# Research on the Implementation Path of Foundation Pit Support Technology in Building Civil Engineering Construction

**Yizhou Fang**

Huaibei Huaihai Construction Engineering Co., Ltd., Huaibei, Anhui, 235000, China

**Keywords:** Building civil engineering; Foundation pit support technology; Geological survey; Support scheme; Dynamic adjustment

**Abstract:** To solve the problems of safety risks and quality hazards caused by non-standard processes in foundation pit support technology implementation in building civil engineering, this study combines implementation principles of foundation pit support technology, analyzes four different implementation paths in a systematic manner from two aspects: preliminary survey and analysis of the application scenario under study, customized design of support scheme catering to specific requirement, strict construction in accordance with regulations and full-process monitoring with dynamic adjustment. Through sorting out the operational logic and key points of each path, The complete implementation system of "data support - program adaptation - process control - dynamic optimization" is summarized. The synergistic effects of each path for ensuring the safety of foundation pit support, improving construction efficiency and enhancing economic viability are discussed to provide a reference operational framework for standardizing the implementation of foundation pit support technology in engineering practice.

## 1. Introduction

Foundation pit support technology is one of the most important techniques in building civil engineering for foundation pit construction. That is, it refers to an integrated technical system that ensures the safety of construction activities such as foundation pit excavation and underground structure construction, and the stability of surrounding buildings (structures) and pipelines. This is done by carrying out geological surveys, using structures like soldier piles, soil nailing walls and diaphragm walls, as well as combining monitoring and protective measures (as passive control) to deal with foundation pit deformation along with anti-soil pressure and subsequent resistive pressures from water. Since the geological conditions and surrounding environment are complex for urban building civil engineering, foundation pit engineering has become one of the most difficult points. In absence of a scientific path for implementing support technology, it is easy to run into some problems such as unreasonable schemes, poor construction quality and delayed risk prevention and control performance which not only endanger engineering safety but also impact progress. So these pain points can be addressed only after clarifying the operational specifications and core requirements of each link from the perspective of the entire technical implementation process. This article will be based on the implementation paths of foundation pit support technology, which delves into detailed analysis of the implementation points for other application ideas to explore optimization paths for foundation pit support technology.

## 2. Implementation Principles of Foundation Pit Support Technology in Building Civil Engineering Construction

### 2.1 Prioritizing Safety and Controlling Risks

In terms of technical implementation, the first step is to take multi-dimensional geological surveys for risk identification and build a foundation. Besides traditional soil layer thickness, bearing capacity and groundwater level investigation method, detection of permeability includes soils layers hydraulic index, the distribution laws of pore water pressure and even some surrounded

  DOI: 10.25236/icacel.2025.031

geological factors. It covers the types of foundations and settlement sensitivity thresholds for adjacent structures and the materials and bearing capacities of underground pipelines. Such data could provide reliable bases to predict the risk. Since the prediction of risk is a comprehensive process that can only be realized by combining survey data, it is needed to use professional calculation models such as slope stability analysis model based on soil pressure theory and numerical simulation model for foundation pit deformation, etc., so as to provide quantitative analysis of probability that the risk events such as collapse, settlement and piping may occur at different construction stages and their scope. For foundation pits constructed in the soft soil areas, the emphasis must be given to estimating the risks of support structures displacing due to soil creep when excavating. In respect to active prevention and control, in addition to formulating conventional emergency response plans, it should be carried out designing a graded prevention and control program. For example, the design of support structures is based on reserve safety margins; limit stiffness and strength parameters of support structures as a function of risk. Set up early warning thresholds for multi-level monitoring in coordinate construction. Control measures should be taken in advance when the monitoring data approaches the warning values, such as increasing the prestress of anchor rods and adjusting excavation pace, rather than wait passively for rectification after exceeding standard. Establish a responsibility tracing mechanism for risk implementation, clarify the risk management and control tasks of each link, and ensure that from survey to design to construction operation monitoring, there is someone in charge at every step of the way, and achieve zero safety hazard construction process.

### 2.2 Adapting to Actual Engineering Conditions

Focus on conducting detailed investigations instead of simply gathering basic information in the preliminary phase at site. Besides the depth of foundation pit and distribution around buildings, Regional underground piping direction should also be considered，It's also crucial to understand that the excavation range surrounding the foundation pit fence filled with obstacles, local topography and geomorphology limits construction machinery agility, in addition，，Also closely watch at local climate conditions on construction. These information directly impact the similarity of the support scheme. Have multi-dimensional comparative analysis based on site conditions to select support type. At the same time, in foundation pits with dense old buildings surrounding them, it is hard to prevent the safety of nearby buildings from being affected by construction vibrations when using soil nailing wall support. In this regard, getting support types with very low vibration and high stiffness (i.e. soldier piles or diaphragm walls) should be the main focus. When the groundwater level is high and a deep foundation pit is constructed, anti-seepage failure may be caused by relying solely on support structures, so it is necessary to combine dewatering technology with the design of support structure types. The construction process of the support structure should fit within the site space coordination scheme adaptation must also involve site satisfaction second-stage integration to consider whether it can be integrated into the later stage main structure, so as to avoid resource waste and construction conflict. With this all-round adaptation design, it is possible to ensure that the support scheme not only meets the technical requirements but also meets the practical operation needs of the engineering site, so as to ensure a stable and reliable support effect.

### 2.3 Balancing Economy and Efficiency

At a basic level,for control costs it is necessary to build detailed cost accounting model and break down the cost of support scheme into main catalogue such as material costs, equipment costs,labor costs.and management. In material cost accounting, specification comparison of steel and concrete is made cost-effectively for optimally selecting materials based on the support structural design parameters. In cost accounting for equipment, it is necessary to select the most suitable scheme "rent/purchase" in terms of f construction time and the number of hours of use. From the perspective of efficiency improvement, redundant time in construction links should be reduced through scheme optimization. In the design of the support scheme, coordinate the sequence of support structure construction and foundation pit excavation to avoid sequence waiting or cross-interference. Choose construction processes with short cycles and mature technologies, and consider the collaborative operation efficiency of construction equipment. Adopt integrated support construction equipment to reduce equipment conversion time [1]. When balancing cost and efficiency, it is necessary to establish a dynamic evaluation mechanism. When one scheme has a slightly higher cost but can significantly shorten the construction period, it is necessary to calculate the subsequent engineering benefits brought by the shortened period and comprehensively evaluate the overall benefits of the scheme. If multiple schemes have similar costs and efficiencies, priority should be given to schemes with low later-stage maintenance costs and minimal impact on the surrounding environment to achieve a balance between short-term costs and long-term benefits, truly reducing resource waste and improving the overall economic viability and implementation efficiency of the project under the premise of ensuring safety and quality.

## 3. Implementation Paths of Foundation Pit Support Technology in Building Civil Engineering Construction

### 3.1 Preliminary Geological Survey and Analysis

Clarify the boundaries of the survey area. Based on the excavation boundary of the foundation pit, the horizontal extension distance should meet the following requirements: for foundation pits with a depth of less than 5 m, extend to a range of 2 times the depth; for foundation pits with a depth of 5–10 m, extend to a range of 2.5 times the depth; for foundation pits with a depth of more than 10 m, extend to a range of 3 times the depth. Simultaneously, this includes the 30 m area around the foundation pit, including buildings (structures) and underground pipelines [2]. At this stage, use a "drilling + geophysical exploration" combined detection method. Plan drilling holes of a quincunx shape, and modify the distance between the holes for variables in trouble level. If soil layers are relatively homogeneous, the spacing is controlled at 20–25 m; for complex soil layers, it can be reduced to 15–18 m. From each hole, one or more layer samples should be taken at different depths and at least 8 groups of samples should be collected per layer. Concentrate on the determination of mechanical parameters（e.g., compression modulus, cohesion and internal friction angle）of soil layers which release back to natural state with recording the seasonal variation range of water table. Double the monitoring in summer to two times a week and monitor once a week during winter Specifies the corrosion strength of groundwater (strong, medium and weak on steel and concrete) [3]. When verification of survey data, compare with historical survey data in the same place. If the error of mechanical parameters is larger than 10%, add up verification drilling holes. Finally, based on the above surveys and analyses a three-dimensional distribution model of soil layers and groundwater movement patterns should be established to provide accurate data support for the design of the support scheme, so as to avoid cases in which due to insufficient safety factors of a support structure caused by errors in data acquisition led to engineering accidents.

### 3.2 Customized Support Scheme Design

Set core design parameters based on survey data. Classify the safety level of the foundation pit according to the sensitivity of the surrounding environment. The horizontal displacement limit of the support structure for a first-level safety level is 30 mm, 50 mm for a second-level, and 80 mm for a third-level. At the same time, determine the anti-seepage design standard. When the groundwater level is higher than the excavation surface, the anti-seepage grade of the support structure should reach P6 or above. Based on these parameters, initially design at least three support schemes such as soil nailing wall + waterproof curtain, soldier pile + anchor rod, and diaphragm wall, and calculate the key indicators of each scheme respectively [4]. For the soil nailing wall scheme, the length of the soil nails should be determined according to soil pressure calculations, generally 1.2–1.5 times the excavation depth, with a spacing of 1.5–2.0 m. For the soldier pile scheme, the reinforcement ratio of the pile body should be determined according to the bending moment calculation results, usually not less than 0.8%. For the diaphragm wall scheme, the length of the trench section should be determined according to the construction equipment, generally 6–8

m. During the scheme comparison phase, quantitatively analyze the costs and benefits. Taking the diaphragm wall scheme as an example, its initial cost is about 25% higher than that of the soldier pile scheme, but its later-stage maintenance cost can be reduced by 30%, and its impact on the surrounding environment during construction is smaller [5]. Finally, organize an expert review team of 7 or more people to score the schemes from four dimensions: structural safety, environmental impact, economic cost, and construction difficulty, with weights of 40%, 20%, 25%, and 15% respectively. The scheme with the highest score should be optimized according to the review opinions, such as adjusting the grout mix ratio of anchor rods and increasing the embedded depth of support structures, to ensure that the scheme complies with regulations and is suitable for the actual engineering conditions.

### 3.3 Strict Construction in Accordance with Regulations

During the pre-construction preparation phase, complete the double verification of equipment and materials. The straightness error of the drill rod of the drilling machinery should be less than 0.3%, and the impact energy of the percussion drill should reach 1.1 times the design requirement. Conduct spot checks on the mechanical properties and chemical composition of steel bars. The ratio of the measured tensile strength to the measured yield strength should not be less than 1.25, and the ratio of the measured yield strength to the standard value should not be greater than 1.3. The concrete mix ratio should be determined through laboratory trials, with a slump error controlled within ±20 mm. Conduct special tests for the anti-seepage grade, with a minimum of 6 test blocks per group [6]. During the construction process, adopt a dual control method of "informatization + manual inspection". When constructing soldier piles, use a laser plumb bob to monitor the verticality of the pile body, with a deviation of less than 0.8% and a pile top elevation error controlled between -50 mm and +100 mm. When constructing anchor rods, record the drilling speed and grouting pressure throughout the process. The grouting pressure should be stable at 0.6–0.8 MPa, and the grouting volume should reach more than 1.2 times the theoretical calculation volume to ensure full grout [7]. Node acceptance should be carried out according to the construction sequence. After the construction of the soil nailing wall is completed, conduct pull-out resistance tests, with a sampling quantity of not less than 1% of the total number and not less than 3 pieces. The average pull-out resistance should be not less than 1.1 times the design value. After the construction of the soldier piles is completed, conduct pile integrity tests, with a sampling quantity of not less than 20% of the total number and at least 1 piece per pile cap. All acceptance results should be documented in written reports. Unqualified items must be rectified until they meet the standards before proceeding to the next process to eliminate quality hazards caused by non-compliant operations.

### 3.4 Full-Process Monitoring with Dynamic Adjustment

During the monitoring point layout planning phase, scientifically set up monitoring points. Evenly arrange ground settlement monitoring points around the foundation pit with a spacing of 10–15 m and a distance of not less than 2 m from the edge of the foundation pit. Set displacement monitoring points for the support structure at the top and key sections of the piles (walls), with 1 point set every 3–5 piles (walls). Set groundwater level monitoring holes on both the inside and outside of the foundation pit, with the inside hole 1–2 m away from the support structure and the outside hole 5–10 m away from the support structure [8]. Adopt an automated monitoring system for data collection, and adjust the sampling frequency according to the construction stage: once every 3 days before foundation pit excavation, twice a day during excavation, and once every 2 days after excavation. The monitoring accuracy for displacement should reach 0.5 mm, and for groundwater level, it should reach 10 mm. The data should be transmitted to the monitoring platform in real-time to automatically generate change curves. Establish four early warning values for classified disposal: level 1 early warning is 60% of design limit, level 2 is 75%, level 3 is 90%, and level4earlywarningis100% [9]. Double the monitoring frequency to 3 times a day when it reaches or exceeds the first level early warning threshold Upon reaching the second-level early warning, form a technical team to conduct reason analysis and timely parameters adjustment in construction, such as shortening excavation step distance and prestress of anchor rod. The third-level early warning is issued, excavating operations are suspended immediately and temporary support set up, for example with steel; Once the fourth-level early warning is triggered, personnel evacuation should be organized immediately and emergency rescue measures such as foundation pit backfilling should be implemented. After the monitoring data return to stable level, re-evaluate whether the safety of the support system is qualified, and determine which construction scheme should be adopted next, so that its support system will always be under control during the whole process.

## 4. Conclusion

The above research shows that the implementation of foundation pit support technology in building civil engineering construction relies on four core paths: preliminary geological survey and analysis provide accurate data support for scheme design to avoid safety hazards caused by data deviations; customized support scheme design combines survey data with actual engineering conditions to ensure adaptability through multi-scheme comparison and expert review; strict construction in accordance with regulations ensures construction quality through equipment and material verification, process control, and node acceptance; full-process monitoring with dynamic adjustment maintains the stability of the support system through scientific monitoring point layout, real-time data collection, and graded disposal. These four paths are progressive and mutually synergistic, effectively reducing the risks of foundation pit support and improving the safety, economic viability, and efficiency of technical implementation.

## References


[1] Feng, Y. T., & Hu, W. J. Application of foundation pit support construction technology in civil engineering of residential buildings [J]. Architecture & Decoration, 2025(5):138-140.

[2] Wang, R. Application of foundation pit support technology in civil engineering construction of buildings [J]. Petrochemical Construction, 2025, 47(2): 115-117.

[3] Huang, C. R. Application of foundation pit support technology in civil engineering construction of buildings [J]. Architecture & Decoration, 2024(16):149-151.

[4] Li, Q. Q. Exploration on the application of foundation pit support construction technology in civil engineering construction of buildings [J]. Architecture, Building Materials & Decoration, 2024(21):70-72.

[5] He, R. W. Practical exploration of deep foundation pit support technology in civil engineering construction of buildings [J]. Architecture, Building Materials & Decoration, 2025(13): 169-171.

[6] Chen, H. W. Exploration on the application of deep foundation pit support technology in civil engineering construction of buildings [J]. Brick World, 2025(6):28-30.

[7] Yang, Z. Y. Exploration on the application of foundation pit support construction technology in civil engineering construction of buildings [J]. Development Guide to Building Materials, 2023, 21(23):77-79.

[8] Yao, Z. Y. Analysis on the application of foundation pit support construction technology in civil engineering of residential buildings [J]. Development Guide to Building Materials, 2024, 22(23):75-77.

[9] Li, Z. C., & Guo, J. J. Research and application of deep foundation pit support technology in civil engineering construction [J]. Urban Architecture and Development, 2025, 6(9): 58-60.