



Assessment Method of Carrying Capacity of Power Grid Engineering Construction Team

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Abstract. The construction team is the executor of power transmission and transformation project construction and the key force to ensure the high-quality construction of power grid projects. Scientifically measuring the carrying capacity of the power grid engineering construction team can clarify the resource gap of the construction team, thereby supporting the optimal allocation of various resources and improving the safety and efficiency of project construction. This study analyzes the mismatch between power grid construction tasks and resource allocation in the extraordinary development stage. From the two dimensions of personnel and equipment, a method for assessing the carrying capacity of the power grid engineering construction team is proposed to support the calculation of the theoretical value of the construction team resource gap.

Keywords: Power Grid Engineering, Construction Team, Carrying Capacity, Calculation Model.

1 Introduction

At present, power grid construction has entered an extraordinary development stage of large-scale centralized construction, high-intensity innovative research, and high-quality transformation and upgrading. The contradiction between the surge in power grid engineering construction tasks and the relatively stable construction team resources has become increasingly prominent. Problems such as a serious decline in the total number of employees in the construction team within power grid enterprises, a shortage of technical and skilled personnel, and a low construction equipment allocation rate are becoming increasingly serious. Socialized construction units are not adaptable to the management requirements of power grid enterprises. Carrying out construction team carrying capacity assessment research can help power grid companies accurately judge the construction situation of infrastructure teams, and reasonably carry out talent training and introduction, thereby ensuring the safe implementation of project construction, improving the quality of project construction, and promoting the more lean development of the infrastructure profession.

Shen Yichen (2025) used the power supply station as the core unit to carry out a special analysis of employee carrying capacity. Construct a carrying capacity assessment model to systematically calculate the matching degree between job load and manpower allocation^[1]. Song YongYong et al. (2023) explained the key concepts and coordination relationships between village and town construction and resource and environmental carrying capacity, Establishing a macro-scale resource and environmental background assessment for village and town construction and micro-scale different guidance Scientific and systematic calculation of the resource and environmental carrying capacity of functional type villages and towns and their coordination evaluation A unified and standardized indicator system is proposed, and the key indicator algorithm and main parameter selection basis are proposed^[2]. Yao Shiru et al. (2022) systematically sorted out the origin and research progress of highway resource and environmental carrying capacity. development and evaluation methods, from four aspects: basic theory, evaluation system, technology drive and practical application and put forward development suggestions^[3]. Zhang Chunxiang et al. (2019) in order to effectively solve production tasks and personnel, Conflicts in equipment and other resources can be analyzed carefully beforehand to formulate a scientific and reasonable construction plan. Plans and countermeasures can help employees get rid of passive work situations^[4]. Tian Chunhong (2017) Two aspects of safety carrying capacity evaluation are proposed, namely safe operation capability evaluation and safety management. System evaluation, the evaluation methods are mainly "scoring system" and "safety checklist method"^[5]. Ye GangJin et al. (2014) used the 100-percent operation risk assessment method to evaluate the identified safety risks. Evaluate, evaluate, and select relays that meet the safety risk level based on the team's safety carrying capacity analysis Protection and maintenance team^[6].

2 Mismatch Between Power Grid Construction Tasks and Resource Allocation

At present, China's power grid construction is in a critical stage of high-quality development. The release of policy dividends and the superposition of new energy transformation needs have promoted the explosive growth of power grid engineering construction tasks. However, the problem of insufficient carrying capacity of the construction team in terms of personnel, technology, and management has become increasingly prominent. The outstanding contradiction between the two has become the core bottleneck restricting the improvement of quality and efficiency in power grid construction, and urgently needs systematic analysis and solution.

Power grid construction tasks are characterized by "centralization and rigidity". Projects are often issued centrally and have strict construction deadlines, which can easily cause construction demands to far exceed the capacity limit of the team during a specific period. However, the cultivation period of the construction team is long, and it is difficult for talent reserves, equipment updates and management optimization to keep up with the growth rate of tasks, forming a structural gap where "the growth rate of tasks is faster than the rate of capability improvement". The working environment in

the construction industry is difficult and the labor intensity is high. It is not attractive to young talents, resulting in a gap in the personnel echelon. In addition, the contrast between rising labor costs and low project quotas has limited profit margins for construction companies and lacks sufficient motivation to expand the size of their teams and improve the quality of their personnel. Problems such as insufficient safety training and poor on-site supervision have further weakened the overall operational capabilities of the team, forming a vicious cycle of "insufficient carrying capacity - quality and safety risks - rising management and control costs". Fluctuations in the global supply chain have caused delays in the delivery of key power equipment, disrupted the pace of construction, and reduced the utilization rate of the team's effective working time, indirectly exacerbating the tight carrying capacity.

The traditional model of relying on experience to assess the capacity limits of construction teams struggles to accurately quantify multidimensional resources such as personnel, equipment, and management. It fails to identify mismatches between task scale and construction capabilities in advance, leading to issues like overcapacity scheduling and blind resource allocation. Conducting scientific calculations of construction team capacity involves transforming qualitative perceptions into quantitative assessments. This process comprehensively evaluates team size, skill composition, mechanical equipment configuration, and management control levels while accounting for disturbances such as equipment supply and external environmental factors. It precisely calculates the reasonable project volume and work front quantities a team can handle at different times. Through capacity assessment, objective bases can be provided for project planning, task allocation, and team selection, effectively breaking the vicious cycle of "insufficient capacity—quality safety risks—rising control costs" from the outset. Additionally, it clearly identifies resource gaps, offering targeted guidance for cultivating in-house teams, managing subcontractors, and supplementing equipment. This promotes dynamic balance between construction task scale and capacity, laying a foundational management framework for orderly progress and quality improvement in power grid projects.

3 Construction Team Carrying Capacity Assessment Method

This study believes that the key resources of the construction team are mainly personnel and equipment, which should be divided into two majors: line and substation. The required key resources are detailed and decomposed based on the professional characteristics to form an evaluation index system. Among them, in terms of personnel, the number of transmission line projects expected to be undertaken by the construction team in a certain year, the number of personnel to be invested in a single transmission line project of a certain voltage level, the number of substation (converter) station projects expected to be undertaken by the construction team in a certain year, the number of personnel to be invested in a single substation (converter) station project of a certain voltage level, etc. In terms of equipment, consider the number of tower bases that need to be constructed for a certain voltage level in a certain year, the construction time required for a single base group tower of a certain voltage level, the construction time needed for a single section of a certain voltage level, the number of wiring sections that need to be completed for a

certain voltage level in a certain year, the frequency of use of engineering equipment of a certain substation (converter) station of a certain voltage level, etc.

3.1 Calculation of Personnel Carrying Capacity

$$N = \alpha_1 \times X + \alpha_2 \times B \quad (1)$$

N is the required number of personnel. α_1 refers to the number of personnel that should be invested in a single transmission line project of a certain voltage level, with the unit being person. X refers to the expected number of transmission line projects to be undertaken by the construction team in a certain year, with the unit being item. α_2 refers to the number of personnel that should be invested in a single substation (converter station) project of a certain voltage level, with the unit being person. B refers to the expected number of substation (converter station) projects to be undertaken by the construction team in a certain year, with the unit being item.

The personnel shortage S of the construction team in a certain year is calculated by the following formula:

$$S = \sum N - A \quad (2)$$

$\sum N$ should be the total number of personnel to be invested in projects of all voltage levels, with the unit being person. A represents the actual number of personnel currently invested, with the unit being person.

3.2 Calculation of Equipment Carrying Capacity

The calculation formula for floor-standing poles, tension machines, tractors, large pulleys and other equipment required for a certain voltage level in a certain year is as follows:

$$N_1 = J \times t_1 / t_Y \times x_1 \quad (3)$$

$$N_2 = Q \times n_2 \times t_2 / t_Y \quad (4)$$

$$N_3 = Q \times n_3 \times t_2 / t_Y \quad (5)$$

$$N_4 = Q \times n_4 \times t_2 / t_Y \quad (6)$$

J represents the number of tower foundations to be completed in a certain year for a certain voltage level, measured in units of foundations, calculated based on the engineering workload. Q represents the number of line erection sections to be completed in a certain year for a certain voltage level, measured in units of sections, calculated based on the engineering workload. t_Y refers to the effective construction time for lines in a year, measured in days, generally set at 280 days. x_1 refers to the coefficient of tower erection using ground-based derricks. t_1 refers to the construction time required for tower erection of a single foundation for a certain voltage level, measured in days. t_2 refers to the construction time required for line erection of a single section for a certain voltage level, measured in days. n_2, n_3, n_4 respectively refer to the number of tension

machines traction machines, and large pulleys required for line erection of a single section for a certain voltage level, measured in units. N_1 , N_2 , N_3 , N_4 respectively refer to the number of ground-based derricks, tension machines, traction machines and large pulleys required for the construction tasks of a certain voltage level in a certain year, calculated based on the workload, measured in units.

The calculation formula for the oil filter, vacuum pump, pressure-resistant equipment, gas recovery device and other equipment required for a certain voltage level in a certain year is as follows:

$$N_5 = B \times n_5 \times t_5 / t_Y \quad (7)$$

$$N_6 = B \times n_6 \times t_6 / t_Y \quad (8)$$

$$N_7 = B \times n_7 \times t_7 / t_Y \quad (9)$$

$$N_8 = B \times n_8 \times t_8 / t_Y \quad (10)$$

B represents the number of substation (converter) station projects to be constructed for a certain voltage level in a certain year, measured in units, calculated based on the engineering workload. t_Y refers to the effective usage time of substation equipment in a year, measured in days, generally set at 280 days. t_5 , t_6 , t_7 , t_8 respectively refer to the usage frequency of oil filters, vacuum pumps, withstand voltage equipment, and gas recovery devices for a certain voltage level substation (converter) station project, measured in day. n_5 , n_6 , n_7 , n_8 respectively refer to the number of oil filters, vacuum pumps, withstand voltage equipment, and gas recovery devices required for a certain voltage level substation (converter) station project, measured in units. N_5 , N_6 , N_7 , N_8 respectively refer to the number of oil filters, vacuum pumps, withstand voltage equipment and gas recovery devices required for the substation construction tasks of a certain voltage level in a certain year, calculated based on the workload, measured in units.

The equipment shortage S for the construction teams in a certain year is calculated using the following formula:

$$S = \sum N - A \quad (11)$$

$\sum N$ represents the total number of equipment to be invested for all voltage levels, measured in units. A represents the actual number of equipment invested currently, measured in units.

3.3 Empirical

Using the above capacity calculation method to calculate the resource shortage of the construction teams of a certain power grid enterprise's subordinate units. It can be found that there is a shortage of 8 personnel, and the shortages of ground-based derricks, tension machines traction machines, and large pulleys are 12 sets, 20 units, 20 units, and 519 units respectively. The shortages of oil filters, vacuum pumps, withstand voltage equipment, and gas recovery devices are 8 units, 10 units, 3 units, and 11 units respectively.

4 Conclusion

Under the extraordinary development stage, the contradiction between power grid engineering construction tasks and construction resources is prominent. Allocating resources more scientifically and rationally to ensure sufficient resources and not waste them is an issue that the construction team must consider. This study analyzes the imbalance problem between power grid engineering construction tasks and resource allocation, proposes a method for measuring construction carrying capacity, and combines the construction team of a subsidiary unit of a power grid enterprise to calculate the resource gap.

In the next step, it is necessary to consider the impact of multi-dimensional factors on the bearing capacity, optimize the bearing capacity calculation method, and improve the accuracy of the calculation.

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