Problems and Countermeasures in Geotechnical Engineering Investigation and Foundation Design in Building Engineering

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Abstract: For the construction of all building projects, geotechnical engineering investigation and foundation structural design are directly related to the safety and stability of buildings, and have a significant impact on their quality and service life. This paper starts from the main difficulties in actual building projects, analyzes countermeasures, adjusts design measures according to the actual situation, increases the efforts in design and investigation, and improves the accuracy of design through information technology means. It aims to eliminate difficulties in investigation and design as much as possible, ensure the stability of building foundations, enable long-term operation of buildings, and reduce later repairs and safety hazards.

1. Introduction

In building engineering, the foundation is known as the "underground lifeline" and is a core part of building engineering, including geotechnical engineering investigation and foundation design. It is also the core link in the entire building engineering project from design, planning to construction. However, at present, some building engineering projects attach little importance to investigation and design, resulting in situations such as distorted geological exploration data and discrepancies between design drawings and the actual conditions. This increases the construction cost of building engineering and exposes the project to risks such as uneven settlement, structural damage, or collapse. Incomplete information and inadequate implementation of technical standards prevent the foundation from fully and stably playing its supporting role. Therefore, this paper focuses on analyzing the technical difficulties in building investigation and foundation design, analyzing the factors causing these problems, and providing solutions to standardize the investigation and design procedures, improve the safety of building engineering projects, and are of great significance for enhancing the construction quality in the early critical path of building engineering.

2. Problems in Geotechnical Engineering Investigation and Foundation Design in Building Engineering

2.1 Inadequate Preparation

The type, depth, and bearing capacity of engineering projects have varying degrees of impact on their final construction results. If data collection is not carried out properly during the process, the overall execution effect in the later stages may be poor [1]. Therefore, to ensure the smooth progress of geological investigation tasks, investigators are required to make thorough preparations and arrangements in the early stages, collect the necessary geological data, and clearly describe the target scope so that they can respond in a targeted manner in case of emergencies [2]. Moreover, during the preliminary data collection stage, it is necessary to examine the surrounding environment and climate conditions in accordance with relevant regulations to minimize their impact on subsequent projects.

2.2 Insufficient Professional Competence of Staff

Generally, the professional competence of technicians plays a crucial role in geological investigation work. However, currently, some geological engineers do not meet high professional

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standards and lack effective skills. Some employees work excessively long hours and rely too much on past project experience, failing to quickly apply new technologies and achievements to their work. As a result, the information obtained cannot effectively meet project requirements [3]. In addition, some employees do not have strong professional and moral qualities and do not approach their work with sufficient rigor and diligence, thereby hindering geological survey work [4]. Some employees do not have strong data processing capabilities, and there are certain deviations in the process of data analysis, which affect the progress of the next stage of work and may even cause structural or safety problems in buildings [5].

2.3 Lack of Coordination between Geotechnical Engineering Investigation and Foundation Design

Geotechnical investigation and foundation design are carried out by different departments, and in many projects, there is a lack of communication and coordination between the two departments, making it impossible for them to work together. In actual operation, geologists may not understand the structural bearing capacity during construction, leading to two situations: First, overestimation results in extended time and increased costs for geological exploration, leading to invisible waste of resources; second, underestimation results in investigation results that do not meet construction requirements, necessitating a re-investigation [6]. If the two cannot cooperate reasonably, efficient construction cannot be achieved, and there will be a waste of manpower and material resources. Therefore, good coordination between the two is essential to ensure the smooth progress and efficient operation of the project [7].

2.4 Unscientific Investigation Methods

The scientific nature of investigation methods is an important factor determining investigation results. During the exploration process, there is a problem of overly 单一 (simplistic) exploration methods. Many exploration units and personnel use only drilling methods when conducting soil engineering exploration, which may limit later experimental methods, making it impossible to carry out certain links in the experimental process and resulting in inaccurate assessment of the actual measured data in geological exploration [8]. If foundation design can only be carried out based on qualitative data surveys and past experience, it will not only render geological investigation work meaningless but also make foundation design rough, imprecise, and unscientific, ultimately negatively affecting the normal progress of building engineering projects [9].

3. Countermeasures for Geotechnical Engineering Investigation and Foundation Design in Building Engineering

3.1 Adequate Preparation

To avoid potential difficulties in foundation design and geotechnical engineering investigation, staff should make thorough preparations, including:

First, a scientific geotechnical engineering investigation plan should be formulated. During the process of geotechnical engineering investigation, relevant department staff need to study data such as local engineering conditions, characteristics, and surrounding terrain, and determine the relevant investigation methods. On this basis, they should have a good understanding of knowledge related to foundation design and use foundation design as a guiding principle for geotechnical engineering investigation work to ensure that the final results meet the needs of foundation and foundation construction, laying an early foundation for improving foundation construction quality and protecting the performance of the project itself.

Second, a precise geological investigation and foundation design outline should be formulated. Attention should be paid to ensuring the accuracy and effectiveness of its content, and the inspection efforts regarding implementation regulations and standards for geotechnical investigations should be strengthened and refined. Moreover, relevant regulations and guidelines for geotechnical investigations should be further improved and standardized to prevent ordinary errors

and accidents caused by non-compliance with investigation procedures. In addition, for the foundation structure investigation report included in the outline, it should be submitted to corresponding inspectors for completion in accordance with relevant evaluation criteria, and individual behaviors should be standardized to ensure the smooth progress of foundation structure investigation work, thereby obtaining scientific, accurate, and reliable data as the main reference for formulating foundation structure design.

3.2 Improve the Professional Quality of Staff

Regarding the improvement of the technical level and quality of investigation and design personnel, it generally involves two aspects: existing employees and recruitment through social channels. For the existing employee team, companies should strengthen training to improve work quality and ability. They can strengthen exchanges with professional colleges and universities offering geology and surveying majors to provide students with practical training opportunities. At the same time, they can also actively invite higher education institutions to offer specialized courses for the company on a regular basis, allowing employees to learn relevant theoretical knowledge and improve their theoretical levels. On this basis, the company should also establish an appropriate reward and punishment system to encourage employees to actively participate in relevant training. For example, if an employee meets certain requirements, the company can provide appropriate financial rewards; if an employee consistently meets the requirements, they can be considered for promotion.

Second, when recruiting, companies need to comprehensively evaluate candidates for investigation positions in terms of theoretical knowledge accumulation, professional skills, and other aspects. After new employees join the company, the human resources department should instill corporate culture to help new investigation employees develop good professional behavior habits and actively improve their abilities in their daily work, thereby ensuring the completion of investigation projects.

3.3 Coordinate Geotechnical Engineering Investigation and Foundation Design

For the two important processes in the same project—foundation design and geotechnical engineering investigation—they should be carried out simultaneously and coordinated with each other. The data obtained should be fair and shared to promote effective connection between the two. Since these two tasks are closely related, they should be unified, and coordination between them should be promoted to facilitate the smooth progress of the project. To better address the coordination between geotechnical engineering investigation and foundation design, the key is to eliminate information barriers between the two, improve the level of technology application and program connection, and ensure the stability of the foundation and the economic efficiency of the project.

First, a preliminary work framework should be established to clarify respective responsibilities. A project workgroup composed of investigation units, design units, owners, and supervisors should be formed in the early stages of the project to clarify their responsibilities in the transfer of investigation data, design responses, and problem-solving, as well as the specified time frames. Designers should provide a "list of investigation requirements" in the early investigation work, emphasizing the need to pay special attention to special on-site conditions, such as groundwater level, soft soil layer distribution, and ground stress values, to avoid blindness in investigation work.
Second, communication and collaboration should be strengthened during the process to eliminate pain points at connection points. During the exploration process, a specialized technical team should be dispatched to participate in important nodes of the design process, such as pile driving inspection and sampling observation, to timely understand the site conditions and adjust their requirements accordingly. If the investigation enterprise discovers abnormal phenomena, such as cracks or high compression of soil layers, it should immediately notify the designers. After the preliminary design draft is completed, a special investigation-design meeting should be held, and the investigation team should conduct a comprehensive analysis and evaluation of the scientific nature and geological adaptability of the design, providing modification suggestions for designs that

do not conform to the actual on-site conditions.

Finally, information technology means should be fully utilized to achieve data sharing and real-time updates. A data-sharing network platform for investigation-design should be established to connect the original investigation data and test results with the design model. This allows designers to directly input design parameters from the investigation data for verification and calculation, avoiding errors caused by repeated input. If the actual stratum is found to be inconsistent with the investigation during construction, feedback can be promptly provided to the investigation and design personnel through the network platform, and a rapid plan for re-investigation and measurement and design adjustment can be formulated. If conditions permit, a third-party review can be introduced for collaborative management to check for deficiencies in the investigation content and verify the accuracy of the investigation data, the consistency between the design and the investigation report data, whether the design can fully and effectively utilize the investigation data, and whether the investigation has avoided the geological risks of the site, thereby drawing attention from both parties to the coordinated work.

3.4 Standardize the Investigation Process

On the basis of ensuring that geotechnical engineering investigation work fully plays its investigation role, relevant units should be required to strictly follow China's corresponding investigation work regulations to standardize the investigation work and investigation personnel for corresponding foundation building engineering projects, ensuring that their investigation work content, work scope, and schedule arrangements are regulated and constrained in accordance with the actual project construction requirements.

First, technicians should strictly follow foundation design principles and combine specific construction site conditions to formulate a comprehensive construction plan, ensuring that the project truly meets energy and environmental protection requirements. Staff should approach the investigation of building geotechnical engineering foundations with strictness to avoid measurement errors. When optimizing foundation design, multiple factors should be comprehensively considered to examine and compare foundation optimization design methods, and theoretical analysis should be emphasized in design methods. The following principles should be followed: First, the foundation of the project design should meet safety requirements; second, the foundation design should fully consider the construction time to ensure its effectiveness and logic; third, when planning, the equipment at the construction site should be examined to make the actual on-site conditions meet the expected plan; fourth, environmental protection factors should be considered in the planning to avoid pollution or damage. Second, personnel investigating the geology and foundation should understand and be familiar with the steps and corresponding standards for geological investigation and ensure the quality of later engineering construction. Moreover, they should conduct comprehensive and accurate research and analysis on the data and information regarding the actual construction of buildings. Finally, relevant personnel should formulate corresponding investigation result reports based on the collected information and analyzed data and submit them to the foundation design personnel to provide basic data for relevant construction work.

4. Conclusion

In conclusion, for building foundations, geotechnical engineering investigation is a crucial link. To correct problems that occurred in previous construction processes and improve construction quality, construction units should make thorough preparations in the early stages, coordinate investigation and design work, improve the professional abilities of investigation personnel, and standardize the investigation process to ensure that investigation work meets the corresponding requirements of buildings and the standards of geological research, thereby ensuring the long-term development of building engineering.

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