Road Work Ahead: New Techniques for Road Reconstruction Using Civil 3D

Peter Funk
5D Solutions, Inc.

Learning Objectives
- Learn how to apply the Road Rehab tools in Civil 3D to a mill and overlay job
- Learn how to incorporate mobile LiDAR data to create a base model for rehab design
- Learn how to apply the rehab tools to design a mill and overlay job that will save materials and produce a better final road
- Learn how the rehab reports can be customized to meet local requirements

Description
With 80% of road construction budgets going toward road rehabilitation, is "mill 2/overlay 2" the best that can be done? This class will explore the new road rehab tools in Civil 3D software, and show how you can use them to reduce milling, cut materials costs, and produce a smoother final road surface. We’ll explore the new tools, as well as how to incorporate mobile LiDAR (light detecting and ranging) into your design process to identify potential problems during design instead of in the field. We’ll also look at how the techniques in these new tools are being used at the United States Department of Transportation.

Speaker
Introduction

The premise for this class is that you can save money and produce a better final road design project using the tools inside of Civil 3D, but there is a catch. In order to reap these benefits, you need a detailed road surface and time both process the data as well as do the design.

For this class we are going to look at what it takes for this process, in terms of the amount of time to collect and process the data, analysis the data and create a design as well as the potential to tighten the cost estimate.

Process

Here is the process that we are going to review in this class:

1. Collecting the data
2. Process the data using Autodesk Recap.
3. Using InfraWorks to extract centerlines
4. Import point clouds into Civil 3D
   a. Alternative using Civil 3D to extract centerline
5. Create an existing ground surface from the point cloud
6. Create an existing ground profile from EG surface
7. Create an assembly for analysis
8. Create a corridor for analysis
9. Create a volume surface for analysis
10. Create a Rehab Corridor
11. Create reports
12. Widening

Process

Let’s review the process that was used on this project to collect, process, analysis and model the road reconstruction job.

Collecting the data

To make this process work, we need to have a detailed surface model, but this data needs to be collected and processed in a cost-effective way. We used mobile LiDAR to collect over 20 miles of data in less than a day. The result was a collection of 75 laz files.
Process the data
To process the data, we used Autodesk ReCap to process and combine these laz files to create ReCap files. This is a very simple process to add the files and then letting ReCap process the files in the background.
Extract Centerlines
Extracting the centerlines can be done in a couple of ways. We have a video that shows InfraWorks can be used to extract string lines for the centerline as well as the edge of pavement lines. The other way these can be extracted is to use Civil 3D to just draw an alignment using the point clouds as a background.

After we do a little analysis, we will go back and add superelevation to the alignment.

Import point clouds into Civil 3D
After the point cloud is processed, we can import it into Civil 3D. The one thing that is important to check is that both the point cloud and the drawing need to have a coordinate system set.

Create an existing ground surface from the point cloud
This is very simple process to do, but there are a few things that you should watch for: I use a filter on the cloud that uses 1’ as the spacing between the points. This will still give you a very dense road surface but won’t give you every point in the cloud.
The other thing is to make sure you use a filter (I used Kriging interpolation) to throw out some noise in the point clouds (such as power lines, overhead signs and vehicles).
Create an existing ground profile from EG surface
This is a pretty simple step, adding the surface profile to the drawing is really an option.

Create an assembly for analysis
At this point, I create a simple assembly that will analysis the surface using generic links. The two sub-assemblies I use Link Offset to Surface to set points on the surface and at 12’ left and right. I then add a vertical link to those points, dropping them 2’.
Create a corridor for analysis
After the creation of the assembly, I create a corridor model using the elements that we’ve made up to now. One key value that should be changed is to NOT use vertical profile points in the profile. Because the surface profile was created from the LiDAR surface, it is very dense and will cause the corridor to take a long time to build.

After the corridor is created, we’ll make a corridor surface using the feature lines that were made by the 2" vertical links. We can use this surface to analyze the slope of the existing surface.

One thing that we can do with the analysis corridor is to extract either the center or the EOP lines produced along the alignment. This chains would have points at the corridor interval and could be used to create a best fit profile, or a simple surface of the existing ground.

Create a volume surface for analysis
With the corridor surface as well as the EG surface we can create a volume surface, using the corridor surface as the base, and the EG surface for comparison. This will create a volume surface that represents the milling volume for the region.

There are a few things we can do with this surface. The first is to look at the volume that is calculated to see how well it matches to a manual estimate.

The second is to do a heat map of the surface to see where along the corridor where we are over and under milling the surface to 2”. I’m going to assume that anything between 1.5 and 2.5” is OK and will only be looking for under and overs. The over mills could be a problem if you are milling into the base course (and potentially destabilizing the road, and the under mill are bad because they may not allow the road to produce a good bond.

To look at this, we’ll change the style of the volume surface to use a depth map with 3 ranges, 0-0.125’, 0.125’ – 0.21’ and 0.21’ and above. After setting the ranges, we can add a table to the model that shows the areas for each of the ranges.
Create a Rehab Corridor
The next very powerful tool that we'll look at is the Rehab Corridor. This flexible tool will mill and/or overlay a roadway with a host of options.

To start, we'll create a rehab corridor using the alignment and surface profile. The profile that is used can just be a simple tangent if desired because the tool will seek the existing ground surface on it's on. When we make the rehab corridor we just make it for the first 100’ of the roadway, and then after it is built, we’ll go back and change the length to the full 8000’ and change the corridor to NOT add corridor stations at vertical profile points.

Figure 6 - Rehab Parameters
Create reports
A major part of the rehab tool are the reporting tools that are built in. These reports give both information on the slope, slope corrections as well as the mill and overlay depths at incremental offsets from the center line.

Figure 7 - Cross Slope Correction
The rehab corridor is "just" a corridor made from an assembly. This assembly can be added with additional lanes or wider shoulders.

**Conclusion**

I think the takeaways from this class should be that the corridor tool in Civil 3D can be used to model both the reconstructed roadway, but that it can also be used as a tool in the modeling process to analyze the existing conditions and explore options for milling and overlay.