Research of Three-Dimension Design in Infrastructure Project Application

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Abstract. The three-dimensional design of transmission and transformation projects is a new development trend of State Grid Corporation. This article examines the key technical and management constraints of three-dimensional design of transmission and transformation projects from multiple perspectives, and uses three-dimensional design results to carry out exploration and control of construction process. Accumulate experience from collision testing, simulation construction, cost saving, time saving and dynamic management and control of materials and equipment resources to form a three-dimensional construction management and control measure for power transmission and transformation projects. By building the engineering data platform of Hebei Company, the design-infrastructure-operation and maintenance integration is realized. Provide a platform for storage, display and interaction for data sharing and integration in design, construction and operation. Realize the three-dimensional integration, monitoring and analysis of power grid information. To achieve the goal of comprehensively improving the technical and management level of the design and management of transmission and transformation projects of Hebei Company, and to promote the application of digital results in the design of transmission and transformation projects of Hebei Company.

1. Introduction
The three-dimension design technology of power transformation project for the power industry has entered to the stage of rapid development in recent years. In December 2016, Liu Zehong, Deputy General Manager of State Grid Corporation clearly said during the investigation and survey to Economic Research Institute of State Grid to strive more efforts to promote the three-dimension design and engineering data center construction. The file Opinions of State Grid Corporation on Comprehensively Applying the Three-Dimension Design of Power Transformation Project and Constructing the Engineering Data Center (No. State Grid Infrastructure 2018 (585)) that was issued in 2018 raised to realize the three-dimension digitalization for the achievements of transmission and transformation project, required the newly constructed transmission and transformation projects of 35kV and above of company shall comprehensively apply the three-dimension design, and synchronously launched the construction of engineering data center. In 2019, the Infrastructure Department of State Grid Corporation issued the opinions on deepening the digitized management application of power grid, raised the innovative grid design technology, deepened the three-dimension design application, as well as promoted the lean management of engineering construction and boosted the high-quality construction of power grid.

The domestic designing institutes have all started to actively respond and promote the three-dimension design means, and carried out the application practice in the practical projects. Along with
the deepening of engineering design state and the requirements of engineering construction are continuously improved, the depth of current three-dimension design and design quality still have a certain difference from the practical demands of construction: The three-dimension design of transmission and transformation project still hasn’t formed the deep experience system of construction drawings with low standardization level; The relevant technical standards and regulations of three-dimension design for the transmission and transformation project of enterprises are not unified and complete; The degree and function of relying on the three-dimension design means to guide the full process of construction still need to be enhanced etc.

According to the actual needs of the construction management unit, this article explores the demand-oriented construction management and control technology: through the study of standardized construction process management methods relying on three-dimensional design results, to achieve effective management and control in collision testing, simulated construction, cost savings, and construction time.

2. Perform Construction Site Analysis and Perform Detailing of Construction Plan

Combined with the three-dimension design plan, it is able to apply the high-definition image information to carry out the mechanical equipment and materials transportation organization plan design, overall plan the road network, control the deploying method of construction machinery and resources on the macro level, as well as specify the transportation plan, site arrangement and process simulation on the micro level so as to comprehensively optimize the mechanized construction plan.

![Figure 1 High-Definition Image of Geographic Information](image)

The detailing needs to combine with the lean lofting and visualized assembly of manufacturers, as well as calibrate the issues such as collision of hardware fittings and iron tower, collision of ground wire and iron tower, collision between poles, collision between bolts, collision of anchoring connection of tower etc. so as to reduce the error rate of products, enhance the supply quality and shorten the engineering construction period.
3. Perform Construction Plan Verification and Perform Construction Progress Simulation

Through the three-dimension digital information model technology, this research guides the development of the special construction plan, carries out profound analysis to the complex procedures, disassembles complicated parts to enable them to be simple and transparent; Simulates the construction plan and on-site construction status, inspects the hazard source and safety risk in advance; Carries out the reasonable verification to the special construction plan and construction procedures.

Figure 2 Demonstration for Deep Equipment Model of Construction Drawing

![Figure 2](image1)

Figure 3 Schematic diagram of construction progress simulation

Liaise with the construction standard and construction process, divide the construction task and simulate the construction procedures, as well as realize the construction simulation based on the three-dimension digital model. In terms of the specific project, it is able to perform the three-dimension construction filing, record the daily construction status by the means of timeline so as to fulfill the full-process three-dimension tracking of construction and optimize the construction progress management.

![Figure 3](image2)
Through the construction of information and visualization, the reform and innovation of management methods are realized. Through the three-dimensional design guidance to prepare a special construction plan, simulate the construction plan and on-site construction status, you can check potential hazards and hidden safety hazards in advance, effectively reduce the safety risk of construction operations, strengthen the entire process of infrastructure control and lean management.

4. **Perform Construction Cost Estimation**

Build the “Five-Dimension Cost Management Model” (three-dimension model+time+expanse), as well as integrate the geometrical, physical, property, cost and management information for the construction project. It is able to apply the cost model to provide the construction plan and cost control data for each party of construction project so that each party is able to confirm the construction progress and construction cost through the cost model before the construction, as well as realize the construction of quota material issuance and reasonably control the cost.

5. **Use digital handover to explore the coordination of substation life cycle linkage**

In response to the requirements for the digital handover of 3D design results, an engineering data platform was built to realize the integration of design, infrastructure and operation.

The construction of "two systems": Query and interaction system: Through the digital results after the handover, the terrain and influence data display, vector display, thematic map data display, three-dimensional animation display and data query and interaction functions can be realized. Substation equipment dynamic monitoring data display system: It is used to realize the effective integration of design drawings, construction process records, basic equipment information, equipment status information, real-time operation data, and provide assistance for operation monitoring and maintenance plan.

By building the engineering data platform of Hebei Company, the management and upgrading of Hebei Company will be further improved, and the full life cycle linkage coordination of design-infrastructure-operation and maintenance integration will be realized. It provides a platform for
storage, display and interaction for data sharing and integration in design, construction and operation, and realizes three-dimensional integration, monitoring and analysis of grid information.

6. Conclusion

Through carrying out the profound application construction of engineering practice, the achievement and resource sharing mechanism of economic research institute and each local design institute has been established. Through construction planning and preparation of risk response plans, the on-site three-level risk occurrence rate was effectively reduced by 12%. The establishment and application of this system ensure the reasonable design margin and reduce the construction error. By carrying out in-depth research on the application of three-dimensional design in infrastructure projects, the integration of design, infrastructure, operation and maintenance of Hebei Company is effectively promoted. Promote the development of digital design technology to a deeper level. The interconnection and correlation of data information breaks through a new height, which really improves the design efficiency and quality, and produces higher added value for the finished product.

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