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CI225016

Road Rehabilitation Made Easy

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Learning Objectives

- Learn how to prepare survey data from different sources for road rehab projects
- Learn how to conduct road rehabilitation project
- Learn how to analyze the results to meet design criteria
- Learn how to define the construction regions to minimize the impact of road closure

Description

During the session we will cover the entire process of a road rehabilitation project. The very first step will define the construction regions to minimize the impact of road closure. The design will start with processing laser scan data in ReCap software and InfraWorks software to create objects like terrain, horizontal feature lines, and vertical features. You will learn the best practices to bring the results to Civil 3D software. Next, we will create a road rehabilitation project in Civil 3D, which will include best-fit alignment and rehab corridor. You will also learn best practices for how to smooth the vertical profile to meet design criteria. After finishing corridor, we will analyze the design and use dynamic model to iterate the design to satisfy the requirements like minimum cross slope and so on.

Speakers

Tomáš Lendvorský *joined Autodesk, 13 years ago and currently is working as Senior Technical Specialist, responsible for the architecture, engineering, and construction (AEC) Autodesk portfolio in Eastern Europe. Tomas has a master's degree in land surveying from Czech Technical University in Prague. For more 25 years he has been working with different infrastructure designing products. His current role is to work with Autodesk partners and customers actively promoting the AEC portfolio. Civil engineering expertise helps him be actively involved in countryfication of the product in different countries, ensuring product suitability for each region. He has over 20 years of working experience with civil designing software. You can reach Tomas at* tomas.lendvorsky@autodesk.com

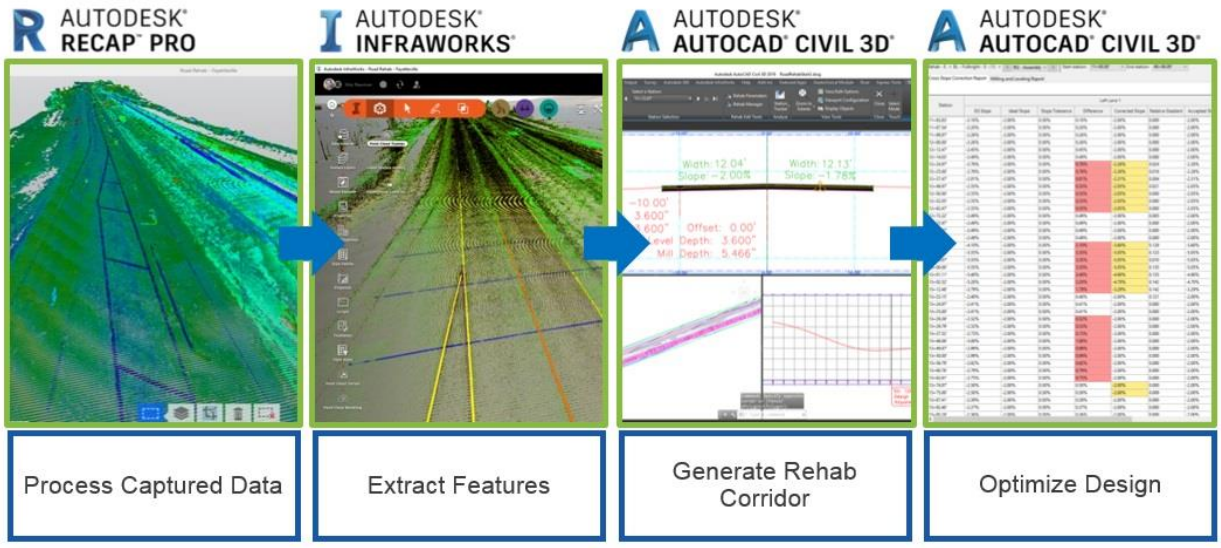
Peter Ingels, *Senior Technical Specialist focusing on Autodesk, Inc.'s, Civil Engineering and Infrastructure Solutions. With a background in engineering and surveying, and over 15 years' experience implementing Autodesk solutions, I'm well positioned to advise on Autodesk's Building Information Modeling BIM for infrastructure strategy.*

Road Rehabilitation functionality

AutoCAD Civil 3D had some functionality, which helped during road rehabilitation process – least-square method to find Best-fit Alignment/Profile elements, specific road rehabilitation Subassemblies, standard Corridor, volumetric calculation and surface analysis. Users were successfully using, but sometimes it was rather tedious job.
Latest release of Civil 3D 2019 came with purposely build Subassemblies to create Road Rehabilitation Corridor, which makes life much easier. We should not forget InfraWorks functionality to process laser scanned data and traffic simulation, also very important for some road rehab projects.

Workflow

Entire workflow, from processing scanned data, can be visualize as follows

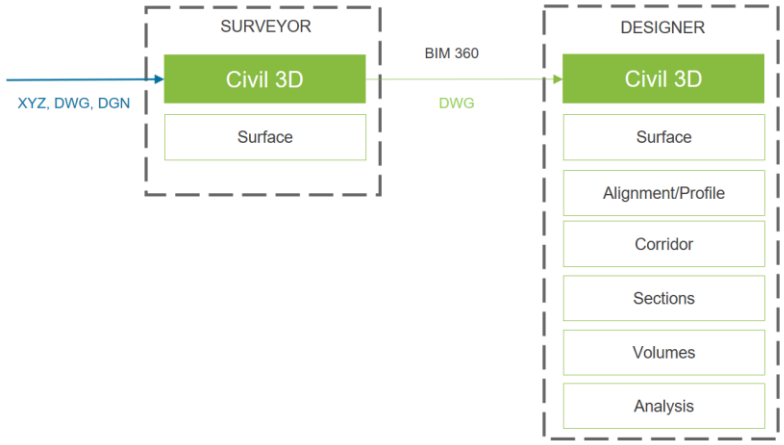


1. In ReCap, import and process the captured raw laser scan data. Data can be cleaned and limited to the required area. The result is in file format, which can be imported to other Autodesk products.
2. In InfraWorks, extract existing horizontal and vertical feature lines from the point cloud data. Horizontal feature lines will play important role in defining corridor. .
3. Civil 3D supports purposely built road rehab corridors, which allow you to create a dynamic 3D model. The model supports design iteration, reports, and analysis for road rehabilitation projects.
4. Civil 3D reports and analyses enables

Prepare survey data from different sources for road rehab projects

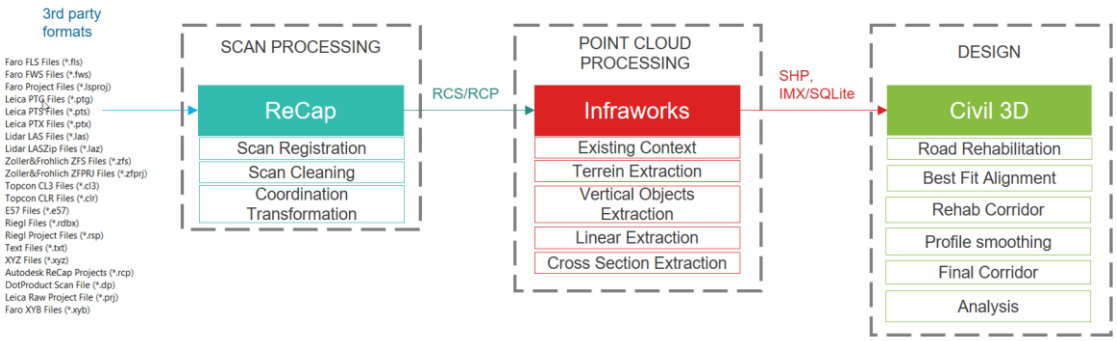
Classical Survey

Classical Survey workflow can be visualized as follows:



Surveyor will use standard Civil 3D functionality to create points either directly from raw survey data using Survey module or can use already processed data in form of points and line/polylines to create Civil 3D Surface.

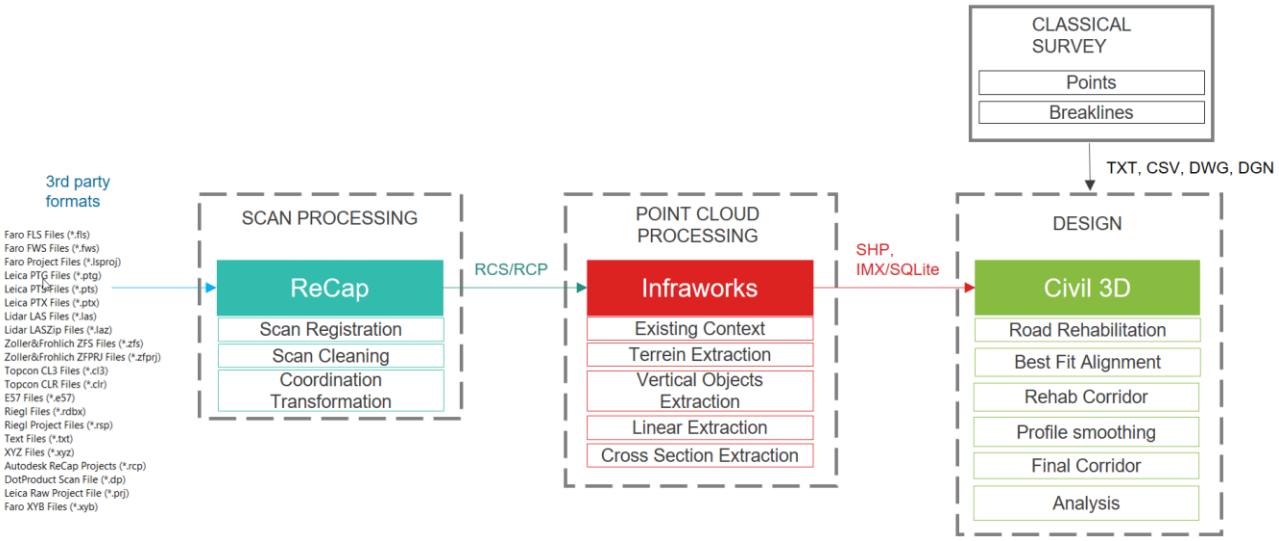
Process Scanned Data



ReCap allows to import raw scanned data from different formats. If the scanned data are not in the correct coordinate system, you can transform scanned point cloud data to required coordinate system.
Subsequently InfraWorks allows to extract important information form point clouds:

- TIN terrain
- Horizontal features like centerline, road edges etc.
- Vertical objects – lamp posts, traffic signs, trees – if necessary for rehabilitation
- Cross Section – cross section points in given interval

Both methods can be combined together and the workflow would be:



Tips:

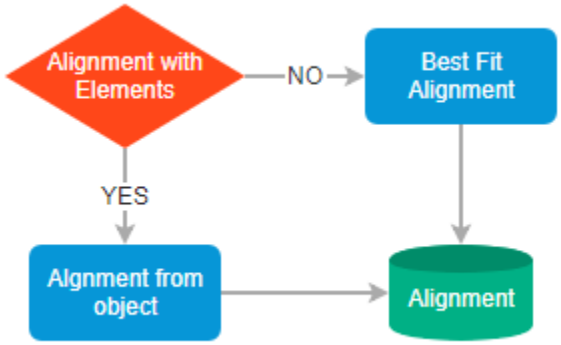
- Breaklines SHP file import – MAPIMPORT command
- Create continuous polylines for centerline and left/right road edge. It will save clicking later
- Centerline convert to 2D (Modify -> Design -> Concert 3D to 2D Polyline), to be able to create Alignment

Road rehabilitation project

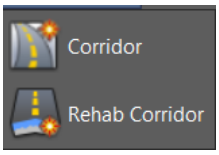
Conduct road rehabilitation project

Civil 3D allows to apply different workflows depending on the goals of road rehab project.

Alignment:
Can be created with elements – straight, spiral and curve – or just as spline line.



Corridor:

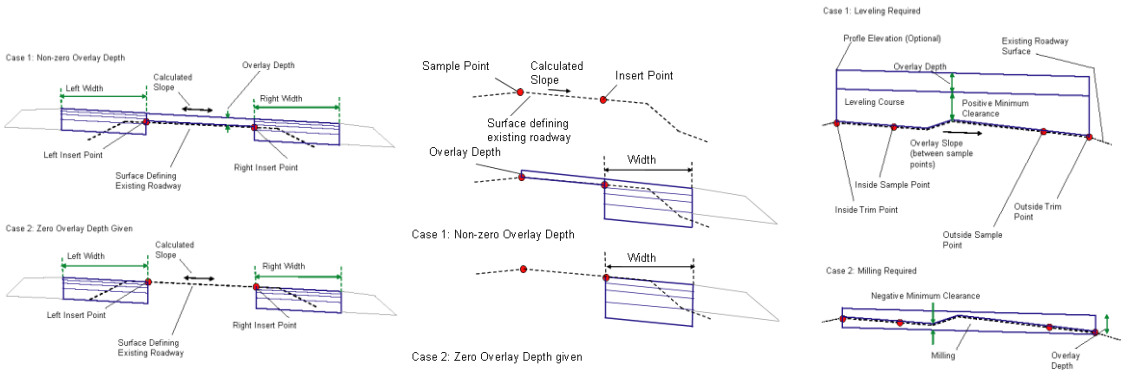


(Standard) Corridor – uses standard subassemblies or subassemblies created with Subassembly composer. Profile can follow EG or can be design using Profile creation tools
Rehab Corridor – uses rehab subassemblies and modifies FG profile, depending on design parameters.

Subassemblies:

Rehab subassemblies for (Standard) Corridor:

- OverlayMillAndLevel1
- OverlayMillAndLevel2
- OverlayWidenMatchSlope1
- OverlayWidenMatchSlope2
- OverlayWidenWithSuper1



Subassembly Composer:

Subassembly composer offers different classes, very useful for road rehabilitation. Following examples are from Help for Links Class:

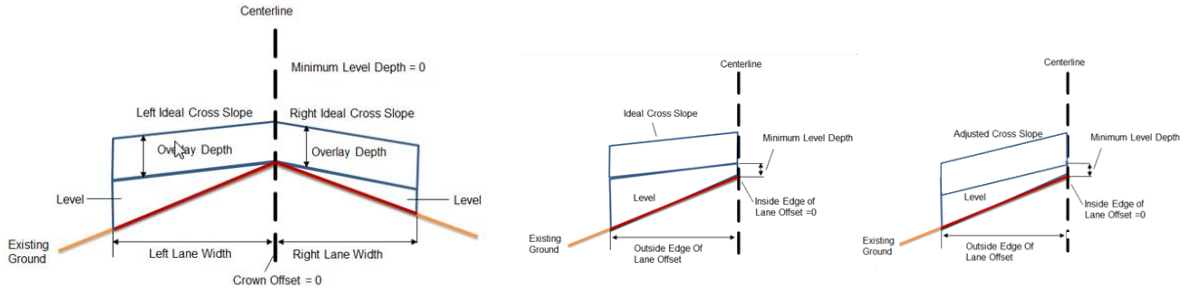
- LinearRegressionSlope - linear regression on the points in a link to find the best fit slope between all of them
- MaxY - maximum Y elevation from a link's points
- MinY - minimum Y elevation from the link's points
- MaxInterceptY(slope) - the highest intercept of a given link's points to the start of another link
- MinInterceptY(slope) - the lowest intercept of a given link's points to the start of another link
- LinearRegressionInterceptY - Y value of the linear regression line (at the start point of the link)

Please explore more possibilities within Subassembly composer, if needed. Example of one Subassembly is delivered as Additional class materials.

Rehab Subassemblies:

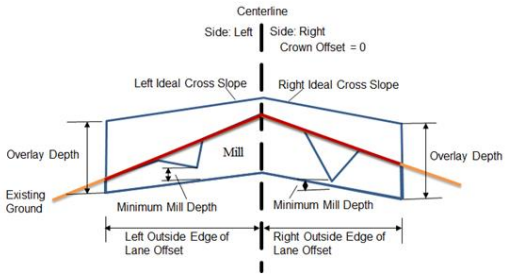
Overlay and Level:

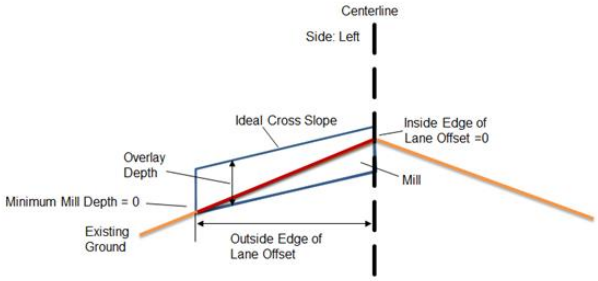
- OverlayLevelCrown and OverlayLevel1Lane1Side:



Overlay and Mill:

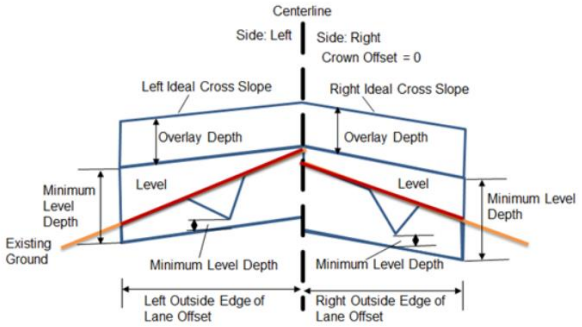
- OverlayMillCrown and OverlayMill1Lane1Side:

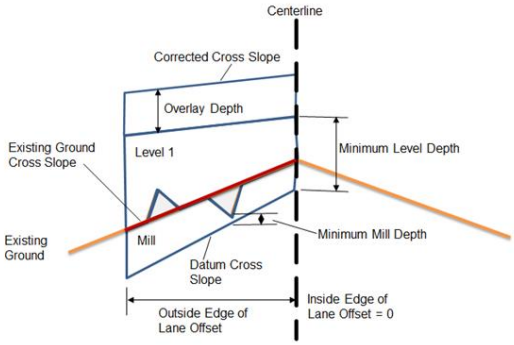




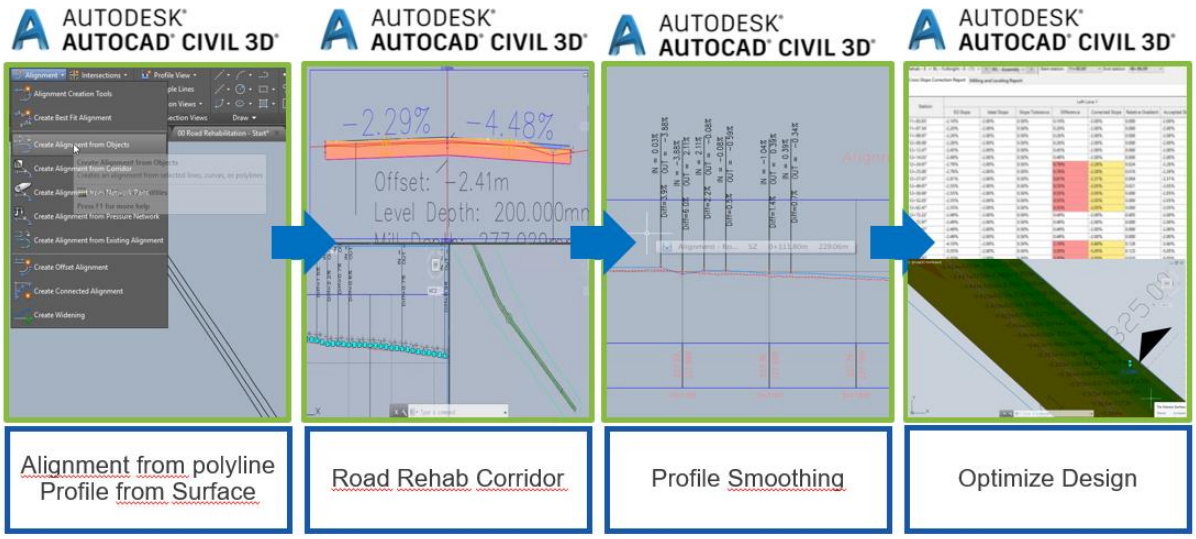
Overlay and Mill and Level:

- OverlayMillLevelCrown and OverlayMillLevel1lane1Side





Road rehabilitation workflow within Civil 3D using new Road Rehab functionality can be visualized as follows:



Road Rehab Corridor

Make sure Coordinate systems of InfraWorks model and Civil 3D DWG file are the same!

Surface creation:
To create EG Surface, you can use IMX file from InfraWorks, containing terrain from Point cloud. In addition to that, I would recommend create CSV file containing Transvers Lines, which should be generated at the same interval and from the very same starting point as you will create Corridor later in the process.

Alignment:
Resurfacing projects usually do not require Alignment containing elements (straight, curve, spiral) and therefore it is sufficient to Create Alignment from object – centerline imported from SHP file.

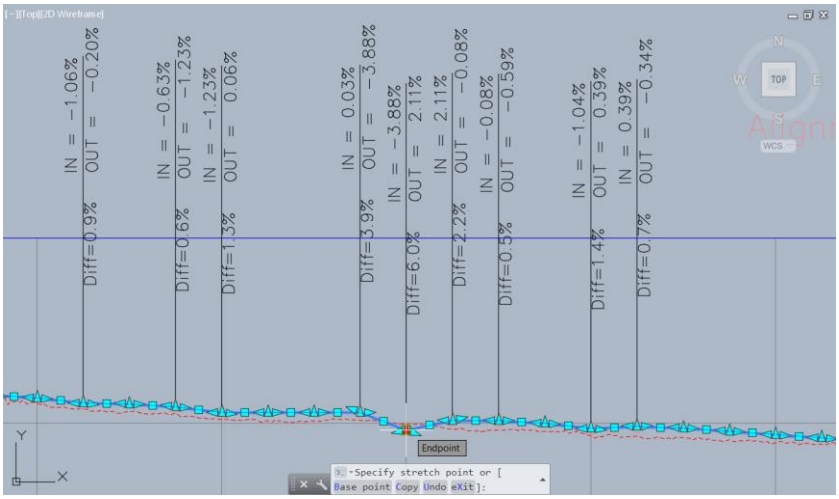
Profile:
Create Surface Profile.

Corridor creation:
Rehab Corridor functionality will drive you through process.

Notes:
- Assemblies are created automatically based on Mill & Level Type
- Additional Subassemblies can be added to Assembly – widening, shoulder, daylight and more, if needed
- Corridor frequency can be modified using Properties dialog box

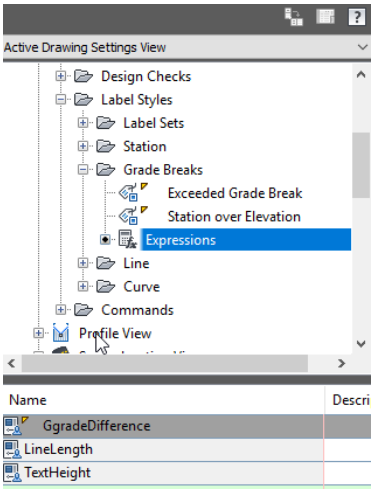
Profile smoothing

Road crown is derived from Rehab Subassembly, EG terrain and parameters. It can result in “bumpy“, eg. IN/OUT grade exceeds defined value. This is why smoothing might be important.

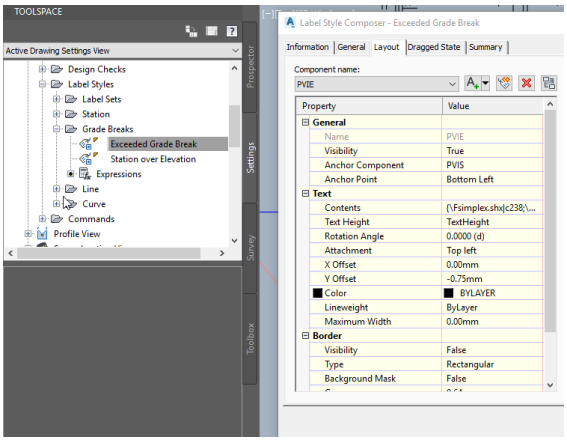


To identify where profile has to be modify you will have to create 3 expressions

- GradeDifference – calculates logitudinal gradient break
  (ABS({Grade Out}-{Grade In}))*100
- TextHeight – will hide text, if gradient break does not exceed given value
  IF(((GradeDifference))<0.5,0,0.0025)
- LineLength - will hide line, if gradient break does not exceed given value
  IF((GradeDifference)<0.5,0,0.075)



Label style “Exceeded Grade Break” you can check in Additional class material

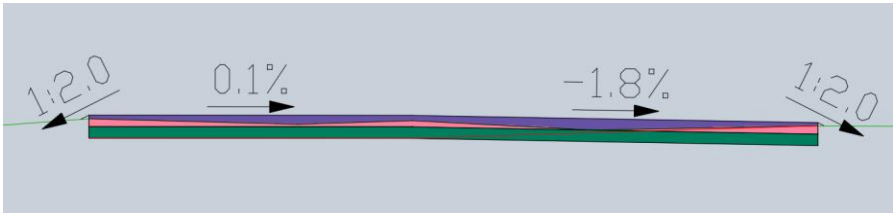


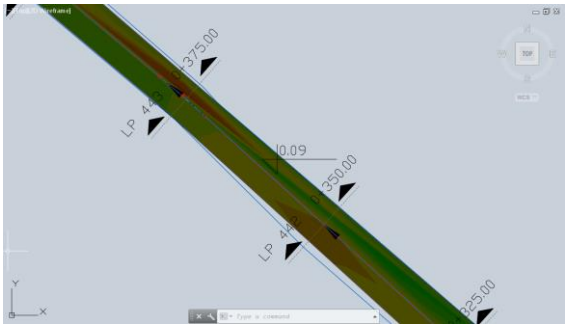
Procedure:

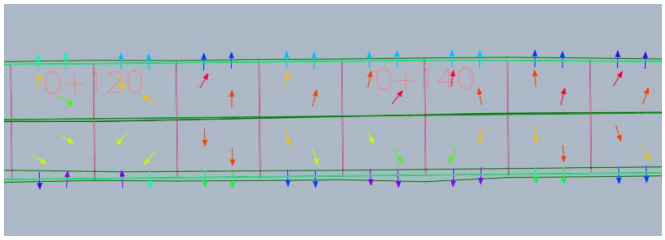
- Create Alignment from Crown corridor feature line
- Create Profile at the same time
- Create Surface profile from new Alignment and draw Profile view
- Assign Label style “Exceeded Grade Break” to design profile
- Edit Rehab Corridor and change alignment to new one and profile to design profile
- Modify profile points exceeding grade break and rebuild corridor

Analysis and Reports

Civil 3D offers variety of reports, surface analysis, section view with labels, which will help you to understand the behavior of design and you can modify/iterate design to meet design requirements.







Impact of road closure

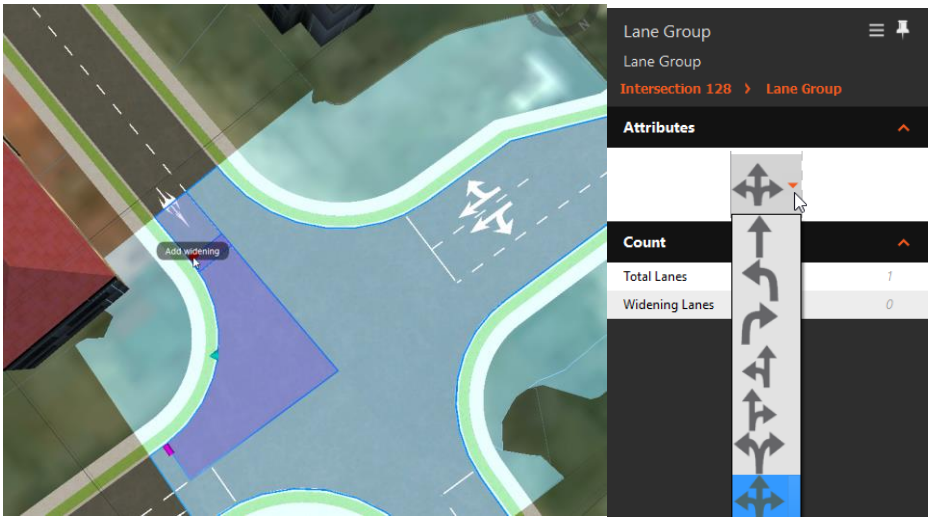
Traffic Simulation will help to define construction regions to minimize impact of road closure

During the construction, the road, or at least part, will have to be closed. It will cause traffic disruption in the surrounding area and traffic simulation will help to predict the traffic and avoid congestion areas.

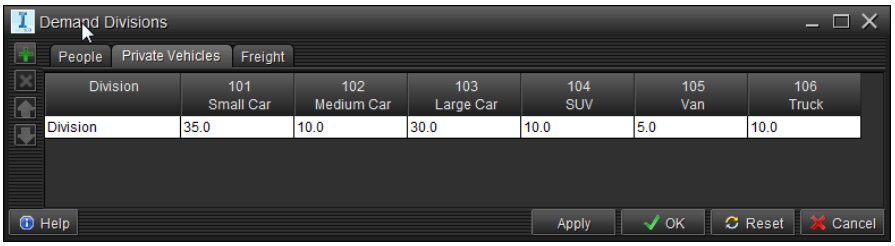
You do not have to be traffic expert and you will get required results. Workflow is simple and contains following important steps:

Step 1:
Build InfraWorks model using Model Builder. Model Builder will create model containing with terrain, roads, buildings and ground imagery. Basically, all you need to start traffic analysis.

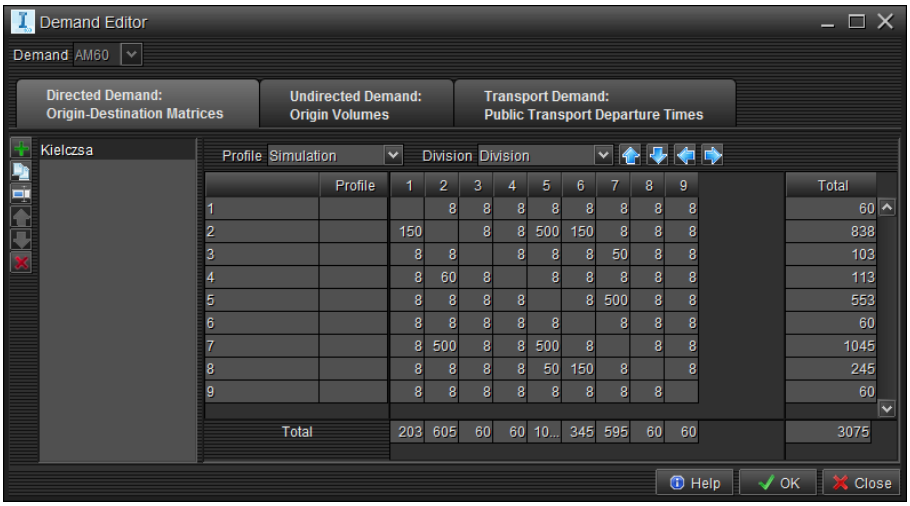
Step 2:
Select area, where you want to run Traffic Simulation.
Note:
You will be prompted to convert all planning road, coming from Model Builder, to Component roads. Traffic Simulation can be done only with Component Roads. I recommend convert only important planning roads before. It applies especially to large areas with many roads. It will give you better understanding the area and in which rods you want to direct the traffic.
Please check, if components roads and especially intersections were created correctly, before the next step.
Important
By default, intersections are created with one lane on each arm and with possibility to turn in any possible direction. You should check each intersection against the reality and add lane or modify intersection. It is important to define only the directions, where traffic can flow, as it will be adopted by traffic simulation.



Step3:
Define Demand Division – proportion of vehicle types travelling on the road.

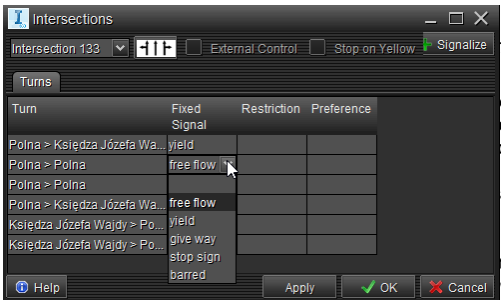


Step 4:
Demand Editor - defines expected number of vehicles, travelling between the Zones. Zones are automatically created on the intersection between road and simulation area boundary.
There are 2 possibilities. If you know the number of vehicles travelling between nodes, use Directed Demand. If you know only volume of vehicles travelling from origin zone, use Undirected Demand Tab.



Step 5:
Intersection Control - defines the signalization on selected intersection. Again, there are 2 possibilities:

- Fixed Signals (free flow, yield, stop etc.)
- Signalized – traffic lights are used



Benefits:

- Existing roads in context created with no additional cost
- Easy traffic flow definition
- Simple results visualization
- Easy to prove and present “What“ and “Why“