

CI226747

Road Work Ahead: New Techniques for Road Reconstruction Using Civil 3D 2019

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Learning Objectives

- Learn how to incorporate mobile LiDAR data to create a base model for rehab design
- Learn how to apply the Road Rehab tools in Civil 3D 2019 to a mill and overlay job
- 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, reduce material 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 in design instead of in the field. We'll also look at how the techniques in these new tools are being used at a United States Department of Transportation.

Speaker(s)

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Introduction

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Workflow

In order to use the mill and overlay tools inside of Civil 3D, you need to have data for a road rehabilitation project. While that may seem obvious, it is an impediment for just jumping and trying out the tool. The following project data is needed:

- An existing ground surface of the road
- The existing centerline alignment of the road with superelevation data
- Profile of existing ground, and optional design profile

Existing Ground

The better the existing ground data is, the more detailed the investigation of the project will be. If you have 25' sections with 3 data points (left, center, right), you're not going to get very much out of the process. On the other hand, if you have a LiDAR surface of the road with points every 2", you'll be able to go a lot of design exploration. We'll be looking at ways to get this type of data next.

Existing Center Line

We're going to be using the Civil 3D Corridor for design, so we need an alignment in the drawing. This can either be the design alignment from historic data, or a best fit alignment pulled from the data. If you add superelevation data for the existing road conditions the tool can be used to put the road back into compliance or even increase the design speed of the road.

Profile Data

The only profile that is needed is an existing ground profile. With the alignment and ground surface, that can be made in a flash. If you want to get really detailed, a new smoothed design profile could be created for the road with vertical curves.

Getting Data

The first step in this process is the collection of a detailed surface. The only practical way to collect this information is with some type of mobile scan. The cost of sending survey crews out to collect the information "by hand" would be prohibitive and having survey crews out in the road to collect a detailed surface would be dangerous and disruptive.

Collecting the Data

That data that we're using for this class was collected from a seven-mile segment of road in Huntsville, Alabama using a mobile LiDAR unit with supplemental ground control. The data was collected in about 2 hours one day and the resulted in a surface with sub centimeter accuracy (and a relative accuracy of much less than that). For the non-surveyors (like me) that means that the road may be off by $\frac{1}{2}$ ", the surface points elevations may only be off by a mm. In other words, the surface that we're going to be making is going to be a really, really good model of the actual roadway.



Mobile LiDAR Unit

Ground control was added for this project to increase the accuracy of the scan and to allow the final product of the process to be used for automated machine guidance (AMG) for “stingless paving”



GROUND CONTROL

Processing the Data

After driving the project, the collected data was downloaded into a series of LAZ files. These files were then added to Autodesk ReCap Professional and processed to produce a series of RCP file (Autodesk's point cloud file format).

After processing the data in ReCap, the point clouds were aggerated in an InfraWorks, and a surface model was created from the bare earth points. This surface model was then exported to Civil 3D as our base surface model.

In addition to processing the surface, the feature extraction tool was utilized inside of InfraWorks to create the centerline of the road from the dashed white lane line in the model. This line was also imported into Civil 3D and turned into an alignment.

Project Setup

After importing the surface and centerline from InfraWorks we did a little bit more work to setup the project. The centerline was converted into a road with a 70-mph design speed. Superelevation was then applied to the centerline, using a 2-lane crowned roadway (While this is a 4-lane divided highway, the centerlines of the two sides deviate enough from each other that treating it as two roads produced better results).

The final step was to create a quick existing ground profile for the alignment.

Mill and Overlay

Baseline

Before we start using the Mill and Overlay tool, let's put together a baseline model of what a basic milling operation might produce. To do this, we use a corridor model and a quick subassembly to replicate what might be happening in the field. We're doing this for a couple of reasons: we want to see the how much material is going to be milled from the surface, and we want to see the depth of the mill across the surface.

2" Milling Ideal

In the ideal world, you would mill the road surface and take off exactly 2" (following the surface of the road). Therefore, a 2" cut on a 24' wide road, will produce 4 cu ft / road foot. For our example, we are modeling over 3000' so the total volume should be 12,000 cu. ft. (444.44 cu. yd.)

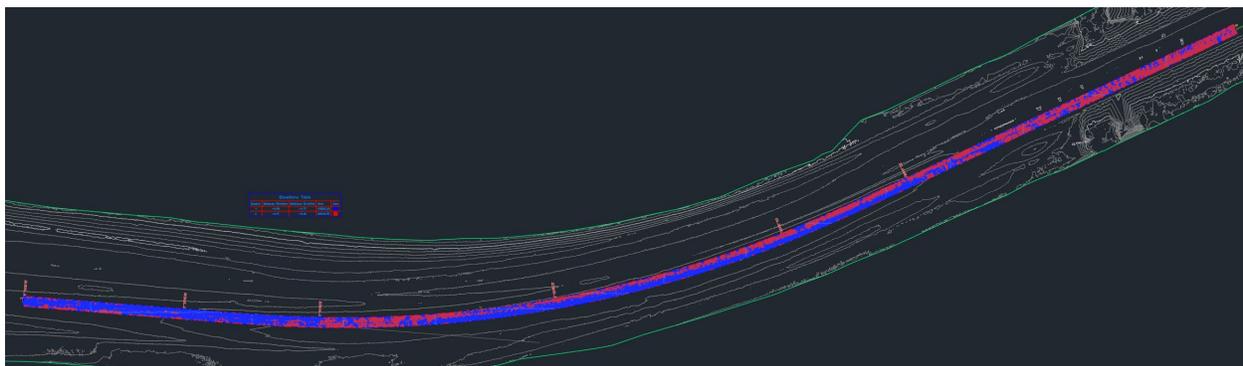
2" Milling Actual

When we use a subassembly to replicate the milling machine and process our LiDAR surface model, we start to see different numbers. The first is a volume number that is 9% higher than the ideal. The second is we see that if we mill 2" down at the centerline and EOP, we end up only milling 61% of the surface to design depth and we leave 31% of the road surface will at least some of the running surface in place.

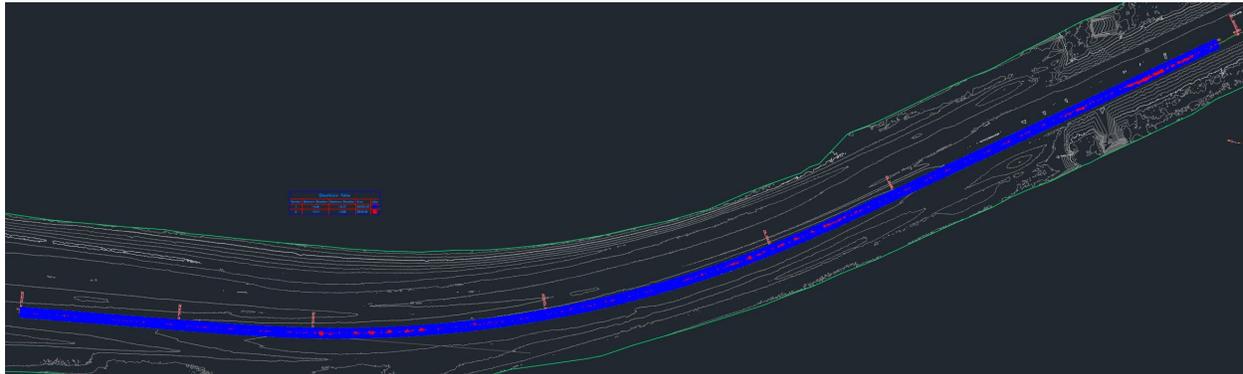
3" Milling Actual

If the design goal is to remove all of the running surface, we're going to have to go deeper with the mill. By milling 3" at the centerline and EOP, we are able to achieve 96% coverage, but at a volume overrun of 34%.

| Design | Volume | Volume Difference | 2" Depth Coverage |
|------------------|-------------|-------------------|-------------------|
| 2" Mill Ideal | 444 cu. Yd. | 0% | 100% |
| 2" Mill (Actual) | 485 cu. Yd. | 9% | 61% |
| 3" Mill (Actual) | 596 cu. Yd. | 34% | 4% |



2" MILLING – RED AREAS ARE LESS THAN 2" DEEP



3" MILLING – RED AREAS ARE LESS THAN 2" DEEP

Mill and Overlay

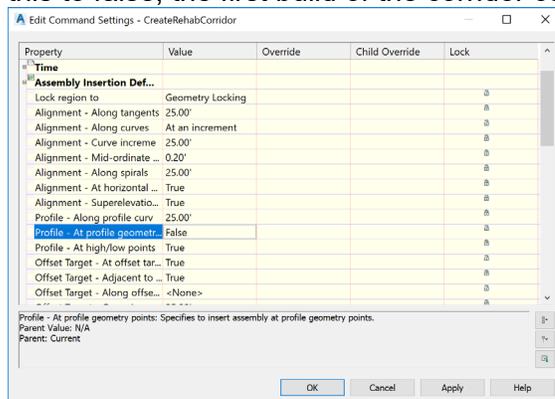
Now that we have some baseline numbers established, let's use the Mill and Overlay, and redesign this project.

Basic Mill and Overlay

The Mill and Overlay is just a variation of the Civil 3D corridor model, designed and optimized for rehabilitation work. It is started from the ribbon just like you'd start a standard corridor, but you don't need to make an assembly.

Pro Tip

Before making a rehab corridor, change the settings for the rehab corridor to NOT add assemblies at Profile geometry points. Because we are working with very dense LiDAR surfaces, the existing ground profile will have a PVI at every triangle face. If you don't set this to false, the first build of the corridor could take few minutes.



REHAB CORRIDOR SETTINGS

Volume and coverage report for Mill and Overlay

| Design | Volume | Volume Difference | 2" Depth Coverage |
|----------------------|-------------|-------------------|-------------------|
| 2" Mill Ideal | 444 cu. Yd. | 0% | 100% |
| 2" Mill and Overlay | 570 cu. Yd. | 128% | 100% |
| 1.6 Mill and Overlay | 480 cu. Yd. | 108% | 66% |

Rehab Manager

Not only is the Mill and Overlay tool a fast way to produce a milling corridor model, the Rehab Manager is a great tool for analyzing and adjusting the model

Design Slope Correction

If you have added superelevation to the alignment, the Rehab Manager can compare the existing cross slope against the required slope for the design speed. If the existing slope is within the correction parameter (slope tolerance), the overlay surface will be trapezoidal to compensate for the milled surface. This will bring the final road into (or closer to the design parameters.

Relative Gradient

This is the change in the slope from station to station. By making this to be a very small number, the amount of “flutter” in the road can be reduced.

Lane Slope Break

This is the amount for slope break between the lanes. On a typical crowned roadway, this would be 4%. As the lanes are calculated for existing slope conditions, the relative gradient can be analysis to make sure there isn’t an excessive amount of change from lane to lane.

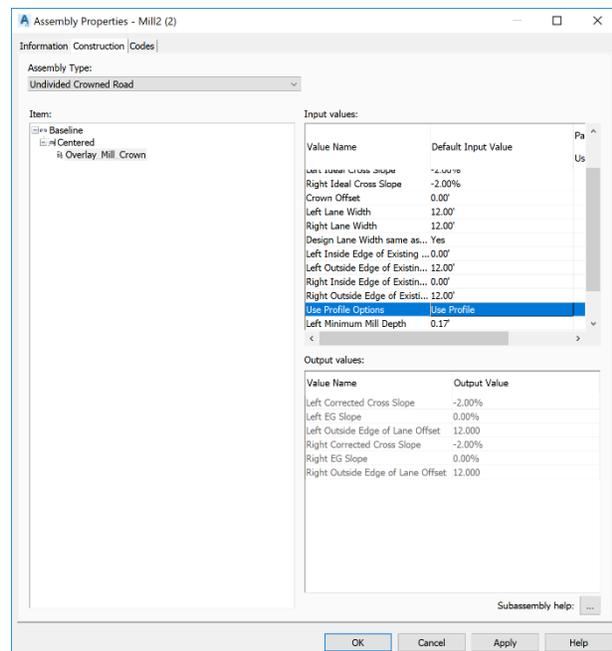
While the Rehab Manager may look like just a report, changes to the design can be made within grid to modify the corridor model.

Using a Design Profile

Another option for the Mill and Overlay is to switch from using the existing ground profile to a design profile. This change will only affect the overlay depth, it isn’t used for the milling. To make the change, open the Assembly Properties, and change the “Use Profile Options” to “Use Profile” and then in the corridor properties, assign the design profile.

Mill and Overlay with Widening

Because the Mill and Overlay is just a corridor, additional subassemblies can be added to change the project from a rehab to a widening.





MILL AND OVERLAY WITH NEW LANE AND SHOULDER

Reports

As part of the Rehab manager, reports of both data grids can be produced. When the reports are exported, two files are created, a raw xml file, and a formatted HTML file. There are a number of different formats for each of the reports, and the formats can be extended or modified by creating new style sheets.

For the 2019 version of the mill and overlay tool, additional information was added to the raw xml file including, elevations at each station, depths and cross section area for each of the material, and the raw station values along the corridor. This information could be accessed with either a style sheet, Excel or an external program to make even more reports.

Automated Machine Guidance

The ultimate report that could be created from the data isn't really a report at all, but are the strings that set the mill depth at the left, right and centerline and the ones that set the overlay depth left, right and center.

Wrapping up

In the past, engineers used cross-sections and traditional survey techniques. Now, through "better" technology, we have extremely accurate LiDAR data which can be collected in a fraction of the time providing exponential increases in data.

We've looked at the techniques for processing the data from field to model. We've learned how to analyze the profiles and engineer model-based surfaces of the milling and overlay. And we reviewed the "gaps" between baseline and best surface design allowing us to demonstrate savings in materials, effort, and overall design to construction processes.

To see the videos, go to this link and register:

<https://5d.retrieve.com/signup?ug=c8f64fe6-cfc6-480f-97b0-ff2283484536>