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Application of BIM Technology in Forward Design of Railway Subgrade

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Abstract: The emergence of digital three-dimensional technology with BIM as the core concept has provided strong technical support and new driving force for railway line design. In order to explore the forward design application of BIM technology in the railway design industry, this paper takes the measurement data of a new railway special line as the original basis, adheres to the principle and process of railway design, and adopts the AUTO CAD Civil3D software in BIM technology to analyze and design the measurement data. Through the surface analysis function of its software, according to the railway design process, the overall ideas and steps of terrain surface, slope design and railway line design are analyzed, and the advantages of Civil3 D software in railway design modeling are preliminarily explored. At the same time, the forward design application of BIM technology in railway design is also explored. It is hoped that this exploration has certain reference significance for the forward design of BIM technology in the railway industry.

1. Introduction

In recent years, BIM technology has been widely used in railway, highway, construction, water conservancy and other industries. Railway is an important pillar of our country. It is necessary to design it simply, quickly and efficiently. At present, many scholars have successively studied the application of BIM technology in the railway industry and achieved fruitful results. Taking a section of Sichuan-Tibet Railway as an example, Liu Jiangtao et al. [1] studied the application of Google Earth and BIM technology to extract large-scale terrain data and establish a digital route selection environment. Based on Auto CAD Civil 3D secondary development, the three-dimensional design of Sichuan-Tibet Railway was realized. It is considered that BIM technology is more effective to solve the content of railway design. In order to realize the parametric modeling of railway line structure, Xia et al. [2] studied the construction process of custom component parametric model based on Autodesk Civil 3D component editor (SAC) by using its advantages of visualization and parametric design. Liu Chengzhe et al. [3] used Auto CAD Civil 3D platform for dynamic design of railway lines based on the expansion project of Jincheng line, and preliminarily verified the feasibility of using Civil 3D for railway line design. Based on the current situation of BIM technology application, Lu Zhuqing [4] points out that the basis of BIM technology is three-

dimensional digital technology, and integrates the information data model of various specialties in the project. Finally, the idea that BIM technology will be applied to the whole life cycle of railway construction projects is put forward. Yi Sirong et al. [5] studied the railway digital line selection design system based on virtual geographical environment, realized the railway three-dimensional solid line selection design in realistic three-dimensional geographical environment, and constructed the railway structure primitive model library by using BIM technology. Based on this, the application of BIM technology in the railway industry is the general trend. It is no longer a simple mold turning, but a standard forward design.

The application of BIM technology in engineering design is the general trend. With the advantages of high efficiency, intuitive, fast and convenient, it is recognized by the state and the owner units and becomes a necessary technology in engineering design. Furthermore, the development of BIM technology in recent years, most of them still use the form of turning the mold and then drawing, exploring the application of BIM. However, most of the software on the market can be realized, and the advantages of this technology can not be greatly extracted. On the contrary, forward design can greatly enhance the advantages of BIM, so as to innovate in engineering design. As the name suggests, ' forward design ' is a design opposite to turning over the mold. It does not use imitation as a means, but can learn from the idea of reverse design and absorb a variety of existing technologies and achievements.

Based on this, this article from the basic measurement data as the basis, through the Auto CAD Civli3D software to form a three-dimensional terrain surface, and then according to the terrain surface route design, grading and route design and many other design content. Through this study, we hope to have some reference for the application of BIM technology in the forward design of railway.

2. Three-Dimensional Surface Establishment

The railway design is based on the overall original terrain, and the railway line design is different for different terrains. Railway design factors to be considered in the majority: geology, topography is the most basic. At present, with the improvement of technology, railway design is also constantly moving towards rationality and accuracy. Based on Civil 3D, the three-dimensional virtual terrain environment model is used for railway design. Using the visualization, linkage and interactivity of this software, the original terrain can be transformed into three-dimensional surface, so as to carry out three-dimensional railway design, which can not only scientifically weigh the scheme, but also make the decision-making convenient, simple and efficient.

The establishment of three-dimensional surface is mainly the establishment of terrain surface. In this paper, Auto CAD Civli 3D software is used to analyze and process the measurement data, and the redundant points and lines are deleted, which can make the three-dimensional modeling better. Based on the measurement data of a project, this paper uses Auto CAD Civli 3D software to establish the three-dimensional surface of the terrain plan, according to the three-dimensional data of the terrain plane (elevation point, contour line, ground object, building) and so on. Component feature object, create a three-dimensional terrain surface. The creation steps are as follows:

When creating a three-dimensional terrain surface in the Civil 3D platform, it is necessary to create an empty surface object first, and then add the source data (such as point cloud file, contour line, DEM file, GIS data, etc.) to the surface definition. This paper mainly uses feature points, feature lines (raster data points, raster data line sets) and other methods to create a three-dimensional terrain model.

In most cases, the original measurement data required for the terrain is provided to the designer through the integration of DWG files. The graphics contain different types of Auto CAD objects,

such as contour lines, ground objects, blocks representing measurement points, and text.

① First find the contour lines and elevation points in the positioning topographic map.

② remove the repeated items, short objects, zero-length objects in the graphics, perform operations such as merging pseudo-nodes and simplifying objects, and then use the PE command to convert the contour line style in the graphics into multiple lines ;

③ check the contour and elevation point properties, check its elevation value.

④ create terrain surface, surface type is triangular mesh surface, surface style choice contours 2m and 10m, as shown in Figure 1;

⑤ in the definition of terrain surface, respectively, to add contour lines and graphics objects, and select the original electronic topographic map contour lines and elevation points, conversion AUTOCAD points to create terrain surfaces and three-dimensional view, as shown in Figure 2.

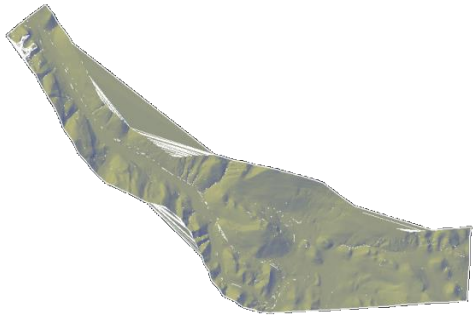

Figure 1: Three-dimensional terrain surface

3. Terrain Slope

Terrain is the foundation of excavation and filling calculation in railway design and the basis of line selection [6]. When designing a fill and dig in Auto CAD Civli3D software, it is necessary to create a grading standard. The grading standards are implemented according to the ' Code for Design of Railway Subgrade ' (TB 10001 2016). In the Auto CAD Civli3D software, expand to the slope standard dialog box and set up the slope method, slope projection and conflict resolution, as shown in Figure 2. The slope method is to set the target object of slope, including surface, elevation, relative elevation and distance. Slope projection is to set the default gradient or slope rate ; the conflict solution is to give three solutions for using the average slope, keeping the slope to a minimum, and keeping the slope to a maximum when an internal corner overlap occurs [7]. A slope object in the same slope group can create a slope group surface to calculate the quantity of fill and dig. Slope is a series of excavation and filling simulation based on the slope reference line. Through multiple slope operations, the required design surface is finally formed.

Slope objects: usually composed of slope foot, slope line, projection line and surface area surrounded by projection line;

Slope group: used to organize a slope in a specified set form to create a slope group surface;

Slope standard: specify the setting of slope method;

Slope target: The slope target is used to define the target that will be intercepted by the projection starting from the slope toe (slope baseline). The slope object needs the target, which can be a surface, distance or elevation, and relative elevation.

Through the powerful surface analysis function of Civil3D, the relationship between the original terrain before field leveling and the terrain after field leveling is transformed into the relationship between the field leveling surface and the terrain surface, and the earthwork calculation problem is solved. Using BIM technology to measure earthwork volume in advance, carry out earthwork

balance, rationally allocate earthwork, select construction machinery and personnel scheduling, ensure construction progress and reduce unnecessary waste.

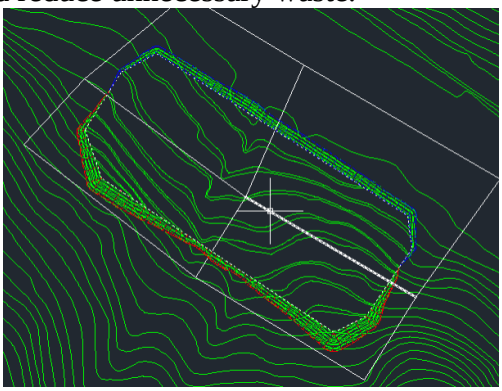

Figure 2: Slope setting

4. Route Design

Line design and optimization is an important task of line selection design. Civil 3D itself has a powerful route design function. [8] The line is called Alignment in Civil 3D, which is the basic element of the objects such as profile, line and sampling line. There are several ways to create routes: (1) create routes using Civil 3D 's own route creation tool; (2) Create lines from AutoCAD objects; (3) converting the existing multi-line objects into lines; (4) from the road model feature line, pipe network object to create lines, etc. [9,10] This section creates lines from AutoCAD objects. On the basis of the previous design, it is necessary to carry out the railway line selection work to create the line center line. After the line centerline is drawn, the longitudinal section needs to be designed. There are two main types of vertical section: design vertical section and dynamic vertical section. The dynamic profile refers to the topographic relief profile under the projection of the line centerline. It can not only be dynamically updated according to the position and editing of the line centerline, but also collect the ground lines within a certain distance on both sides of the line through the offset function for comparative analysis. The design profile is a regular geometric line containing straight lines and curves determined by engineers after comparison in many aspects such as technology, economy, safety, stability and aesthetics. It reflects the ups and downs of the line position in the space after the opening of the railway line. It is generally created by the profile design tool and can be edited by pinches and scenes.

Railway subgrade, slope and other structures are usually extended from one or more standard cross-sections along a specific line. The assembly is the standard cross-section of Civil 3D to generate linear objects such as lines. A standard cross section can be called an assembly. An assembly is composed of multiple components, such as roadbed components, slope components, side ditch components, etc. These components can create a variety of assemblies through different combinations. The component is composed of three basic units: Point, Link and Shape. The standard assembly cross section pattern is composed of reference lines and reference points. By adjusting the relationship between the parts and the baseline and the reference point position, the actual required assembly is formed. However, the resulting model is not continuous, and code needs to be added for each geometric unit. Codes with the same name are automatically connected as they extend along the line, forming a continuous 3D model, as shown in Figure 3.

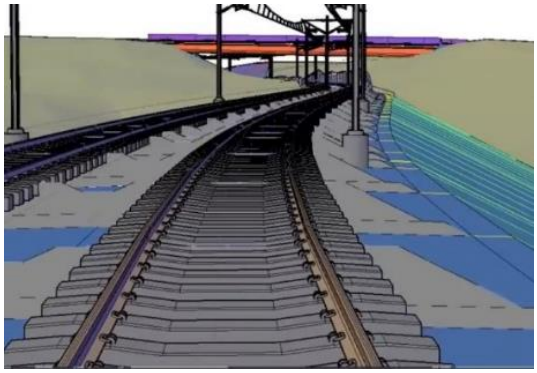

Figure 3: Railway routes

5. Conclusions

Based on Auto CAD Civil 3D software in BIM technology, this paper explores the forward design and application of BIM technology in railway industry. By transferring the feature points (contour lines, elevation points, etc.) in the measurement plan into the software, the original terrain is transformed into a terrain surface, and then the railway route is designed according to the field level surface formed by the filling and excavation analysis. It can be concluded that BIM technology has great advantages in the process of railway forward design, and Auto CAD Civli3 D software can not only simply generate terrain surface, carry out earthwork balance and railway route design work, but also interact with Revit software to complete the three-dimensional design of railway subgrade.

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