Research on Single Tower Cost Prediction Technology of Transmission Line Engineering Based on 3D Design

Wenhan Chen¹, Xuecheng Qi¹, Jingyu Fang¹, Jian Shao², Chao Chen*³

¹State Grid Zhejiang Electric Power Co., Ltd. Construction Branch, Hangzhou, Zhejiang Province, 310016, China
²Wanbang Engineering Management Consulting Co., Ltd., Ningbo, Zhejiang Province, 315000, China;
³School of Economics and Management, North China Electric Power University, Beijing 102206, China.

*Corresponding author’s e-mail: juzen123@163.com

Abstract. Overhead transmission line project investment and construction is an important part of the daily investment activities of power grid companies. With the continuous advancement and implementation of my country's power system reform, improving the efficiency and efficiency of investment in power grid projects has become the main way for grid companies to invest. The construction and development of overhead line projects is an important support for power grid companies to ensure the safe and stable supply of electricity. The construction cost control of large-scale overhead line projects faces many influencing factors. Factors such as terrain, geology, meteorology, and transportation conditions will cause large differences in cost and other realities. Therefore, strengthen the lean management of the construction cost determination of overhead line projects, rely on the development and application of three-dimensional design, strengthen the construction of a "tower-oriented" construction cost determination system, reasonably control project investment, and increase the level of power grid construction investment efficiency.

1. Introduction

With the development of economy and society, the development of power grid enterprises faces a new form, and investment management faces new requirements. It is urgent to implement a precise investment strategy for power grids to comprehensively improve the efficiency and efficiency level [1]. At the same time, in the context of power system reform, the power grid enterprises will face cash flow reduction, investment capacity weakened, and grid investment is subject to government control, so investment accuracy needs to be further improved [2]. The overhead transmission line project is a type of engineering with long space continuity. It is affected by factors such as topography, geology, meteorology and transportation conditions. The actual value between tower and tower is very different [3-5]. In the current industry standards, whether it is the "Power System Construction Budgeting and Calculation Regulations (2013 Edition)" or "DL/T5205-2011 Power Construction Engineering Quantity List Pricing Specification-Transmission Line", it cannot solve the single-base of overhead transmission line engineering. Therefore, under the current cost model, how to reasonably determine the cost of a single base tower for a transmission line project is one of the important issues facing grid companies.
For a long time, the estimated budget, completion settlement and financial final accounts of overhead transmission line projects are all priced based on the entire line, which cannot reflect the actual cost level of each base tower, and the cost accuracy needs to be further improved. Therefore, we must innovate the pricing model and strengthen the lean management of the construction cost of overhead line projects[4-5].

2. Three-dimensional design and power grid engineering development and application

2.1 The basic concept of 3D design
3D design is the foundation of a new generation of intelligent design platforms. At present, my country's various industries and industries are extensively and deeply applying 3D design technology. The popularization of 3D technology in the power industry is also an inevitable trend for future development. With the development of modern technology, the integration of design business and informatization means is increasing day by day. Digital design with three-dimensional design as the core will become the main axis throughout the entire process and life cycle of the project. Through the three-dimensional design of overhead transmission line engineering, the design quality and design efficiency of the project will be greatly improved. The degree of visualization is greatly improved, and the difficulty of retrieval is greatly reduced. Engineering information will be digitally transferred by the design department to other production or management departments. Data information will go through design, construction, operation, maintenance until decommissioning, multi-stage, multi-link, multi-department joint maintenance and use, supporting the management concept of the full life cycle of the functional power grid. The in-depth application research of the three-dimensional design of overhead transmission line engineering is the focus of current research of power grid companies.

2.2 Importance analysis of carrying out 3D design of transmission line engineering
The development of 3D design has experienced many years of exploration and development, and has summarized many valuable experiences. In the process, there have also been attempts to convert the 2D design and the 3D mold to the 2D drawing, which not only greatly reduced the efficiency of the 3D design, but also increased the heavy engineering for the designer; in addition, the digital results of the 3D design of the power grid It is difficult to standardize, there are obstacles to data communication, and there is a lack of effective technical means and system carriers to promote the vertical expansion and value-added application of design results. With the implementation of the three-dimensional construction of power grid design and the development of power grid data analysis and application work, the landing speed of three-dimensional design has also been significantly accelerated, and the sharing, accuracy, completeness, applicability, and reuse of data have been greatly improved In order to comprehensively improve the engineering design and technical level.

(1) The development of 3D design is a clear requirement of State Grid Corporation
State Grid Co., Ltd. has clearly proposed to carry out digital 3D design of power transmission and transformation projects, especially in the Notice of the State Grid Infrastructure Department on Printing and Distributing the 2017 Power Transmission and Transformation Engineering Design Competition Work Plan (Infrastructure Technology [2017] No. 22) The document clearly launches a special competition for substation 3D design, and requires the participating units to be equipped with a substation 3D design software system for 2 years or more, so it is urgent to build a substation 3D design system and carry out digital 3D design.

(2) Promote design standardization and technological innovation of design units
At present, within the design unit, there are phenomena of non-standard drawing, inaccurate calculation, and unclear expression of drawing information. Based on the digital three-dimensional design system, it can promote design units to establish a standardized design system to achieve technological innovation in engineering construction management, including: design standardization, drawing standardization, equipment standardization, calculation standardization, and information standardization.
(3) Improve the design quality and efficiency of overhead transmission lines
To realize the three-dimensional design of overhead transmission line projects, through three-dimensional collision inspection and safety clearance verification, to avoid design changes and rework caused by collisions during the construction process, as well as schedule delays and cost waste caused thereby, and improve design quality. Using the system to cut out the three-dimensional model to achieve the size, elevation, serial number rapid labeling and accurate statistics of materials. Taking engineering data as the core, after the digital 3D engineering model is modified, the drawings are updated according to the data to ensure the consistency of the design results and improve the design efficiency.

3. Application Prospect of 3D Design in Overhead Transmission Line Engineering
In recent years, with the rapid development of information technology, 3D design has gradually become a development trend in the design field due to its advantages of visualization, standardization, and informatization. At present, the design and design work of overhead transmission lines has gradually popularized the digital design technology.

3.1 Single base tower pricing application case
The line project of a certain place is newly built with a total length of 2.7km (overhead 2.5km, cable 0.2km). The terrain ratio is 100% in the hills, and the geological division is 40% for rocks, 50% for loose sands, and 10% for ordinary soils.

The construction simulation of the example project, the main parameters of the measured project are shown in the following table. The price of the quota and equipment materials used in the study is the same as that of the existing pricing system.
Table 1. Sample data.

| Serial number | Tower type       | Human transport (km) | Car transport (km) | terrain |
|---------------|------------------|----------------------|--------------------|---------|
| 1             | 1GGD2_24         | 0.45                 |                    | hills   |
| 2             | 1GGD2_33         | 0.4                  |                    | hills   |
| 3             | 1D2-SJC2/23      | 0.4                  |                    | hills   |
| 4             | 1D2-SJC2/20      | 0.5                  |                    | hills   |
| 5             | 1D2-SJC3/24      | 0.24                 |                    | hills   |
| 6             | 1D2-SJC4/18      | 0.35                 |                    | hills   |
| 7             | 1D2-SJC4/22      | 0.3                  |                    | hills   |
| 8             | 1D2-SJC4/26      | 0.15                 |                    | hills   |

(1) Cost calculations that cannot be directly attributed to a single base tower
1) Wire-laying project: The cost of the overhead line project under the existing pricing system is 61,142.00 yuan.
2) Attachment project: For the cost of the installation of the anti-vibration hammer, refer to the 13 version of the fixed terrain increase factor table. The attachment project hill terrain increase factor is 5% and the mountain increase coefficient is 20%. The proportion of hilly terrain in the example project is 5%*6/(5%*6+2*20%)=43%, and the proportion of mountain topography is 2*20%/(5%*6+2*20%)=57%.

(2) Cost calculation directly attributable to a single tower
The cost of calculating the 1# tower is shown in the table below.

Table 2. Cost of 1# tower

| Serial number | Project or expense name | Calculation method | Amount of expenses (yuan) |
|---------------|-------------------------|--------------------|---------------------------|
| 1             | Basic engineering       | Calculated by calculation | 22.0358                  |
| 2             | Tower engineering       | Calculated by calculation | 14.8145                  |
| 3             | Grounding engineering   | Calculated by calculation | 1.1725                   |
|               |                         | Materials and fittings that can be directly attributed to a single base tower are calculated on a real basis | 3.0119                   |
| 5             | Attachment engineering  | Materials that cannot be directly attributed to a single base tower are calculated according to the terrain of the tower | 0.0831                   |
| 6             | Auxiliary engineering   | Calculated by calculation | 0.1354                   |
|               |                         | total               | 41.2532                  |

Similarly, the single base cost of other towers can be calculated, as summarized in the table below.

Table 3. Budget investment under the innovative pricing model.
Compared with the existing pricing system, the accuracy of the ontology investment of the innovative pricing system is increased, and the accuracy ratio is increased by 4.06%.

4. Conclusion
Although the single-base tower pricing method will increase the working time of preparation, review and evaluation to a certain extent, with the improvement of the cost software and the skilled application of relevant personnel, the compilation efficiency can be further improved. Moreover, the depth of the single-base budget is more detailed and closer to the actual situation of the project, which helps to strengthen the cost management of infrastructure projects, standardize the management process, refine the management system, effectively control the project cost, improve the investment efficiency, and promote the scientific management of infrastructure projects.

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