
CET-2030 Construction Graphics Inroads Road Modeler Procedure Summary

The following procedures will allow you to design, produce and display roadway geometrics in a master file using Inroads. The standard procedure summary is:

- Create a Proposed Horizontal Alignment.
- Station and Annotate the Horizontal Alignment for display on plans.
- Create an Existing Profile along the Alignment.
- Design a Proposed Vertical Alignment on the Profile.
- Annotate the Profile and Vertical Alignment for display on plans.
- Create Typical Section Templates.
- Assign application locations for the Templates.
- Model the roadway along its length.
- Create a proposed roadway surface.
- Cut cross-sections along the Alignment.

Step 1 Geometry Project Set-up

The Geometry Project file is where all horizontal and vertical alignments are stored and associated with one another as well as profile windows.

1. To begin, enter into your SITEXXX.dgn file from Inroads and Microstation. Save the file as **ROADXXX.dgn** in your **CET2030** folder.
2. From Inroads and the Bentley Inroads Control Window Choose **File>New**.
3. Select the **Geometry Tab** and select Type: **Geometry Project**.
4. Choose a name for you Geometry Project. (**Road**)
5. Hit **Apply**.
6. Save the project in the **CET2030/INROADS** folder with an .alg extension.

Step 2 Import Alignment from Graphics

1. Design your horizontal alignment

Use Microstation commands to produce tangents. After your tangents have been placed, create a **Complex Chain** out of the tangents which will allow an easier import to Inroads.

2. From Inroads and the SelectCad Main Control Window Choose **File>Import>Geometry** From the From **Graphics Tab** Choose:
 - a. Type: **Horizontal Alignment**
 - b. Name: Enter a name for your alignment (**Road1**)
 - c. Style: **Default**
 - d. Horizontal Curve Definition: **Arc**
 - e. Target Geometry Project: **Road**

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- f. Select: Resolve Gaps and Non-Tangencies
 3. Hit the **Apply** Button
 4. Select your graphics for your alignment. (**One Snap and Two Clicks and a reset only!**)
 5. Expand the ROAD geometric project icon tree to see if Road horizontal alignment exists. If not you need to import correctly.
 6. From **Geometry>Horizontal Curve Set>Define Curve** define the correct curve radius for the PI.
 - a. SCS Curve Set type, Define Transition by Length
 - b. Set Radius
 - c. Change Horizontal Alignment level to Centerlines
 - d. Apply
 7. Change the Horizontal Alignment graphics to LV=Centerlines.
 8. Copy the Centerline out to form right of way lines on either side of the roadway. Change the graphics to LV=Prop. Lines & ROW .
 9. Save your Geometry Project from the Bentley Inroads Control Window and your Microstation file from the Microstation window.

Step 3 Review & Station the Horizontal Alignment

The alignment should be reviewed and then graphics written into the file for descriptive display on plans.

1. Make you **Road1** Horizontal Alignment your **Active Alignment** by highlighting the Road1 name in the Bentley Inroads Control Window.
2. From **Geometry>Review Horizontal** look at the report about the alignment to see if it looks correct. (Check alignment length and curve data.)
3. Enact the Stationing command from **Geometry>View Geometry>Stationing**
4. From the **Main Tab**:
 - a. Select your Horizontal Alignment
 - b. Method: **Automatic**
 - c. Interval: **100'**
 - d. Unselect everything except for Majors and Cardinals
5. By clicking each item's name in the Symbology box, edit Major & Cardinal Stations text to FT=3, LW=1, LV=Stationing. Major Ticks & Cardinal Leaders to LW=0, LV=Stationing.
6. From the **Regular stations Tab** Select in the **Major** category:
Parallel, Upstation, Left, Precision=0, Format: (sss)+ss.ss, Offset=0.10, Ticks = +/- 0.05, Majors/Minor=0.
7. **Cardinals Tab** Select: Perpendicular, Upstation, Format:: ss+ss.ss, Precision: 0.12

8. Hit the **Apply** Button first, then Undo and reset items if things don't look correct.
9. From **Geometry>View Geometry>Curve Set Annotation**
 - a. From the Main Tab Select the alignment and limits. Turn off the Tangents and PI Symbol. Edit text to FT=3,, LW=1, LV=Stationing. Check on Absolute Angle = 0°.
 - b. From the **Advanced tab** select: Station, R, Dc, Arc Length, Delta, T & E.
 - c. Select the correct format for the station (ss+ss.sss) and add descriptive **prefixes** for each of the selected curve elements. Use a ' suffix for any measurement in feet.
 - d. Hit the **Apply** button to place the curve data.
10. Drape the Topo Surface with a Centerline Feature for future use.

Use **Surface>Design Surface>Generate Longitudinal Feature** to create a draped centerline feature on the Topo surface. This will allow the existing elevation along the centerline to be annotated in the cross-sections.

- a. From the Main Tab
 - i. Surface: **Topo**
 - ii. Interval: **10'**
 - iii. Name: **EXCL1, 2 & 3** (for the 3 portions of the horizontal alignment)
 - iv. Feature Style: **Centerline**
 - v. Point Type: **Breakline**
 - vi. Turn off: Generate Graphics only
 - vii. Check on: **Exclude from Triangulation**.
- b. From the Controls Tab
 - i. Vertical: **Drape to Topo** surface.
 - ii. **Apply** and select the Original Centerline.
 - iii. Check for feature at Surface>View Surface>Features
 - iv. **Save the Topo Surface w/o retriangulation**.
 - v. **Delete the generated EXCL graphics. Be careful not to delete the stationing. (Turn of stationing level if you so desire before deleting the EXCL lines)**

Step 4 Create a Profile Window

In order to design a Vertical Alignment for a roadway, a profile window with the existing grade along the horizontal alignment is needed.

1. Place a thick line weight reference line to the right of your topo in the road master file which will serve as a marker for the profile.
2. Open the **Evaluation>Profile>Create Profile** command.
3. From the **General** select:
 - a. Set Name: Name of set of profiles (**Road1**) First in the HA Road1.
 - b. Direction: Left to Right, Exaggeration: **4:1** (20 scale drawing)
 - c. Symbology: **Topo** (edit Profile to LW=0,LC=2, LV=Fence) Apply the edit.
4. From **Source**: Create: **Window & Data**, Alignment: **Road1**
5. From the **Controls Folder** select:
 - a. Elevation: **High:1120 Low : 1080**
 - b. Stations: Use Full Alignment Length
6. From the **Axes Folder**: No changes
7. From the **Grid Folder** Select **only Major Horizontal & Vertical Grids**
8. From the **Details Folder**: Click off Legend and Title Text & box.
9. Hit the **Apply** button and place the profile with a data point at your reference mark in your file. (Do not retriangulate the Topo when asked)

Step 5 Design a Vertical Alignment

1. Using **File>New** create and save a new Vertical Alignment (Road1) from the Geometry Tab.
2. From **Geometry>Vertical Curve Set>Add PI** begin to place PI points along your profile and your Road1 horizontal & vertical alignments active. Hit **Apply** and manually place points where you think they should go, carefully snapping to points at the beginning and the end of the alignment at the centerline of the intersecting roadways. The software will update the alignment on the profile so that you can see the vertical alignment as you design it.
3. If necessary, **Move** current PI's or **Insert** new ones using the other Curve Set commands .
4. When you think your alignment is established well enough, round PI stations to even and grades to even 0.04% using **Geometry>Vertical Curve Set>Define Curve**. Using a **Define PVI** By option of **Station and Entrance Grade**, even up your stations and grades. Hit **Apply** to enact changes each time!!!! *Do not delete the % sign when editing the grade since this will give you large grades and a tangent that is off of the profile!!!*
5. Finally, **define** your **vertical curves** with the same command box. Define by **K-Value** and toggle to **Length** to determine if the minimum 200' length is satisfied. Enter **200'** if needed. Hit the **Apply** button to enact changes each time!!

6. Review the vertical alignment. From **Geometry>View Geometry>Review Vertical** look at the report about the alignment to see if it looks correct. (Check alignment length and curve data and elevations. Look for duplicate PI's.)
7. **Save** the Geometry Project.

Step 6 Annotate the Profile & Vertical Alignment

The alignment should be reviewed and then graphics written into the file for descriptive display on plans.

1. Make your **Road1** Alignments your **Active Alignments** by highlighting the Road1 name in the Bentley Inroads Control Window.
2. Enact the **Evaluation>Profile>Annotate Profile** command
3. From the **General Heading** Select:
 - a. Profile Set : **Road1** (This highlights the profile window)
 - b. Vertical Alignment: **Road1**
 - c. Surface: **Topo**
4. From the **Selection Heading**:
 - a. **Remove Everything except Existing & Proposed**
5. From the **Existing folder** set precision to 0.1, interval = 50' Click on the colored end tab on the Data line and select LW=0, FT=3, LV=Trees, Offsets Horiz.= -0.2, Vertical = 2.5 (Hit **OK**)
6. From the **Proposed folder** set precision to 0.12, interval = 50' Click on the colored end tab on the Data line and select LW=1, FT=3, LV=Ex. Bldgs Offsets Horiz.= 0.1, Vertical = 6.5 (Hit **OK**)
7. From the **Frames - Symbology Folder** unselect Leader, Frames & Tick.
8. Hit the **Apply** button to permanently place the graphics. If a mistake has been made make the changes to the proper settings and hit apply again.
9. Enact the **Geometry>View Geometry> Vertical Annotation** command.
 - a. From the Main Tab select the proper alignments.
 - b. From the **Points Tab** select **PVC, PVI and PVT** text and points. Edit FT=3 for all text.
 - c. From the **Curves Tab** select **Common Curves** select only Length (0), Entrance and Exit Grade (0.12) (50%) and Sight Distance (0). Edit FT=3.
 - d. From the **Curves Tab** select **Symmetric Parabolic**. Select only **K** and edit FT=3.
 - e. From the **Tangents Tab** select **Grade** (0.12) (50%)
 - f. From the **Affixes Tab** set an = behind each appropriate prefix in each required category and remove the "Grade" prefix in the Tangent category.
 - g. Hit the **Apply** button to place the graphics. If a mistake has been made make the changes to the proper settings and hit apply again.

Step 7 Create Typical Section Templates

Your designed typical section needs to be replicated with templates that will be run along the alignments to design the road. Standard road piece templates can be assembled and modified into a full typical template.

1. Go to **Modeler>Create** Template.
 - a. File>Save As> Road1.itl
 - b. With the CET2030/Inroads/Road1.itl highlighted **File>New Folder** and name it Road1.
 - c. With the Road1 Folder highlighted **File>New Template** and name it **Normal**
2. Open the **Pavements Folder**. Check on the **Dynamic Settings** button. Locate and drag the **12' Travel Lane** to the right into the template grid. While doing so, right click and check **Mirror**. Place the template at the center origin point.
3. Open the **Misc. Components folder**, locate and drag the **30" C&G** template to the edge of the 12' lane.
4. Open the **End Conditions folder**, locate and drag the **Urban Slope with Sidewalk** to the back of the curb.
5. Edit the points of the template to make the template replicate the design typical section. Right click a point, choose edit and modify slope, horizontal or vertical distances of the component. For this exercise, edit the following points:
 - a. EP L & R : Horizontal = 16' Slope = 1.6%
 - b. EP1 L & R & CL1's: Vertical = -0.25'
 - c. EP2 L & R & CL2' s: Vertical = -0.75'
 - d. CG2 L & R: Vertical = -1.50'
 - e. CG1 L & R: Vector Offset = 1.50'
 - f. Shoulder L & R: Slope = 2.00%, Horizontal = 10'
 - g. BC_L & R: Horizontal = 0.42'
 - h. TC_L & R: Horizontal = 0.08'
6. Modify the sidewalk to be 2' inward from the shoulder.
 - a. Delete the displayed Sidewalk Component with a Right Click and Delete Component Command.
 - b. Right click the window **Add Component>Constrained**.
 - i. Click in 4 points in the approximate location of the proposed sidewalk at a location 2' in from the shoulder.
7. Edit the points of the sidewalk in the following manner:
 - a. Point R/L : Rename SW_R/L
 - i. Constraint 1: Horizontal to Shoulder = -2.00'
 - ii. Constraint 2: Slope to Shoulder = 2.0%

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- b. Point 1R/L : Rename SW1_R/L
 - i. Constraint 1: Horizontal to SW_R/L = -4.00'
 - ii. Constraint 2: Slope to SW_R/L = 2.0%
 - c. Point 2R/L : Rename SW2_R/L
 - i. Constraint 1: Horizontal to SW1_R/L = 0.0'
 - ii. Constraint 2: Vertical to SW1_R/L = -0.33'
 - d. Point 3R/L : Rename SW3_R/L
 - i. Constraint 1: Horizontal to SW_R/L = 0.00'
 - ii. Constraint 2: Vertical to SW_R/L = -0.33'
 - e. Right click the sidewalk component shape and Edit the component.
 - i. Ensure that the **Close Shape box** is checked **on**.
 - ii. **Rename** the component **Sidewalk_R/L**
 - iii. Change the **Style** to **Prop. SW**
 - f. **Repeat for opposite side of road sidewalk.**
8. In the Library Window, **copy and paste** the **Normal** template into the Road1 folder. Rename it **2/3 Super**. Edit the right lane slope to **+1.6%** to slope to the left. Edit the **Right Gutter Slope** to **-5.4%**.
 9. In the Library Window, **copy and paste** the **2/3 Super** template into the Road1 folder. Rename it **Full Super**. Edit both lane slopes to **+2.7%** to slope to the left. Edit the **Right Gutter Slope** to **-4.3%**.
 10. **File>Save** the template library.

Step 8 Define & Model the Roadway

The roadway definition tells the software where to apply which templates, on what horizontal and vertical alignment to what surface for the existing ground. It will also help in transitioning the templates smoothly as the superelevation develops through the curve.

Ensure that you have **opened** and have **active** your **Surface: Topo**, your **Geometry Project: Road1** and your **Template Library: Road1**

1. From the Bentley Inroads Control Window choose **Modeler>Roadway Designer**.
2. Click on the Manage Corridors Icon (The 1st Button) in the Tool banner.
 - a. Name: **Road1** Type: **Alignment**
 - b. Horizontal Alignment: **Road1**
 - c. Vertical Alignment: **Road1**
 - d. **ADD**
3. Click on the Template Drops Icon (2nd Button)
 - a. Expand the Template Library tree to find and open **Road1** templates.

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- b. Add Drops at required stations for your alignment (Click a template and enter the required station for that template.) Enter **25'** Intervals.
 - c. Close the Add Drops window **File>Save As : Road1.ird**
 4. Click through the alignment in the lower right window to see how the templates and drops react along the road.
 5. Click in the **Blue Curve** areas in the **Upper-left Corridor Area** where the superelevation should be transitioning. This will open a new window displaying an isometric view of the transition area.
 - a. **Right click a template point** and **move** the template to be able to see the transition.
 - b. Hit **OK** to open a new window of the template in the transition area. Slide the slider bar to see if/how the template transitions through the area.
 - c. Right click and Edit Points that allow the road surface to transition smoothly through the area. It will be necessary to change the **Slope Constraint** to **None**. Again move the slider bar to see if the transition is successful. Repeat in all areas to Unconstrain all points necessary for every transitions to move smoothly. **Save**.
 6. From the **Corridor Manager** lower right hand corner hit **Process All**.
 7. **Save** the Roadway Library from the Bentley Inroads Control Window.

Step 9 Create the Road Surface and Graphics

This step will create a surface for the designed road and will allow road features to be drawn in the Microstation file.

1. From the Bentley Inroads Control Window choose **Modeler>Roadway Designer**.
2. Click the Create Surface Icon (last Button in the line)
 - a. Name: **Road**
 - b. Check: Empty Design Surface, Triangulate, Add Exterior Boundary
 - c. **Apply**
3. **Surface>View Surface>Triangles**
 - a. Display the **Road** surface triangles.
 - b. Delete any jumping triangles along the top/toe of slope areas between stations 3+00 to 10+00. (**SURFACE>EDIT SURFACE>DELETE TRIANGLES**).
 - c. When finished Right Click and **Save As** the surface as **Road.dtm**. Delete the triangles from the graphics file. Compress and save the Road.dgn file in Microstation.
4. Go to **Surface>View Surface>Features**.
 - a. **Move** the originally drawn **centerline** that is at **Elev. = 0 to Level=54**.
 - b. Check on the Road1 features that exist at the ground level. Thus check **on**:
 - i. Tie L & R (Cut & Fill)

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- ii. Shoulder L & R and SW L & R
 - iii. BC, TC and Gutter L & R
 - iv. EP L & R
 - v. CL
5. **Apply.**
 6. Change the attributes of the modeled roadway to match our normal level structure.
 - a. **Slopes Level:** LW=1 with Toe/Top= Dashed (LC=2) Be careful since cut and fill toes/tops are not a contiguous line.
 - b. **Roads, Curbs & Walks Level:** LW=2 for E/P and LW=0 for Curbs.
 - c. **Centerline :** LW=0, LC=7.
 - d. Compress and save the Road.dgn file.

Step 10 Create and Annotate Cross-Sections

Finally we can create cross-sections at any location and interval desired. First we also need to make a surface out of the Subgrade features.

1. Turn off the Centerline, Proposed Pavement & Top Slopes level.
2. **Surface>View Surface>Features**
 - a. Display the following features from the Road1 surface:
 - i. BC L&R, GC1 L&R, EP3 L&R and CL3
 - b. Change the level of the newly displayed features to LV=46 (unused).
 - c. Import Level 46 to a new surface called Subgrade (50' & 10')
 - d. Triangulate the surface. (Max Length= 25')
 - e. Delete the jumping triangles and save the surface.
3. Open the **Evaluation>Cross-section>Create Cross-Section** command.
4. From the **General Heading** Select:
 - a. Set Name: **Road1**
 - b. Create: **Window & Data**
 - c. Interval: **100'**
 - d. Offsets: +/- 100'
 - e. Source: **Alignment (Road1)**
 - f. Vertical Exaggeration: **1.0**
 - g. Check on Topo, Road & Subgrade Surfaces
 - h. Edit Symbology:
 - i. **Road & Subgrade** surfaces Cross-section Lines– LW=2, LC=0, LV=Fence, **Apply**

ii. **Topo** Surface Cross-section Lines- LW=0, LC=2 LV-Striping
Apply

5. From the **Source Heading** Select Alignment: Road1
6. From the **Include Heading** All Checked off
7. From the **Controls Folder** select:
 - a. Limits : Elevations: **High- 1110 & Low 1105**
 - b. Limits: Stations: **4+00 to 8+00**
 - c. Critical sections: All checked off.
 - d. Check on **Planarize** at 0.0 Elevation.
8. From the Layout Heading:
 - a. General: Mode= **Stacked**,
 - b. Spacing: **5 sections** per column. Vertical Top to bottom: 25'
9. From the Axes Heading: Leave setting alone.
10. From the Details Heading: No Title or Legend Text or Box.
11. Hit the **Apply** Button and then a data point to **locate** the sections in the file. Do not retriangulate the Topo.dtm file when asked.
12. Open the **Evaluation>Cross-section>Update Cross-section** command.\
13. Select Road1 under cross-section set.
14. Under the Crossing Features heading, click on the **Display On** button
 - a. Highlight Surface **Road** then Feature **Road1-CL** hit **Apply**.
 - b. Highlight Surface **Topo** then features **EXCL 1,2,3** hit **Apply**.
15. Open the **Evaluation>Cross-section>Annotate Cross-Section** command.
16. From the **Main Tab** select:
 - a. Cross-section set: **Road1**
 - b. Surface: First run though with **Topo** then with **Road** checked on.
17. From the **Points Folder** : Check off all boxes.
18. From the **Segments Folder** : Check off all boxes.
19. From the **Features Folder** select:
 - a. Check on: **Elevation Only**
 - b. Precision: 0.1 (Topo), 0.12 (Road)
 - c. **No Prefixes**. Edit elevations to absolute angle placement by clicking the colored box in the Elevation line. LW=0 (Topo) LW=1 (Road) LV=Topo Elevs for each surface.
 - d. **Under the Annotate Heading**: Highlight the centerline features and hit **Apply**.

20. Adjust the annotation including the stationing to appropriate levels, weights, text sizes and locations.
21. Modify the subgrade surface displayed to show proper subgrade shape.
22. Display Cut & Fill by End Area Quantities.
 - a. From Evaluations>Volumes>End Area Volumes
 - i. Select Topo & Road Surfaces
 - ii. Station Limits 4+00 to 8+00
 - iii. Units = **Cubic Yards**
 - b. From the Annotation Heading
 - i. Select Cut & Fill Areas & Volumes
 - ii. Select Precision = 0 for all selected cases.
 - c. **Apply**
 - d. Move results into proper positions using Microstation commands.