Research on Optimization of Deep Excavation Support Scheme Based on Distance Discriminant Analysis Method

LongYun Wei[a], Nan Zhang[b] and Yang Li[c]

China Solibase Engineering Co., Ltd., Beijing 101300, China;

[a]wyunlong1124@163.com, [b]wozn324@163.com, [c]boyliyang@163.com

Abstract. With the rapid growth of China's national economy and urban construction, various factors make deep excavation engineering a challenging, high-risk and difficult geotechnical engineering technical subject. It plays an important role in concrete construction and has very high requirements for technology. In deep excavation engineering, in order to achieve the same supporting purpose, there are many alternative schemes, among which each scheme has its own characteristics. The choice of deep excavation support scheme is a complex multi-factor decision-making problem. Based on the idea of distance discriminant analysis theory, considering the principle of distance discriminant analysis method and the specific characteristics of deep excavation support scheme, this article tries to apply discriminant analysis method to the optimization research of deep excavation support scheme, so as to discuss the optimization design of deep excavation support project. It is hoped that the research in this article can further ensure the construction effect of building projects and provide some reference for similar projects.

Keywords: Distance discrimination, Deep excavation support, Construction technique.

1. Introduction

With the rapid growth of national economic construction and urban construction, the construction industry has also developed rapidly, and the construction technology used in construction has also been improved [1]. Deep excavation support construction technology is a deep excavation treatment technology commonly used in large-scale construction projects such as high-rise buildings and super-high-rise buildings. During the excavation of foundation pits in large-scale construction projects, its depth will continue to increase, and with the increasing depth of foundation pits, the geological conditions of foundation pits will become worse and worse. If water seepage and other harsh construction environment will occur in the groundwater section, the stability of the foundation pit will be affected, and thus the construction safety will be threatened [2]. At present, the underground engineering construction in urban construction is increasing day by day, followed by the increasing scale of foundation pit. It should not only ensure the stability of the slope, but also meet the requirements of deformation control to ensure the safety of buildings, underground pipelines and roads around the foundation pit [3]. Moreover, with the rising land price in large and medium-sized cities, the utilization rate of space increases, and more and more engineering projects are faced with the need of foundation pit excavation in complex urban environment [4]. Among them, the urban construction space is narrow, the excavation scope is limited, the surrounding environment is complex, the underground municipal pipelines are densely covered, and the excavation depth of the foundation pit is generally deep. Once it is unstable and destroyed, it will cause huge casualties and economic losses, causing huge social adverse effects [5].

Due to the limitation of urban construction land, the severity of surrounding environment, and the complexity and uncertainty of geotechnical media involved in the excavation and maintenance of deep excavation, deep excavation engineering has become a challenging, high-risk and difficult geotechnical engineering technical subject [6]. In order to ensure the safety and stability of deep excavation construction, effective technical measures must be taken to provide safety guarantee for the construction. In order to ensure the achievement of the construction quality and safety objectives, construction enterprises should base themselves on the reality, scientifically select the types of supporting technologies, and implement the key points of construction technologies, so as to

effectively improve the economic and social benefits of construction enterprises [7]. The optimal design scheme of deep excavation in complex environment involves the consideration of investment and various safety factors. The first step is to compare and select the optimal scheme, and then calculate the optimal design of the supporting structure itself [8]. Scientific and reasonable application of construction technology in construction projects can provide more effective guarantee for the construction quality of construction projects, further improve the overall quality of construction projects, effectively reduce the cost of construction enterprises and help enterprises gain advantages in the fierce competition [9]. In this article, the idea of distance discriminant analysis theory is used for reference, the principle of distance discriminant analysis method and the specific characteristics of deep excavation support scheme are considered, and the discriminant analysis method is tried to be applied to the optimization research of this problem, and good results are achieved.

2. Construction technology of deep excavation support

The deep excavation support technology can play an effective role in safeguarding, effectively avoiding a series of problems such as earth collapse and soil leakage around the foundation pit, and effectively improving the construction quality of the project. In terms of deep excavation construction, there are many construction technologies. For example: row pile supporting technology, underground continuous wall technology, soil nail supporting technology, net root pile supporting technology, etc [10]. Among them, pile foundation has been widely used in soft soil areas because of its superior characteristics, but the choice of pile foundation support methods is mostly determined by experience, which lacks rationality. Especially in the soft soil area, the supporting method of pile foundation has a great relationship with the physical and mechanical properties of soft soil. When applying row pile support technology, bored piles and excavated piles should be distributed reasonably. Usually, the arrangement density of bored piles will increase with the deepening of the foundation pit. If the distance between bored piles is too far, it will not be able to stabilize the soil layer and protect the deep excavation. If the distance is too close, it will waste reinforced concrete materials and increase useless workload. Therefore, the construction personnel should consider the actual soil retaining effect and the spacing distance between bored piles. When using deep mixing pile supporting technology, we should also master the geological environment conditions of deep excavation site, analyze the feasibility of technology application and supporting effect according to the geological environment conditions, and make full preparations before deep mixing pile supporting construction.

3. Application of deep excavation support construction technology in practical engineering

According to the commonly used construction technologies of deep excavation support, there are many kinds of them, and each kind of support construction technology has its own characteristics and advantages. In carrying out practical projects, knowing these conditions is the premise of type optimization and detailed design of deep excavation supporting structure. Moreover, according to the site engineering geological and hydrogeological conditions, the surrounding environment and the depth of the foundation pit, according to the relevant technical specifications and regulations of foundation pit engineering, combined with the experience of similar projects around, and taking into account the factors such as technology, economy, construction period, etc., the effective construction technology of deep excavation support should be selected. Figure 1 shows the supporting structure of foundation pit.

Figure 1 Foundation pit supporting structure

When the construction technology of deep excavation support is implemented, the construction staff should make preparations before construction and strictly check the various factors existing in the construction site. Scientifically measure and survey the geological conditions of the deep excavation supporting construction site, so as to ensure the quality of the actual project. In addition, in order to meet the information requirements of design and calculation, the parameters of retaining wall should be set strictly according to the requirements of relevant codes on foundation pit stability, retaining pile wall strength and deformation control, and according to the actual construction requirements and the basic characteristics and functional requirements of buildings.

4. Optimization of deep excavation support scheme based on distance discriminant analysis

Geological exploration is an indispensable link in the construction of building engineering and occupies an important position in the deep excavation support construction. Therefore, it is very important to do a good job in comprehensive geological survey. Before construction, we should do a good job in geological survey immediately, scientifically analyze the survey data, select the appropriate supporting construction technology, and work out a scientific and reasonable scheme. In order to ensure the smooth construction of deep excavation supporting project, firstly, the construction scheme should be comprehensively and scientifically analyzed before the project construction to ensure the rigor of the construction scheme and construction progress. Different deep excavation support methods have different application scopes and different practical application effects. It is necessary to consider the actual situation, engineering requirements and construction conditions and choose a reasonable and scientific support method. For example, steel sheet pile support has the advantages of simple process and low cost in foundation pit construction. When applied to engineering construction in soft soil areas, steel sheet pile support has some problems such as easy extrusion deformation and large flexibility, so it is not suitable for deep excavation construction.

The measured data of the displacement and deformation of each supporting structure, the axial force of the supporting structure and the surrounding ground settlement are all within the requirements of the design and specification. In the complex and unfavorable surrounding environment, it is feasible to adopt the scheme of digging cast-in-place pile and reinforced concrete inner support structure combined with cement jet grouting pile to stop water. It is also feasible from the technical and economic point of view that the reinforced soil nailing wall with micro-pile and prestressed anchor combined with internal brace supports the north and south sides. The construction scheme of 3D spatial data model of deep excavation is shown in Figure 2.

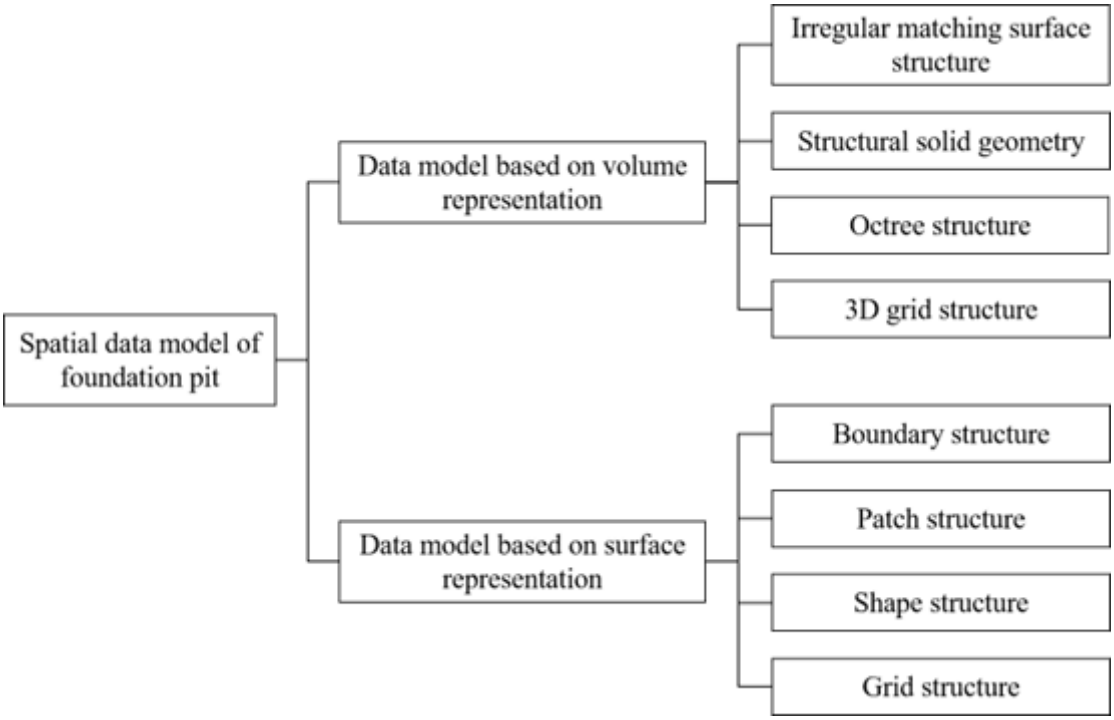

Figure 2 Construction scheme of three-dimensional spatial data model

In this article, the theory of distance discriminant analysis is applied to the optimal discrimination of deep excavation support schemes. By studying a large number of engineering examples, the complex relationship between various factors and support schemes is found, and the distance discriminant analysis model of the optimal scheme is established. According to the concept of Mahalanobis distance and the theory of distance discriminant analysis method, the population G is assumed to be m-dimensional population:

$$G = (X_1, X_2, \ldots, X_m)^T \tag{1}$$

Let $\mu_i = E(X_i)$, then the mean vector of the population G is:

$$\mu = (\mu_1, \mu_2, \ldots, \mu_m)^T \tag{2}$$

Covariance matrix is:

$$\sum = Cov(G) = E\left[(G-\mu)(G-\mu)^T\right] \tag{3}$$

The Mahalanobis distance between the sample and the total G is defined as:

$$d^2(X, G) = (X-\mu)^T \sum^{-1} (X-\mu) \tag{4}$$

Consider the case of two populations. When the covariance of the two populations is equal, the Mahalanobis distance from sample X to the two populations is:

$$\begin{aligned} d^2(X, G_i) &= (X-\mu)^T \sum^{-1} (X-\mu_i) \\ &= X^T \sum^{-1} X - 2Y_i(X) \end{aligned} \tag{5}$$

Where: $Y_i(X)$ is the discriminant function of X. For a given sample X to be judged, calculate its Mahalanobis distance to each population:

$$Y_i(X) = X^T \left(\sum^{-1} \mu_i\right) - \frac{1}{2} (\mu_i)^T \sum^{-1} \mu_i \tag{6}$$

The square difference of Mahalanobis distance between sample X and two populations was investigated, and the distance criterion was obtained as follows:

$$\left.\begin{array}{l} X \in G_1, \left(Y_1(X) > Y_2(X)\right) \\ X \in G_2, \left(Y_1(X) \le Y_2(X)\right) \end{array}\right\} \tag{7}$$

In the construction of deep excavation support for builders, there are many types of support technologies, and the application conditions and application specifications of different technologies are different. In order to ensure the best application effect of all kinds of support technologies, it is necessary to select the most appropriate support technology in combination with the on-site data. The building will encounter different construction environments, and different factors will affect the deep excavation construction. One of the more common factors is the influence of groundwater, so it is necessary to deal with groundwater scientifically during construction to reduce the adverse effects of groundwater on deep excavation. The common method is to use drainage to lower the water level and reduce the effect of water pressure protection and support. In the selection of support technology, the construction experience should not be used as the basis for selection, but it is necessary to go deep into reality, make a detailed investigation on the site geological conditions, hydrological conditions and environmental conditions, carefully analyze the collected data and information, formulate a scientific construction scheme based on the analysis results, and implement it in engineering practice.

5. Conclusions

The growth of building construction technology has a great relationship with the improvement of basic construction level, and the construction quality of basic engineering has a great influence on the overall construction quality. Building foundation is the basic premise of high-quality construction of building engineering. In building foundation construction, the foundation pit support construction must achieve the quality and safety control objectives with reasonable standard technology and strict supervision and management. Moreover, the design of foundation pit support should reasonably select targeted and applicable support forms according to different engineering geological conditions and surrounding environment, so as to give full play to the advantages and functions of various support forms. Based on the idea of distance discriminant analysis theory, considering the principle of distance discriminant analysis method and the specific characteristics of deep excavation support scheme, this article tries to apply discriminant analysis method to the optimization research of deep excavation support scheme. Moreover, the significance of deep excavation support engineering is given, especially in complex environment, which should be paid special attention to. Otherwise, if you are not careful, you will have certain adverse consequences and threaten the safety of life and property. Therefore, the staff in design and research should consider it more comprehensively, and make the designed supporting structure more scientific and reasonable. Only rational application of deep excavation support technology can ensure the stability and reliability of high-rise buildings, provide a safe environment for people, and promote the sustainable growth of construction industry. This study can ensure the construction effect of building engineering and provide some reference for actual construction.

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