USE OF DIGITAL LAND MODELS IN AUTOMATED EXECUTION OF EMBANKMENT WORKS

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Abstract*:The following project tackles modern solutions in the execution of embankments for railroads making use of Digital Terrain models with wich machines can be guided using GPS positioning such as Autograders for leveling platforms according to the designed heights and platform slopes or Excavators in digging twinning steps, slopes covered with rip-rap and so on. The DTM's are developed individually for each platform using ArcGIS and according to the designed heighs and offsets specified in the project.*

Keywords: *TIN, Digital Terrain Model, Autograder, Platform, Excavation, Embankment ;*

1. Introduction

This project has as object of study the automation process of the embankment works specific to the railways by means of digital models and the GPS / TPS technology installed on equipment such as:

- Autograder for adjusting the platforms regarding their width and the slope imposed by the slope points resulting from the designed transversal and longitudinal profiles;
- the excavator for the execution of the ground excavations necessary for the foundation and of the twinning steps;
- the bulldozer for stripping the vegetal material from the contour of the area of interest.

2. Materials and Methods

Spatial Data Aquisition

This stage involves the collection of data that serve to create the digital model of the terrain, these being extrapolated from the designed transverse and longitudinal profiles. This data will be accumulated in a microsoft excell document, broken down into worksheets specific to each platform and will be used to create digital models in the ArcGIS program. In the spatial data acquisition stage, the platform-specific points will be extrapolated as follows:

- shoulder / foot of the slope for the broken stone prism (road bed);
- shoulder, foot and coma for the sorted broken stone platform;
- the earth platform that serves to create the models.

The shoulder and foot of the slope will be extrapolated independently, respectively the twinning steps for the creation of digital models that serve the excavators in the execution of excavations for the foundation ground and for the implementation of the protection prism with boulders or slopes (earth platform or topsoil).

FID	X	Y	Z
1	88424.369	527659.495	182.669
2	88431.195	527640.696	181.742
3	88431.826	527638.960	181.669
4	88438.023	527621.898	176.800
5	88444.869	527603.103	176.600
6	88448.931	527591.997	176.210
7	88451.750	527584.319	176.230
8	88458.684	527565.552	176.240
9	88465.690	527546.810	176.250
10	88466.012	527545.952	176.250
11	88472.785	527528.099	176.260
12	88479.986	527509.427	176.280
13	88484.309	527498.386	176.292
14	88487.311	527490.800	176.265
15	88494.778	527472.228	176.198
16	88502.403	527453.718	176.131
17	88503.135	527451.966	176.125
18	88510.204	527435.280	176.115
19	88518.190	527416.921	176.104
20	88523.051	527405.984	176.097
21	88526.359	527398.642	176.117
22	88534.709	527380.444	176.168

Excavatie | Balast | Anrocamente | PSS | Piatra

Fig. 1. The inventory of coordinates related to each type of platform

The integration stage of the data in the informational system

For the integration of the data from the measurements, in the information system, we will import the worksheet from excel that contains the coordinate inventory and the XY data display command is executed.

As GPS technology is being used in the execution, it is imperative to establish the geodetic data that will include the digital model to be created in order to relate it to the topographic network developed especially for the project in question.

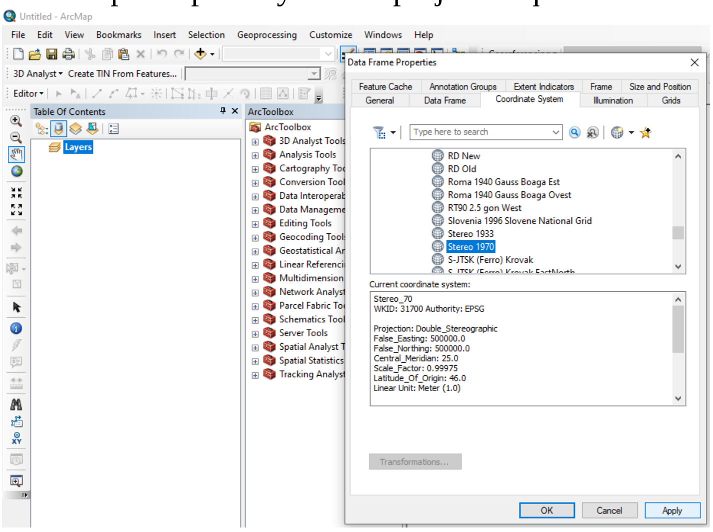

Fig. 2. Implementation of the Projection System

Data processing in the GIS environment involves the creation of polygon-shaped shape structures that reproduce the footprint of the platform in question, the integration of the designed points and the creation of the digital model. To create the structure we will make use of the ArcCatalog Tree, selecting the target file and creating the shapefile structure later importing the structure created in the GIS environment.

In order to carto-edit, the spatial editing will start, targeting the created polygon and the addition of vertex-type elements to the breaking points of the platform's footprint, because the objective of digital modeling is the surface above it.

Digital Modelling

Digital modeling involves the creation of a TIN that accurately reflects the dimensions and dimensions imposed by the projected situation plan and the transverse and longitudinal profiles, respectively.

The data framework for creating the digital model is represented by the inventory of coordinates and the polygon type entity previously obtained by the spatial union of the polygon that perimeter delimits the target platform and the points carrying altimetric information (called declivity points).

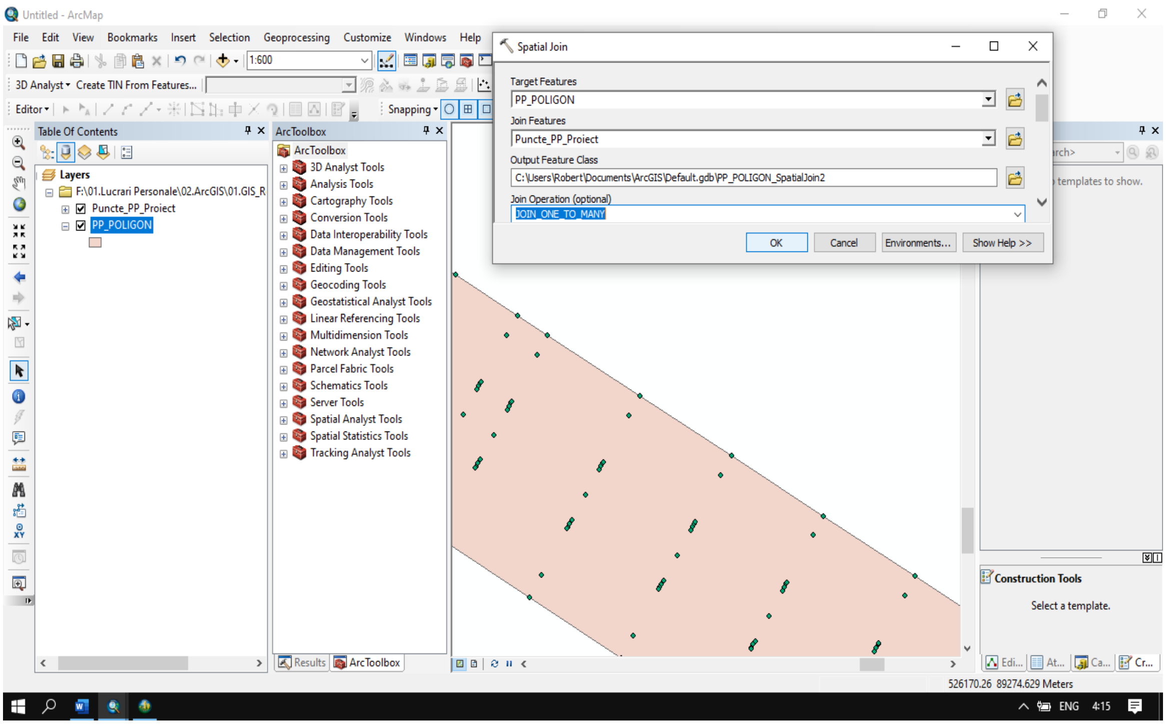

Fig. 3 The spatial union is the polygon type entity with the declivity points of the platform

To create a TIN we will use the command "Create TIN From Features" from the 3D Analyst menu and in the dialog we will select the target layers. In the "Height Source" section we will select the column corresponding to the altimetric values associated with them from the attribute tables.

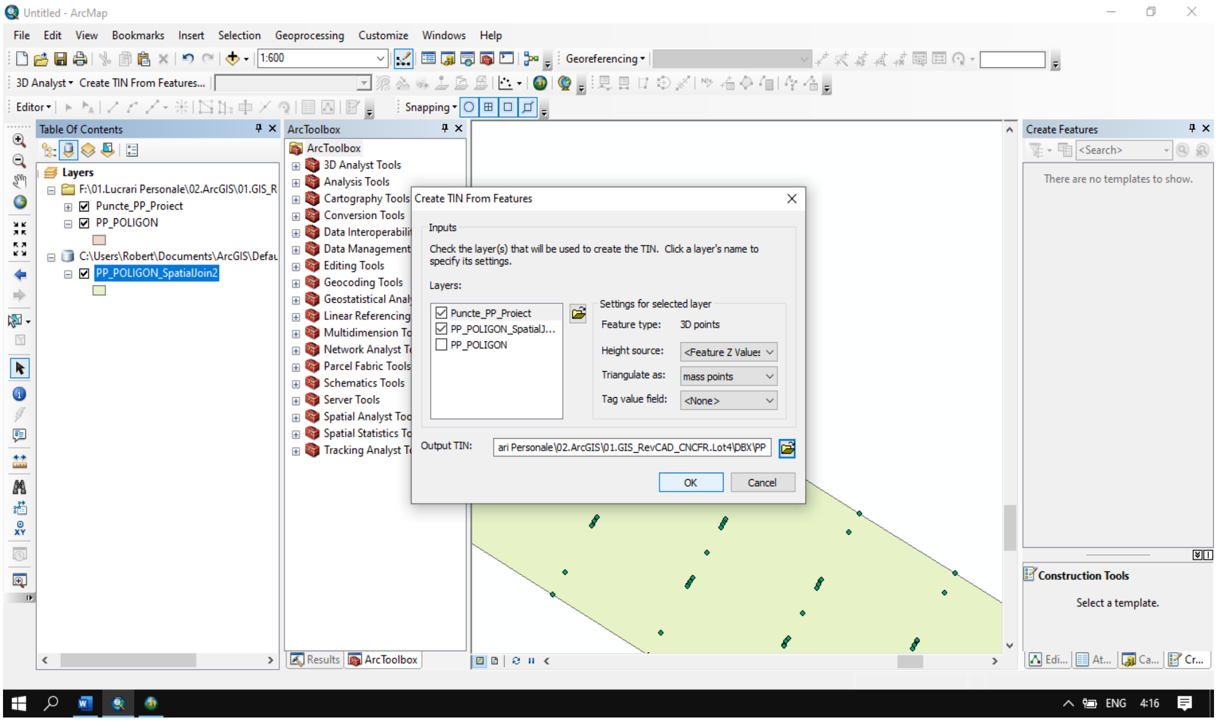

Fig. 4. Selection of the constituent entities of the proposed digital model

After importing the digital model into the machine's computer and orienting it by parking with the GPS system on a known terminal or via a total dedicated station, it will determine the machine's position relative to the created model and provide the altimetric difference between the machine's position. or the bucket of the excavator) and the position of the platform in the model, following that the operator performs the earthwork so that, when the machine passes on the surface of the platform, it does not distort the level of the objective.

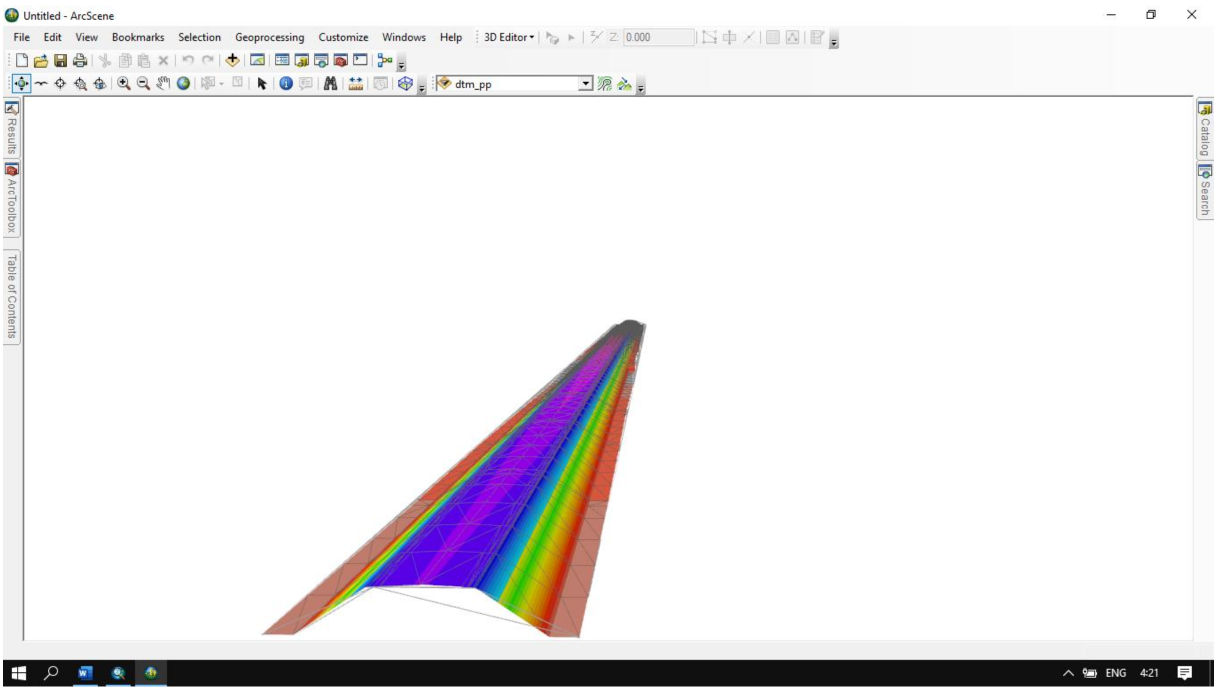

Fig. 5. The digital model of a platform

Following the creation of all platforms through the ArcMap program, they will be imported into ArcScene to verify the correctness of their geometric and volumetric modeling, as well as the common edges in order to identify possible errors in card editing. This check is done by consulting a cross-sectional profile type.

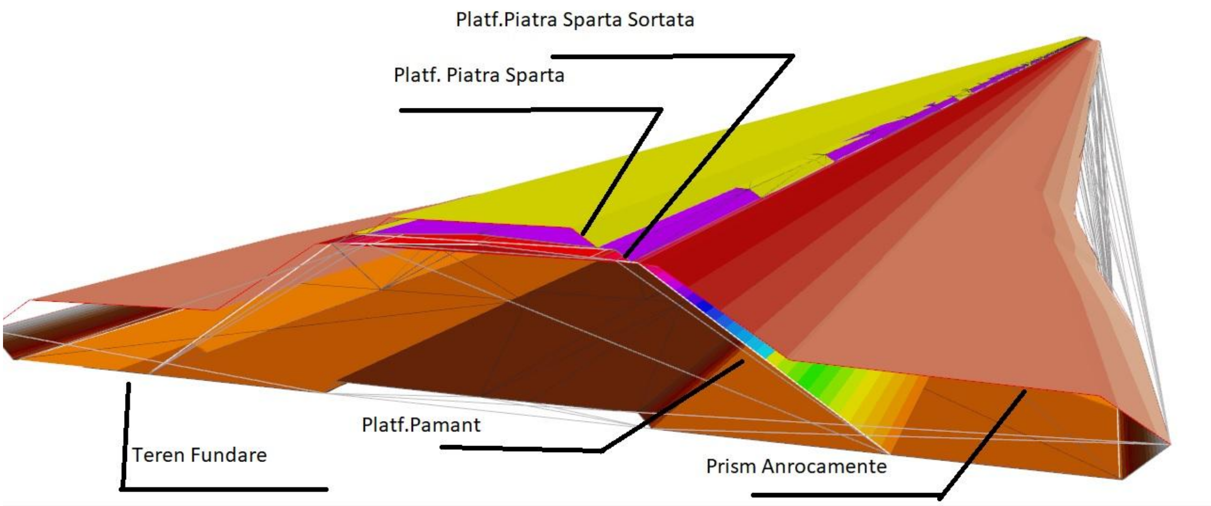

Fig. 6. Overlay, view and verify platforms in the ArcMap program

3. Results and Discussion

By implementing an automated embankment execution system using digital models, the aim is to eliminate discrepancies between planning and actual execution. This mode of execution brilliantly satisfies the objectives pursued by rigorous planning of execution costs on the one hand and further facilitates the execution process, the number of people involved in it and the reduction of costs overall.

Fig. 7. Digital model used in production

4. Conclusions

This approach reduces to some extent the presence of the surveyor in the field, who performs only sporadic checks and adjacent works such as tracing mileage positions, probe checking the altimetric positioning of the machine blade, tracing single elements such as catenary posts, of drainage manholes, main and secondary line axes, etc.

The use of digital models allows to meet the requirements specified in the execution technology such as making successive layers of filling to predetermined thicknesses for folding with geotextile or geonet material as appropriate, this being possible due to the altimetric solution offered by the machine computer in relation to the reference surface (designed platform).

Using digital modeling in addressing this problem we can solve technical problems in the field using dedicated software, accurately meeting the needs of the beneficiary. The solution of problems of this nature will be done quickly, efficiently and safely, thus following the trend of automation in execution, which allows real-time monitoring of the evolution of works, their control and implicit cost reduction.

5. References

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