USING MODERN SOFTWARE IN SURVEYING, GIS AND AGRICULTURAL ROAD DESIGN

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Abstract*. The application Advanced Road Design (ARD) developed by the company CadApps Australia, employs using AutoCAD® or AutoCAD® Civil 3D® platforms and offers advanced features for the design and rehabilitation of roads according to Romanian standards.* It *includes basic commands for drawing geometric elements of the road (plane and vertical), automatic connection of intersections, automatic generation of longitudinal and transverse profiles and calculating filling and cutting volumes involved. Already known to design engineers of roads in our country, the application Advanced Road Design enables the interactive design of longitudinal and transverse profile and of site plan so that changes made during the project will update quickly in the drawings and quantityreports. The road design aimed to preserve existing settlement (existing pavement) and avoid expensive earthmoving work. The route follows the field line, so as to ensure the discharge of rainwater from the road platform into the existing gullies, the width of the road system to the existing reshaped land, the rainwater drainage systems, downloads in gutters, culverts as well as the development of intersections with side streets. Advanced Road Design application is recommended especially due to its work capabilities in AutoCAD and that the user does not require extensive knowledge of AutoCAD. Advanced Road Design generates the AutoCAD elements from the project without having to use the drawing step that loses time with the details, that being an impediment to the completion of the project in time. Undoubtedly, we can say that with good 3D topographic survey there can be designed, at least 1 km / day, including final drawings and corresponding quantity reports.*

Key words: *road, surveing, transversal profile, geometrical elements, road structure*

INTRODUCTION

The application Advanced Road Design (ARD) developed by the company CadApps Australia, employs using AutoCAD® or AutoCAD® Civil 3D® platforms and offers advanced features for the design and rehabilitation of roads according to Romanian standards.

It includes basic commands for drawing geometric elements of the road (plane and vertical), automatic connection of intersections, automatic generation of longitudinal and transverse profiles and calculating filling and cutting volumes involved.

MATERIAL AND METHODS

Generating ground surface

In order to generate ground surface we have procedded to create a workfilefor the current case "străzi.dwg". We opened "străzi.dwg" and generated the ground surface from field using the 3D.

Thus we can use several methods of generating areas:

- By points from the topographic survey;
- By XYZ file coordinate;
- By 3D points in DWG drawing;
- By 3D polylines from DWG drawing (Breaklines) etc; [4].

For the generated surface to be as closest to reality as possible it is recommended to use at least two of these methods.

The first step was to define the existing surface on which the communication path is to be achieved. From menu the command window "Prospector" is selected, where by right-click command on "Surface" the option "New" will be appeled.

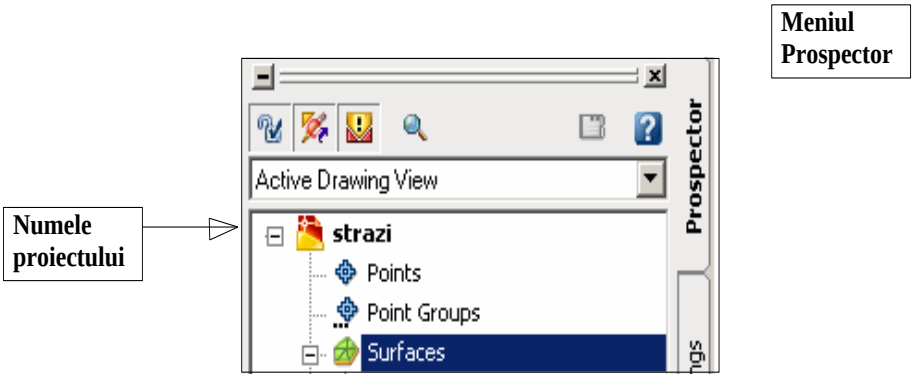


Fig. 1. Surface generating

When performing this command the following window will appear where we will name the area “Existent” and will assign its type TIN surface (Triangular Irregular Netwark). Further on, this surface will be assigned points raised in the following way: using the menu Prospector we select the worksurface pressing the plus sign in front of the area’s name, we do the same thing Definition and a menu where we can add points, polylines, file points, etc. to the surface. In this case, the points have already been drawn in 3D in the .dwg workfile, we need to add objects in the drawing ("Drawing objects"). [7, 8]

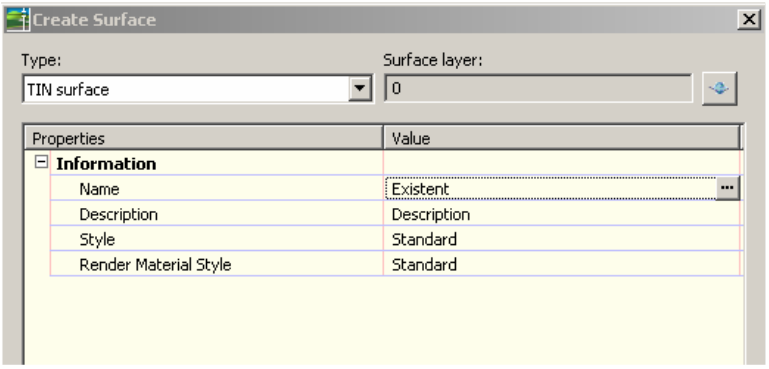


Fig. 2. Choosing the surface generating type

To add surface points: “Prospetor” “Surface”=>”Existent” =>”Definition” =>”Points Groups” and use “Add” command.

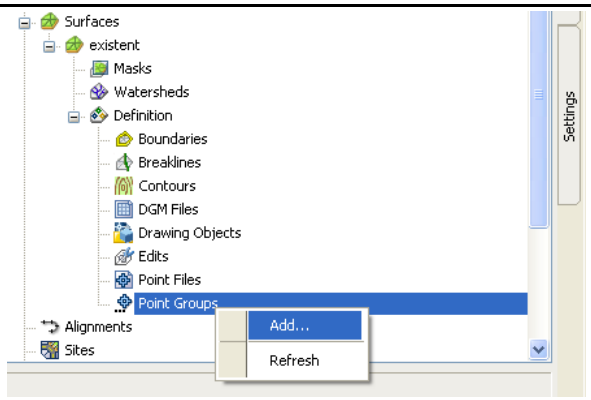


Fig. 3. Adding the points that define the surface

In this moment the surface is defined by these points.

The styles for displaying surface are: contour lines, triangulation, etc. From the Prospector menu, right click on surface ->"Properties"->"Surface Style" ->"Edit:"

Fig. 4. Setting the surface displaying style

We display surface contour lines (Major and Minor Contour Contour), choose colors, line type, etc. This operation is visible in Fig. 5 and Fig 6.

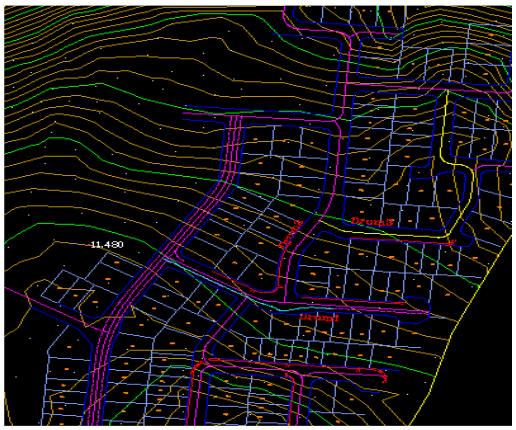


Fig 5. Grafic surface display

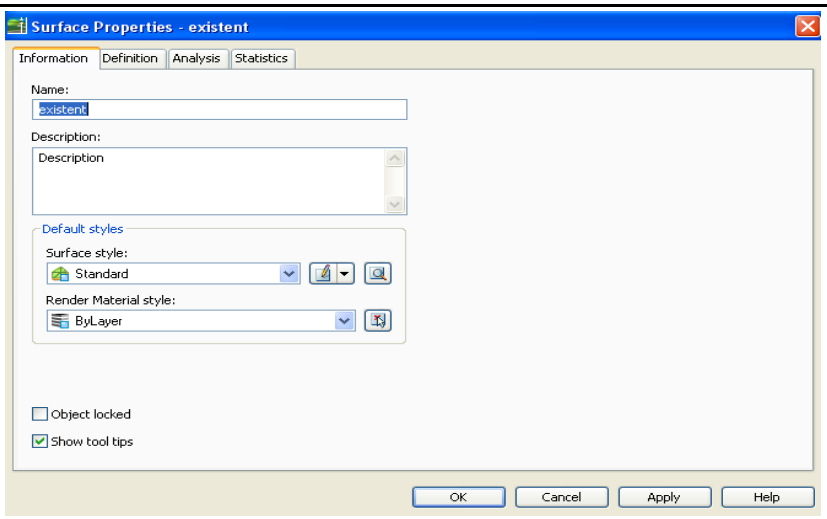


Fig. 6. Surface Properties Box

Creating the road axis

To make the communication path axis we use "2D Polyline" command. In this way by drawing 2D Polyline on the path that will be the road axis, we could define the communication path by its axis. For ARD to recognize this axis we will have to use from AUTOCAD menu the command bar "Alignments", "Alignment->Create from polyline".Fig. 7 [1, 2, 3].

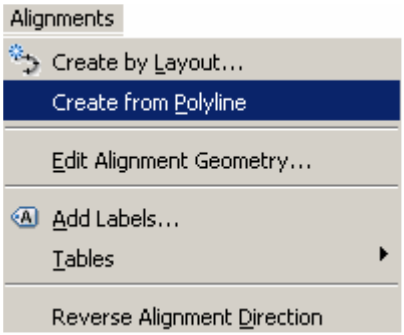


Fig. 7. Aligments Menu

When this window appears we select the polyline corresponding to the road axis we want to create.

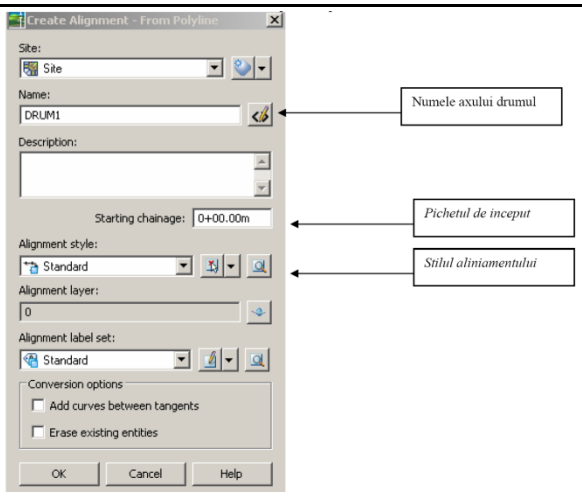


Fig. 8. Create Alignments – From Polyline Box

Press "OK" and the program automatically pickets and labels the axis. What is seen now in the next figure needs to be edited, for example, to remove the arrows that define the alignment we use Alignment Properties command.

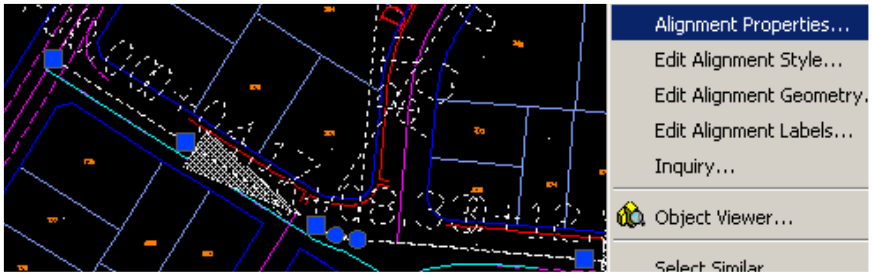


Fig.9 . Alignment Edit Properties Box

On completion of these commands you can see that the design is stripped of details that do not use and are in our way in designing the process.

Longitudinal profile design

Longitudinal profile design is, in fact, the introduction in using ARD. Thus, if until now we have worked with basic software, ie AUTOCAD, henceforth we only use commands from the Advanced Road Design application.

In “ROADS” menu we used the "Select / Create road element" command and selected the previously created axis Fig. 10. [6]

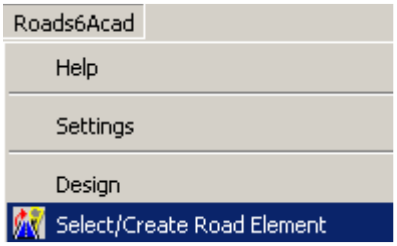


Fig. 10. Main ARD Menu

After using this command a window poped up permitting to set: the surface to which the longitudinal profile relates, the distances between current profiles, and distance of this profiles to the designed axis Fig. 11.

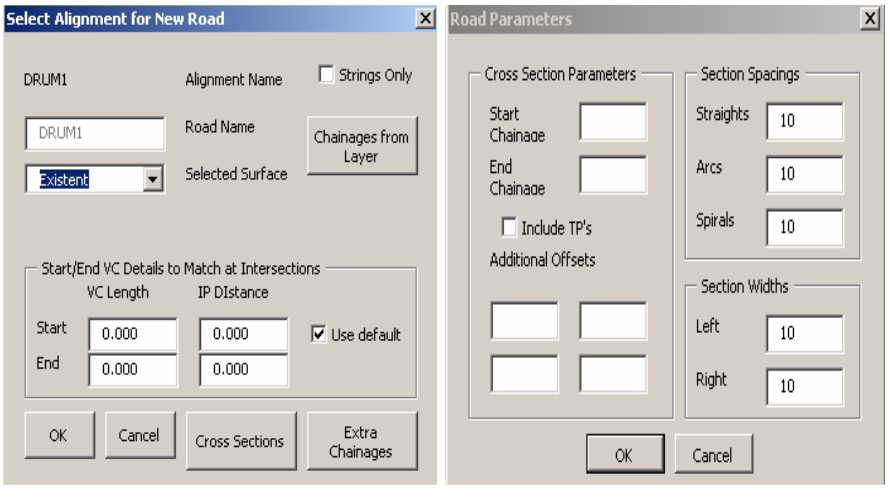


Fig. 11. Setting the New Road Alignment and Road parameters

After setting these parameters press "OK" at which point it will automatically open the edit window of the longitudinal profile - Vertical Grading Editor.

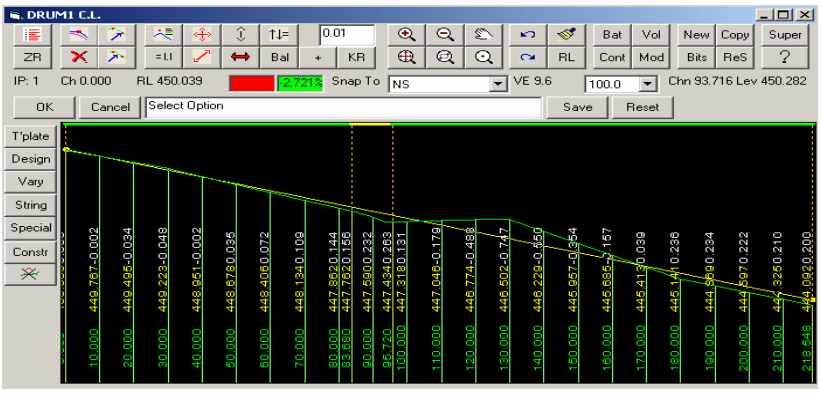


Fig. 12. Longitudinal profile Editor

From this window all the road designing functions can be used. The first step is to determine the design parameters: minimum and maximum gradients, display of quotas and pickets of natural land but also of the designed one, the balance between cut and fill, etc. To set these parameters use the "Road Parameters" button.

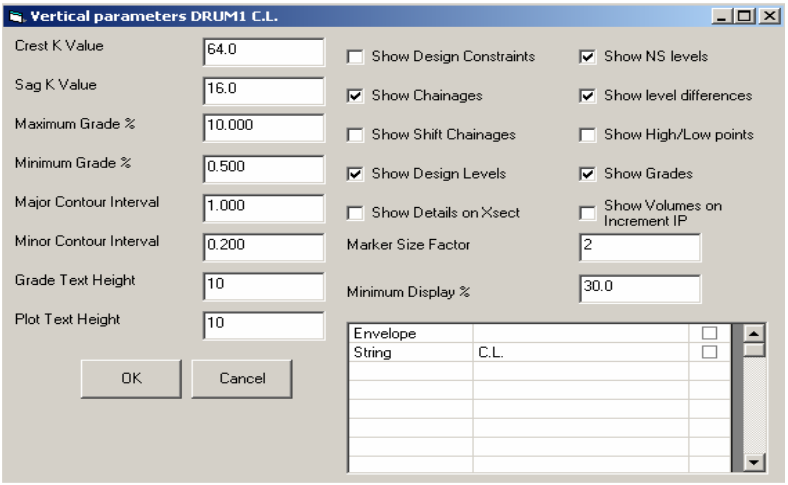


Fig. 13. Editing the geometrical road details (Obs. The most important are: Maximum grade %, Minimum grade %, Show NS levels, Show Design Levels, Show level differences)

It is easily noted that both the site plan and longitudinal profile of the respective road can be simultaneously displayed, through a green marker and in the longitudinally profile window moving the mouse in any position kilometers (CHN) and elevation (Lev) are displayed.

It will proceed to the design of the road red line introducing a parabolic vertical connection curve by using the "Add IP" command to introduce an IP (Intersection Point) and designating its position along the longitudinal profile. [6]

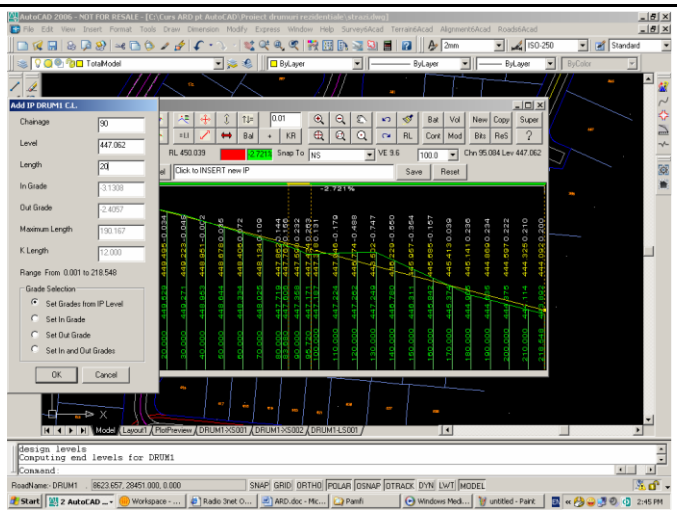
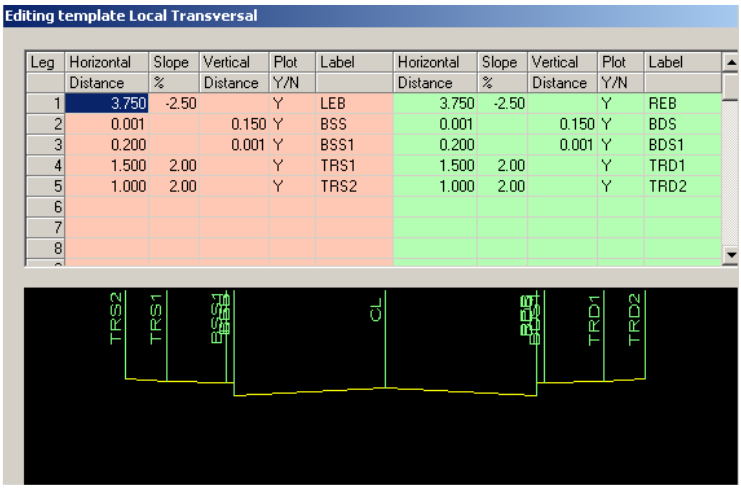


Fig. 14. Editing vertical grading elements

Applying the typical tranversal profile

This operation is one of the most important because at this point, practically the way the communication path will look like is materialized. In this phase will determine the type of profile, road width, geometry of ditches, alleys, etc. [4, 5]

From the VGE window the command "T'Plate" will be used and then the "New Local" option.



Leg	Horizontal Distance	Slope %	Vertical Distance	Plot Y/N	Label	Horizontal Distance	Slope %	Vertical Distance	Plot Y/N	Label
1	3.750	-2.50		Y	LEB	3.750	-2.50		Y	REB
2	0.001		0.150	Y	BSS	0.001		0.150	Y	BDS
3	0.200		0.001	Y	BSS1	0.200		0.001	Y	BDS1
4	1.500	2.00		Y	TRS1	1.500	2.00		Y	TRD1
5	1.000	2.00		Y	TRS2	1.000	2.00		Y	TRD2
6										
7										
8										

Fig. 15. Editing template Local transversal

LEB / REB are defined as roadway edges, BSS / BTS as left/right upside borders, BSS1 / BDS1 as rear left/right border, TRS1/TRD1 as left/right pavement edge, TRS2/TRD2 as rear left/right pavement edge. The only codes that are of particular importance are LEB / REB and allow automatic setting of intersections connections.

At this point the surface could be restored also taking into account the changes made by designing the communication routes.

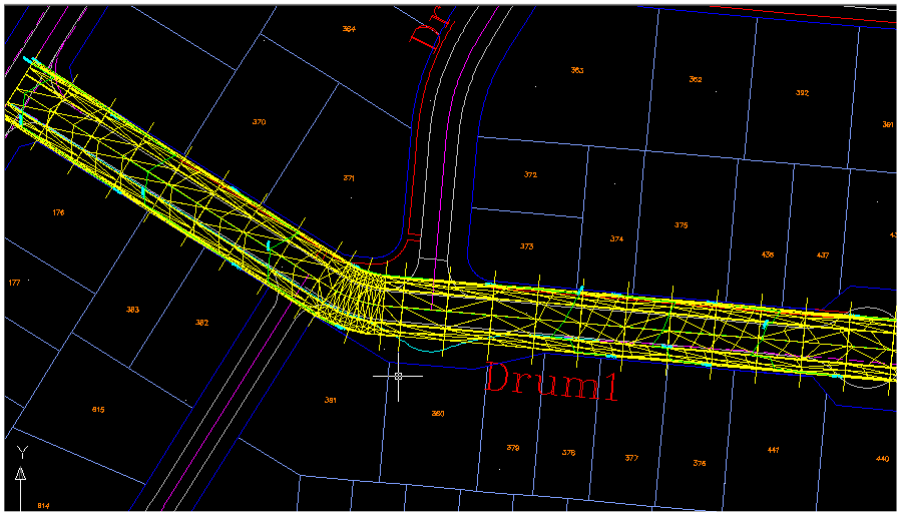


Fig. 16. The communication route view

RESULTS AND DICUSSIONS

Already known to design engineers of roads in our country, the application Advanced Road Design enables the interactive design of longitudinal and transverse profile and of site plan so that changes made during the project will update quickly in the drawings and quantityreports.

The road design aimed to preserve existing settlement (existing pavement) and avoid expensive earthmoving work. The route follows the field line, so as to ensure the discharge of rainwater from the road platform into the existing gullies, the width of the road system to the existing reshaped land, the rainwater drainage systems, downloads in gutters, culverts as well as the development of intersections with side streets.

The typical tranversal profile has the characteristics of a country road with a lane:

- Carriageway width 4.0 m;
- Platform width 5.0 m
- Roadside width 2 x 0.5 m

Crossing road slopes are 2.5% carriageway and 4% on roadsides.

Sizing calculation was based on minimal data traffic, geotechnical study and existing materials constituting the road layers. These revealed that over the existing paving (average 15 cm thick), it is necessary to execute a foundation layer of ballast 20 cm thick, over which will be added a layer of ordinary macadam 8 cm thick and an asphalt clothing 6 cm thick.

CONCLUSIONS

The first step to implement the process in Advanced Road Design (ARD) program consists in topographical data processing and generating a ground surface of existing land. The area will be created from AutoCAD 3D points and 3D layout elements of the existing footprint of the road or the existing center line, carriage way edges and roadsides, ditches, embankments and trench bottoms, property boundaries and accesses.

Tracing and defining the geometrical elements of the designed center line will be achived interactively according to STAS 863-85 using the "Horizontal Design" module developed by Eng. Marius Benea from Civil Software SRL Cluj-Napoca.

This module is integrated with the application Advanced Road Design and is distributed with it. The process is very simple: select the alignments on which the program recommends, according to STAS, circular curve or clothoid in accordance with the design speed. The geometrical elements are introduced in ARD to generate the designed center line on which we will finalize the red line and transversal profiles.

By selecting the center line, ARD instantly displays a window with longitudinal profile, where the road can be interactively designed. The advantage of applications such as ARD is that it was designed in mostly from the perspective of the designer not from the AutoCAD drawer perspective. In fact, the program automatically generates charts with transversal and longitudinal profiles that will be "arranged" in AutoCAD in the form of Layouts according to the page format and the cartridge with its own table.

Also ARD allows finalizing the site plan, namely advanced functionality for displaying the pickets eith the coresponding kilometer positions across all the characteristic points of the route (Ti, Te curves and Oi, Oe clothoids) and points imposed on the route (accesses to properties, existing culverts). Display in the corresponding layers of AutoCAD the 2D polylines of the footprint of designed road – center line, roadway edges, roadsides, ditches, etc.

As we mentioned, the design is done by opening a single ARD window - "Vertical Grading Editor" (VGE). Thus, in this window, the red line will be designed with corresponding vertical curves connections (the program displays the connection rays and the input and output gradients of each connection).

When changing the vertical position of the connecting curve, the corresponding cross-sectional profile is updated instantaneously, and by using "Vol" command automatically gives the amounts of cut and fill and the movement of the embankment for each kilometer positions.

Additionally, ARD generates a report regarding total quantities of coatings applied in the road system. To change any element of the project, the report shall be updated by simply reaplying the command.

Another important element offered by Advanced Road Design is generating a text file with projected elevations of each designed element of the road. In this case, one can export the report regarding the number of pickets (absolute coordinates XYZ). This report has proved to be very useful for subsequent drawing of the designed road axis and red line.

When printing transversal profiles, the display and presentation mode are settated only once. The parameter settings are saved in a file, so that they can be reentered in any other project.

The elevation of the platform elements can be generated automatically by the program and the properties boundries can be highlighted (crucial feature!) at coressponding scale.

Advanced Road Design application is recommended especially due to its work capabilities in AutoCAD and that the user does not require extensive knowledge of AutoCAD. Advanced Road Design generates the AutoCAD elements from the project without having to use the drawing step that loses time with the details, that being an impediment to the completion of the project in time.

Undoubtedly, we can say that with good 3D topographic survey there can be designed, at least 1 km / day, including final drawings and corresponding quantity reports.

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