

# Effective Reinforcement Treatment of Foundation Pit Slope Instability in Geotechnical Engineering Construction

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**Abstract:** The foundation pit slope instability is a common issue in geotechnical engineering construction, which is harmful. It not only affects the construction progress, but also poses a threat to operation, causing casualties and huge economic losses. Accordingly, it is necessary to master the slope reinforcement treatment technology. Based on the specific situation, the reinforcement treatment technology and the control of the construction process were selected to effectively enhance the stability and firmness of the foundation pit slope and make the geotechnical engineering construction proceed smoothly. This work mainly discussed the foundation pit slope instability in geotechnical engineering construction, explored the influencing factors on foundation pit slope instability, and put forward effective reinforcement treatment methods. Simultaneously, the reinforcement construction of foundation pit slope instability in detail was discussed, thus guiding the effective response to the foundation pit slope instability in geotechnical engineering construction and accumulating corresponding reinforcement treatment experience.

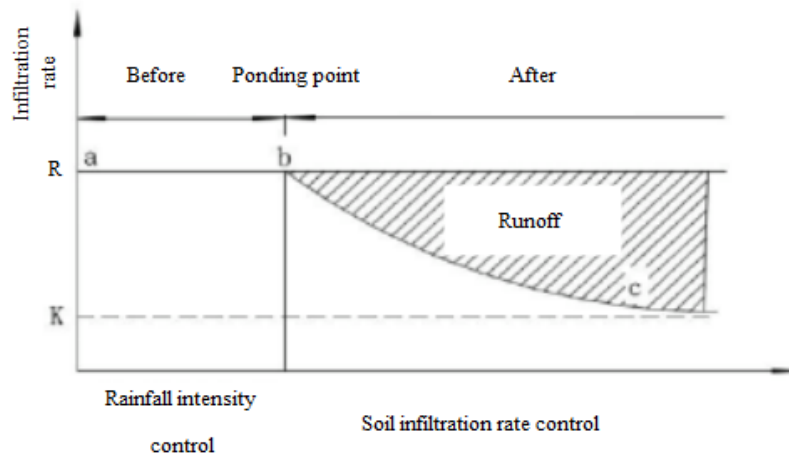
## 1. Introduction

With the improvement of urban construction process, engineering construction projects and construction complexity, slope instability occurs occasionally especially in some geotechnical engineering construction, resulting in large casualties and economic losses. Therefore, it is necessary to cope with the slope instability in geotechnical engineering construction, mainly the reinforcement treatment [1]. In the specific geotechnical engineering foundation pit slope instability reinforcement treatment, it must be based on the engineering practice. Combined with the previous foundation pit supporting construction cases, the effective reinforcement plan was made and the reinforcement treatment scheme was written to ensure the effectiveness of the foundation pit slope reinforcement treatment.

## 2. Cause of Foundation Pit Slope Instability in Geotechnical Engineering Construction

### 2.1 Topography and landform

Different geotechnical engineering corresponds to different construction environment, and different environment corresponds to different topography and landform. The characteristics of topography and landform will affect the stability of foundation pit slope. For example, once there is heavy rainfall, a large amount of ponding may be generated in the concave section construction. Consequently, a large amount of ponding may wash out the slope of the foundation pit, resulting in the foundation pit slope instability. The process of slope rainfall infiltration is shown in Fig. 1.



**Fig. 1.** Slope rainfall infiltration process

## 2.2 Human factors

The foundation pit construction in geotechnical engineering construction mainly depends on human and material resources. The construction quality or construction technology of staff will also affect the stability of foundation pit slope. In the foundation pit construction, the slope height and slope ratio are involved, and the slope height and slope ratio are negatively correlated with the stability of the foundation pit slope. The specific slope height and slope ratio of the foundation pit slope need to be calculated in detail by professional technicians according to the construction of topography and landform and engineering requirements. If the staff level is low and the construction technology is insufficient, the construction standards specified in the design can not be reached, resulting in inaccurate exploration and calculation results.

## 2.3 Rock mass structure

Rock mass structure mainly includes two aspects: structural plane and structural body. In the geotechnical foundation pit construction, the rock mass structure will directly affect the stability of foundation pit slope. For example, rock cutting will be involved in the excavation of geotechnical foundation pit. Different types of rocks have different hardness, which will directly affect the flatness or smoothness of rock cutting and the stability of foundation pit slope [2].

## 3. Reinforcement and Treatment Technology of Geotechnical Foundation Pit Slope

### 3.1 Conventional HDPE impermeable membrane reinforcement technology

In practical application, HDPE impermeable membrane reinforcement technology is mainly used to isolate rainwater and external water with the help of impermeable membrane, thus effectively avoiding rainwater infiltration. HDPE impermeable membrane has good heat resistance, cold resistance and impermeability. Its application in foundation pit slope reinforcement construction can prevent the foundation pit slope instability caused by a large amount of external rainwater deposition and scouring. At the same time, the application of HDPE impermeable membrane can avoid the occurrence of foundation pit slope cracks, minimize the probability of foundation pit slope displacement, and coordinate with the trench anchorage method to effectively strengthen the foundation pit slope.

### 3.2 Anti slide pile support technology

In practical construction, the anti slide pile support technology is usually suitable for the relatively complicated objective environment of geotechnical engineering. This technology, used for the reinforcement of foundation pit slope, can effectively control the movement of fracture zone around the slope, thereby avoiding the adverse impact of plastic deformation on the foundation pit slope. Common support carriers include anti slide pile, anchor cable, anchor bolt, retaining wall, etc., and the

schematic diagram of support treatment is shown in Fig. 2. In the application process, anti-slide piles are usually installed in the foundation pit slope. Through this operation, the adverse impact of rainwater and surface water scouring on the slope structure can be prevented, thus effectively improving the firmness and stability of the foundation pit slope [3]. Besides, the anti slide pile can also be poured by manual hole digging and mechanical hole forming. However, the mechanical hole casting method needs to be combined with different geological conditions for operation, thereby effectively ensuring the scientific and effective application of the reinforcement technology.

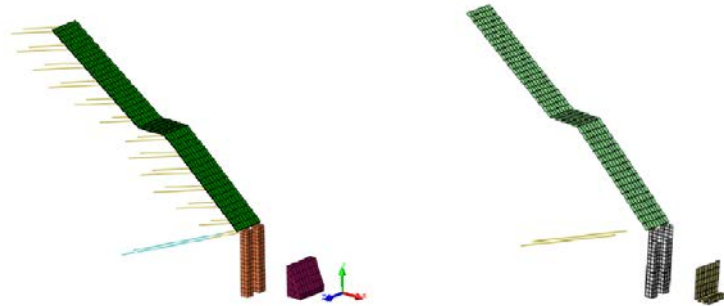


Fig 2. Schematic diagram of anti slide pile, anchor cable, anchor bolt, retaining wall, etc.

### 3.3 Drainage reinforcement technology

Drainage reinforcement technology can achieve remarkable results in the reinforcement treatment of foundation pit slope instability. In practical application, this technology can effectively reduce the water content of foundation pit slope through surface drainage and slope drainage. In the process of surface drainage, drainage ditches need to be set outside the landslide to effectively reduce the inflow of surface water in the landslide. In the process of slope drainage, blind drainage ditches, horizontal drainage holes and corridors can be set with the help of natural drainage ditches, thus draining the water in the landslide and avoiding the adverse effect of water erosion on the foundation pit slope. In the practical application of drainage reinforcement technology, constructors need to formulate drainage scheme in combination with the actual situation of foundation pit slope construction site, thereby ensuring the effectiveness of technical application.

### 3.4 Composite reinforcement technology

In geotechnical engineering construction, there is usually a construction environment with relatively complex geological conditions. Therefore, constructors need to combine various different reinforcement technologies and apply composite reinforcement technology to improve the firmness and stability of foundation pit slope. In the early stage of construction, the application of this technology first needs to select the appropriate technology type according to the actual situation of the project. In the middle and later stages of construction, the stability of the slope is monitored, and the slope instability is found in time and effective measures are taken to prevent and control, thus avoiding the subsequent construction links. The application of composite reinforcement technology is mainly to make up for the disadvantages and defects of traditional reinforcement technology. In practical application, it is sufficient for the overall stability of foundation pit slope, and comprehensively considers and analyzes the geological conditions, geological structure and adaptability between structures around the slope. In the current geotechnical engineering construction, the commonly used composite reinforcement treatment technology is mainly the net shotcrete support technology and three dimensional net planting grass support technology.

## 4. Reinforcement and Treatment of Foundation Pit Slope in Geotechnical Engineering Construction

### 4.1 Before construction: determine the correct construction process

Before the formal construction, the construction procedure of foundation pit slope is determined. Considering the discontinuity of foundation pit slope soil layer and the phenomenon of sludge pack,

the excavation and support construction of the foundation pit must be combined, and the construction principle of "layered excavation and no over excavation" must be practiced, thus reasonably determining the construction process [4]. The technical method of large-area excavation can be adopted. When excavating to the bottom of the support beam, the underground water level must be measured to ensure that the distance between the water level and the beam bottom is more than 500mm. The support part of the base shall be leveled in combination with the engineering design drawings, and then the laying of beam bottom, reinforcement installation, reinforcement binding, side form installation, support concrete pouring, etc., shall be completed. The specific process is shown in Fig. 1.

#### **4.2 Under construction: determine the correct construction method**

The first is the construction method of soil layer. In pit excavation process, if silt layer is encountered, a temporary channel shall be built and then filled. Due to the obvious fluidity and compressibility of sludge, the temporary road will have the problem of settlement. Therefore, after the design of support beam and waist beam is completed, the silt under the temporary road needs to be corrected. In the process of excavating silt layer, vertical support shall be adopted to avoid slope deformation due to the nature of the silt. The second is the construction of gravel filling layer. The rock fill layer with small thickness can be treated by removal and replacement to meet the needs of slope reinforcement [5]. The rock filling layer with large thickness should be cleaned by manual digging pile in the process of excavation, and finally by rotary digging pile for construction. For the rock fill layer with very large thickness, the technical method of punching pile must be directly used for construction. The third is the construction of gravel layer. Constructors should reasonably select the drilling tools, and adjust the thickness of the ground outer diameter according to the actual situation of the gravel layer. Also, they should strictly control the specific gravity of mortar, use high-quality bentonite, and control its viscosity, specific gravity, sand content, etc., to ensure that it meets the requirements of preventing slope collapse. Finally, the construction method of high groundwater level is selected. To optimize the mud performance, it is recommended to make mud in a natural way. At the same time, bentonite and soda ash need to be added to the mud to optimize the mud performance. In order to avoid slope collapse, the stability of hole wall should be improved in the process of mud allocation and use. Dewatering should be carried out in the foundation pit. A dewatering well is established in the foundation pit, and then the dewatering well is pumped by single well and single pump, thus reducing the water level in the foundation pit stratum and laying a solid foundation for subsequent construction.

#### **4.3 After construction: determine reasonable treatment method**

It is mainly to determine the treatment method of slope collapse, backfill the collapse position, and compact the excavation area of the foundation pit repeatedly, thus improving the overall stability of the foundation pit. Tree stumps or other objects are placed and fixed along the slope to support the foundation pit slope, and expose the silty soil on the slope to the natural environment. The water of mucky soil is discharged along the slope through the sun, and the mucky soil is drained and consolidated. After waiting for a period of time, the subsequent excavation work will be carried out to form a new and stable slope. Finally, the settlement and displacement deviation of foundation pit slope are controlled within a reasonable range to solve the problem of foundation pit slope collapse.

### **5. Conclusion**

In order to ensure the construction quality of geotechnical engineering, the common risk factors in construction must be considered, such as the common foundation pit slope instability problem. Effective reinforcement measures should be taken in time to improve the overall safety and stability of the project. In the foundation pit slope reinforcement treatment, it is also necessary to cope with it flexibly according to the actual situation, analyze the cause of instability, formulate effective

reinforcement treatment scheme, make scientific deployment of reinforcement treatment, thus maximizing the value of slope reinforcement treatment.

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