STANDARD PROCESS OF 3D TOPO-SURVEY FOR ROAD DESIGN

Proposed for Topographic Survey of Da Nang - Quang Ngai Expressway

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1. TEC's ability in 3D Topo-survey for road design

TEC's survey teams have applied 3D Topo-survey technology for road design for many project. The first project that 3D topo-survey were carried out by TEC is NH.10 project that is 14 years ago.

With 14 years of experience, high skill staffs, new equipment and soft wares, now TEC can carry out topo-survey using 3D survey technology at highest quality and accurately for all of the transportation infrastructure projects.

We would like to describe below our standard process of 3D Topo-survey for road design.

2. Standard process of 3D Topo-survey for road design

2.1 Definition of 3D digital model

3D model of terrain's surface (as known DTM - Digital Terrain Model) is a mathematical model of topographic surface and objects on it. In this, terrain's surface is divided into extremely minute planes. If a plane is triangular-shaped, the model built from these plane is a triangular network (a network is very popular now).

Using measure points and topographic lines (3D line built from measure points) to form a triangular network based on some following principles:

- Triangle vertices are measure points;
- Triangle edges don't intersect and don't intersect 3D lines;
- Triangles don't obscure the others.

2.2 Procedure of surveying topography by 3D technology

- Firstly, establishment of plan and elevation control networks is done as usual.

- Survey method in the field is the same for both 2D plan and 3D plan, but the number of detail points is more than 2D plan and depends on difficult level of terrain. This request will sure enough data for building 3D model.

- After processing, a measure point is expressed on a drawing in terms of a block which contains information about its recognition, plan coordinates and elevation, code.

- Making 3D topographic lines for objects on the ground based on point block. Object expressed by 3D topographic lines usually are roads, rivers, canals, ponds, lakes, houses, edge of fields, dykes, etc. Objects of the same type are set to a layer like road layer, house layer, river layer, etc. to advantage for searching and managing of the drawing's information. Houses of residential quarters also are expressed by 3D lines, namely outside border of house is 3D line, symbol shown kind of house is 2D line or notes and put in other layer. The software provides commands to solve this problem easily.

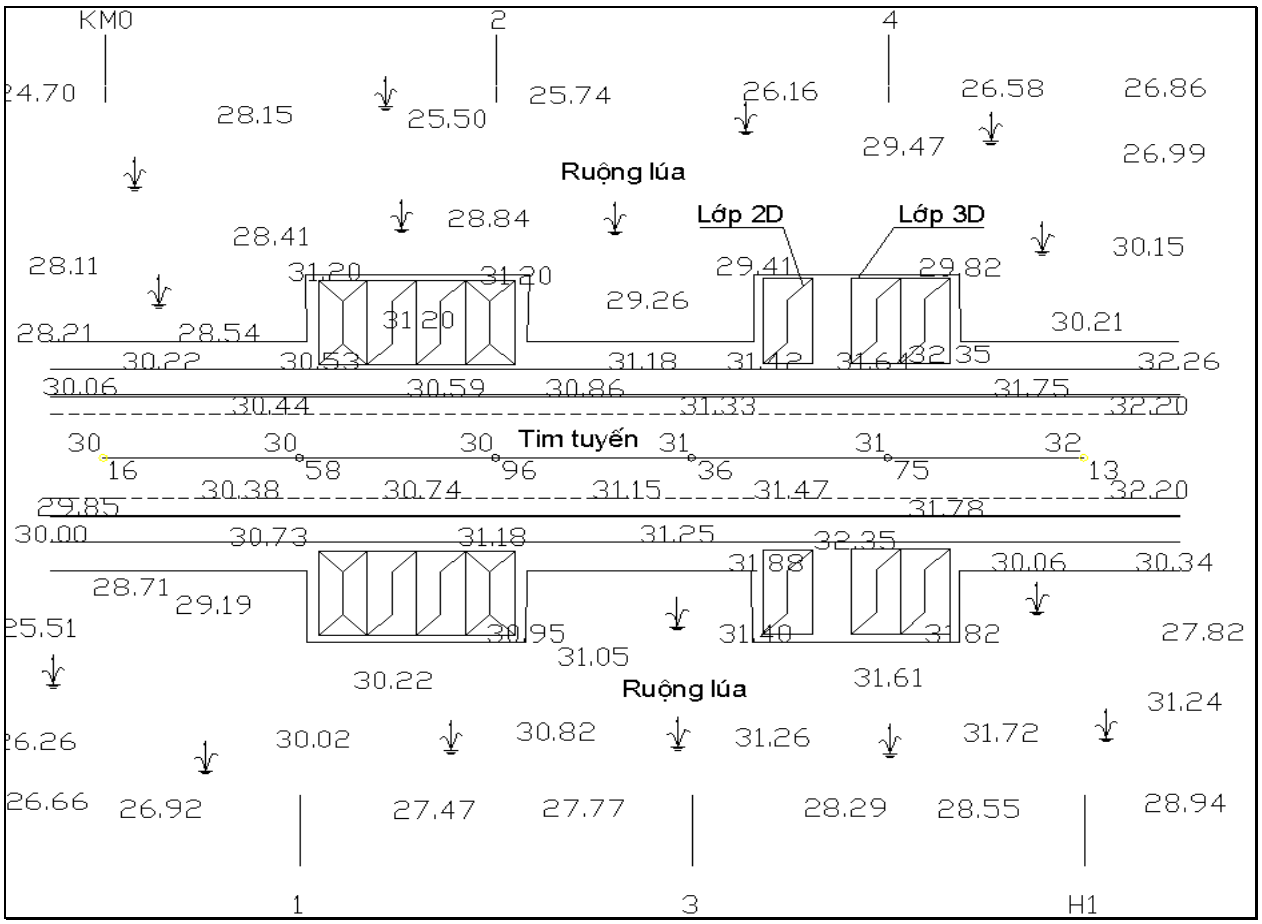

Fig 1: 3D plan of the section of route

2.3 Building DTM

- *Checking elevation of detail points.*

  - If a detail point on drawing isn't right position, the software provides a feature to put point in its right place, then a point will have elevation equal the value shown on the drawing.

- *Building DTM*

  - DTM is only built after finishing both making 3D lines and checking elevation.

  - The software provides tools to build DTM based on 3D objects in according to the principles in 2.1 items above. In this case 3D objects consist of point blocks and 3D topographic lines which scarcely make. And triangular network reproduced terrain's surface is triangular irregular network (TIN).

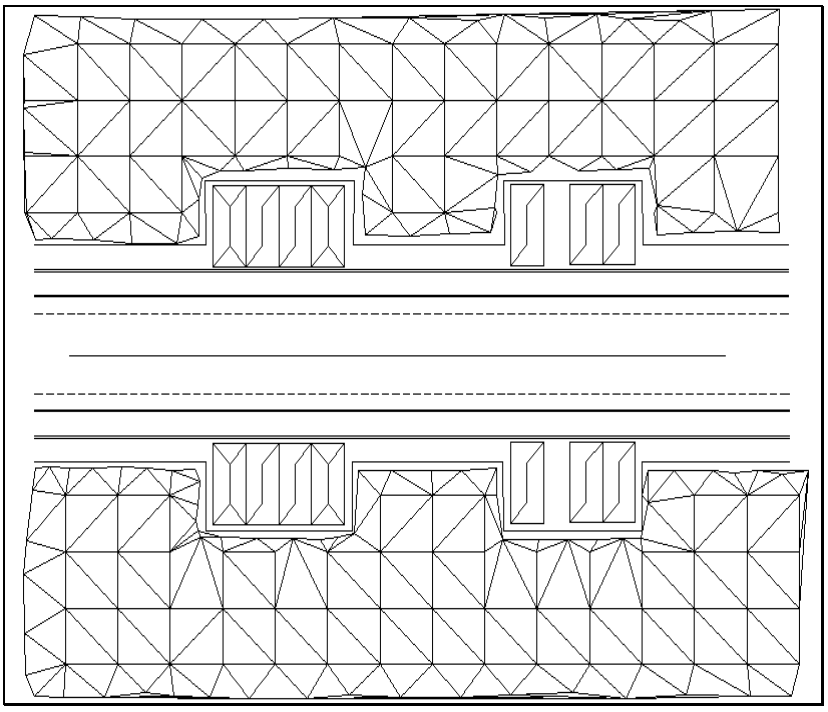

Fig 2: DTM consists of triangular network and 3D topographic lines

  - DTM is created can now be rotated on a drawing of graphics software Cad common to see the view from any direction in 3D space. If the model is built from objects that contain errors raw, triangular grid at that location will be the local mutation helps us easily recognizable to remove or adjust the composition containing such crude errors.

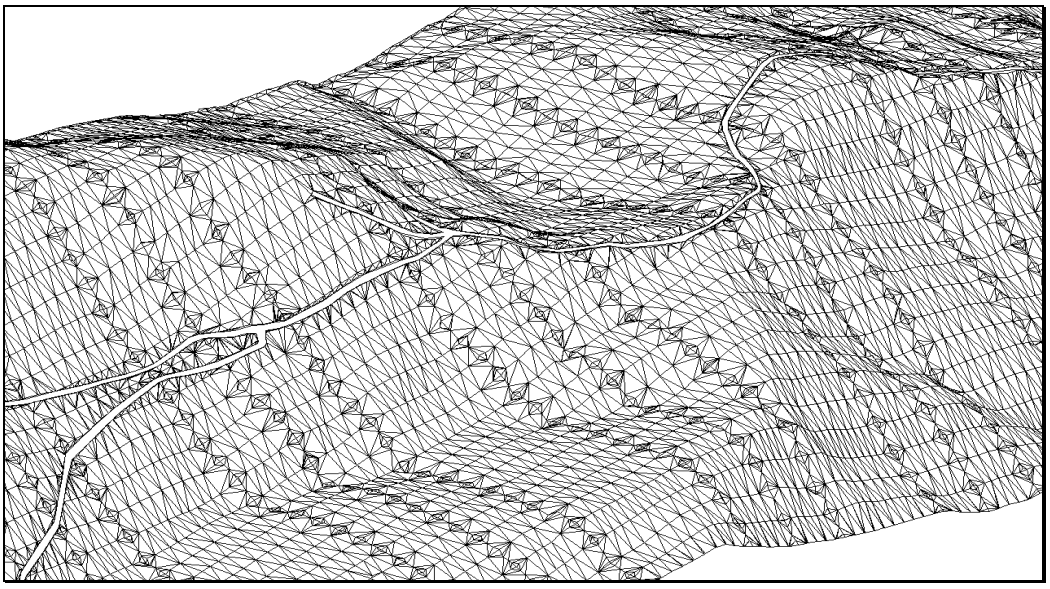

Fig 3: Perspective figure of DTM

- *Effect error on DTM's accuracy*

  - Measuring error: error of determining the details.

  - Errors due to insufficient density of detail - the detail points are not located in the unique position to show the change of surface topography.

  - Errors from the line 3D terrain may not fully reflect the current state of works on the surface

  Therefore, the accuracy of the DTM depends on the measuring in the field. Map made by 3D technology requires huge workload in the field

2.4 Create terrain sections from DTM

- *Create longitudinal*

  - Route after the locate on a map, use software to create longitudinal distance between the piles option on monitoring along. Longitudinal survey created by this method is sufficient to show the change of terrain as well as online works at the intersection with route location passing.

  - The name of the first stakes on the longitudinal along the default name of the layer containing the 3D line that cuts across route, so look at the monitor along

can easily visualize the terrain passing routes. The stakes will be located along the survey to determine its place.

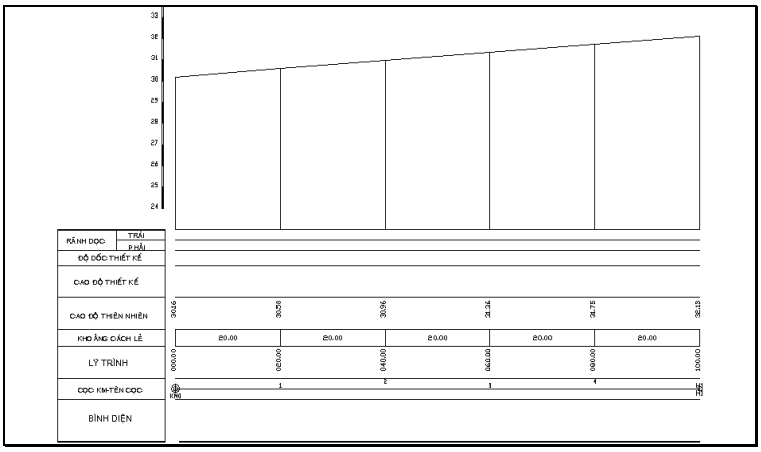

Fig 4: Profile was drawn in TKD software

- *Create cross-section*

  - Cross section of the route was created after the longitudinal section (can be interpolated from the DTM model, or measured directly on the field).

  - When conducted to create cross-sectional, the software offers the choice of horizontal monitoring range, the minimum distance of individual points on the horizontal monitor.

The level of detail on the survey also notes the name of the layer containing the 3D objects that cut through the monitoring level. Therefore, similar longitudinal section, look at the cross section can easily visualize the terrain in its place.

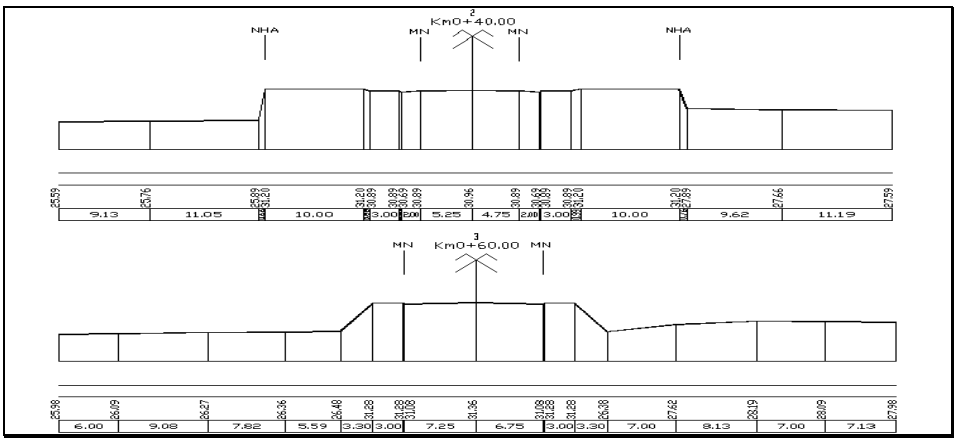

Fig 5: Cross sections drawn by TKD software

- *Create a cross-section of other works on the route*

- In most projects for transportation, in addition to the identified section of the main route there are other items such as bridges, culverts ... should also be cross-related data to provide design unit. Creating sections of this work is also done similar to the main route.

- *Format data file section and provides design unit*

  - Data file in the form of cross-default text file with the extension. "Vmc" for such formats, file data is not only smaller but also very convenient to see and deal with software other popular.

    In addition the software also allows data export in different file formats to fit the format required by software designers

- *Establish statistics from data file*

  - As mentioned above, longitudinal section contains complete information on the location coordinates of the intersection, the intersections of the high points of intersection of the center of the intersection with route such as power lines, roads people's daily traffic, sewer, ... Using this software will quickly establish the statistics of crossings of monitoring data from the file along.

2.5 Benefits of DTM applications

- The model of three-dimensional surface topography simulation of the rough slope, the change of terrain and objects, helps the designer to easily visualize the terrain from which to make the plan route at advantages.

- The surface topography should be digitized to create 3D models section from quick and simple.

- For large intersections, junctions or routes with smaller radius curves, the three-dimensional digital modeling to create a cross-sectional validity of the data is much higher than with traditional methods of measurement. Three-dimensional numerical model is useful to examine projects in difficult terrain as well as inform the user correctly identified direction of cross-section.

3. Objects were done by 3D technology

- No.1 highway construction project, section from Cau Gie to Ninh Binh

- 2E highway improvement project in Lao People's Democratic Republic
- Hanoi urban railway project - Line No.3: from Nhon to Hanoi station (cooperating with Systra consultant of France)
- Hanoi - Haiphong expressway project

(The attachment of 3D AutoCAD files show result of 3D Topo-survey as examples)

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