

**Cleanup**

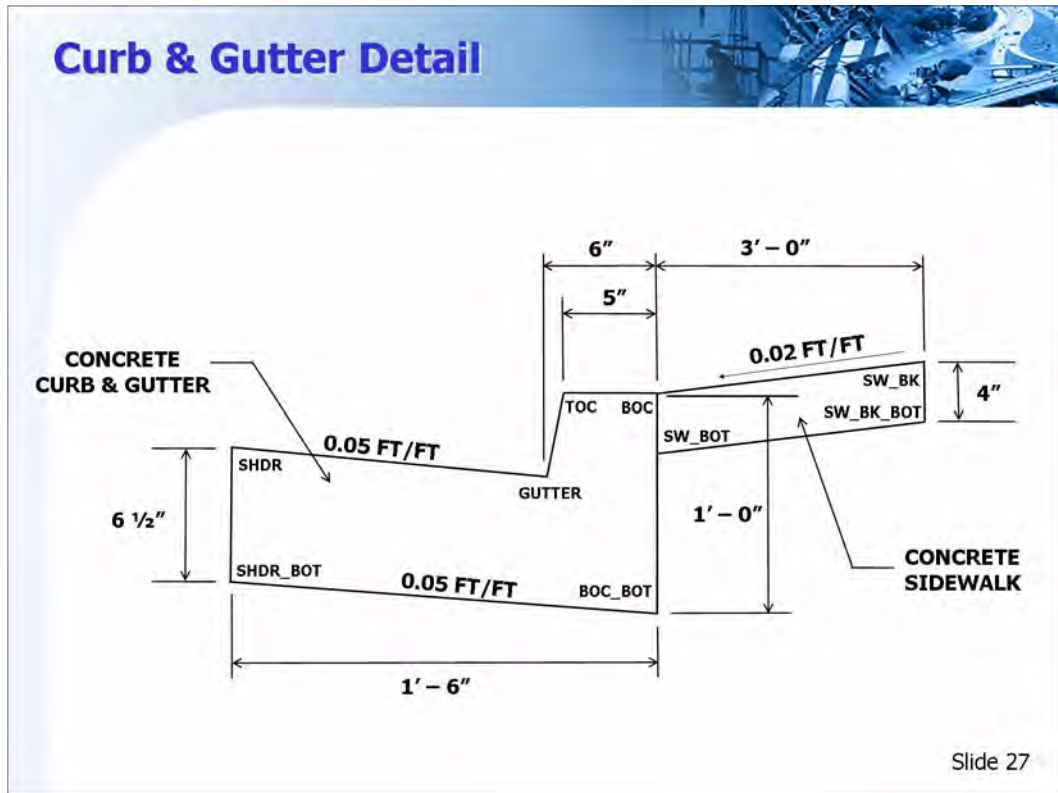
When finished, exit MicroStation and InRoads.



# Roadway Detail



## Curb and Gutter Detail



# Cut and Fill Detail

