Application and Innovation of Anti-floating Technology in Basement Structure Design

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Abstract: The basement, affected by the groundwater level, often needs anti-floating design and different anti-floating design methods in the construction process, construction time and cost, which have a greater difference. The optimization and innovation of the design method need to be combined with the actual situation.

1. Introduction

With the development of the city, the use of underground space has been paid more and more attention. Combined with this situation, the building's basement anti-floating problem is also attracting more and more attention. The groundwater level often changes with the change of season and rainfall, and these changes will cause the basement wall and the bottom plate to be affected by the water pressure change to produce different force state. Designers can not combine the actual situation of the basement wall and the floor of the force of the reasonable simulation and then will produce deformation, cracking, resulting in a series of problems such as engineering quality. Combined with an engineering example, this paper makes a comprehensive comparison of three kinds of technical ideas for reference by engineering and management personnel.

2. Project Overview

Chengjiang Guang Long Tourism Town project is the provincial and municipal key ecological civilization construction project and one of the national characteristic tourism town. Project site is located in Yuxi Chengjiang County City, Yunnan province Shan north, Guang Long road East, Zhibai village south side.

Most of the site elevation is between 1732.95~1740.83m, height difference 7.88m, elevation between 1735.08~1746.04, high out of the site 5.21~0m. The proposed project under the big chassis monolithic basement layer, and the underground contour near the site Red line, the underground contour distance with the ground red line generally about 2.2~5.5m, the local concave section is farther, about 8.5m. The surrounding environment of the foundation pit is more complicated, and the proposed building features are detailed in table 1. The north, east and south side of the proposed building pit are open spaces, the surrounding environment of the foundation pit is relatively simple, the surrounding environment of the north, east and south of the foundation pit will be more complicated.

3. Geological conditions and anti-floating design analysis

According to the survey results, detailing 1, the proposed site is generally stacked thick layer fourth series of flushing and Flushing of the lake, belong to the fourth series of loose and weak strata, pore development, for the groundwater occurrence and migration of the site, in which the groundwater is mainly deposited in strong permeability of clay gravel (3)3 and (3) 6, As the main water-bearing strata, the groundwater is rich, silty clay layer (2) 1, (2) 2, (3) 1, (3) 2, (3)4, (3)5, (3)7 permeability is weak, water-rich poor, and the silt containing silty clay and (3)3 Aquifer is affected by the viscous soil water resistance, has a certain micro-pressure, This layer of groundwater mainly receives the atmospheric precipitation and the West upstream gully surface

water and the groundwater side replenishment, belongs to the upper layer stagnation and the diving type. Detail Table 2

	Content in water	Corrosi	Corrosion grade of				
Corrosive media		Effects of cli	matic factors	Effects of os	steel bar in reinforced		
lineenu	(110,2)	Environment category	Corrosion Rating	Penetration category	Corrosion Rating	concrete structure with water	
SO ₄ ²⁻	28.9~29.9						
Mg ²⁺	29.2~34.0	II	Slightly				
Total salinity	381.5~427.1						
PH value	6.98~7.16			В	Slightly		
Corrosive CO2	0.0~2.2				Singhting		
Cl ⁻	7.1~17.7					Slightly	
Comprehensi ve evaluation of corrosion grade	Water is slig	htly corrosive to) concrete struc	ture and reinfor	ced concrete str	ucture.	

Table 2 Table of corrosion evaluation of ground water



Figure 1 Engineering geology diagram

4. Anti-floating calculation analysis

4.1 Adding Weight method

According to the situation of soil and the actual situation of the project, the basement counterweight floor is combined with C15 concrete and reinforced concrete structure floor (due to the characteristics of anti-floating counterweight, this weight plate adopts C15 concrete, which can further reduce the project cost.)), the formation of anti-floating counterweight, the overall thickness of 1300mm thick, according to the design requirements, weight can be used in concrete. There is weak soil in the basement floor below the ground soil, using the method of replacement filling, mainly using gravel for filling.

The compaction coefficient of backfill gravel soil in basement is ≥ 0.96 , and the characteristic value of foundation bearing capacity is fak ≥ 200 kpa after filling.

According to the above principle, the actual calculation to obtain the results, by checking the local anti-floating layout must be in the original base plate 500mm thick base, another increase of 800mm thick concrete (that is, the floor thickness of 1300mm), can achieve the overall anti-floating basement requirements, as follows:

(27+10.2+12.5+0.8x25)/(57.8+0.8x9.8) = 1.06 On this basis, to optimize, using the plate roof joint counterweight method to check, assuming that the top of the board to add 200mm of concrete, (because the project needs to plant a certain amount of green plants on the ground, due to the greening rate on the board to cover the soil requirements, board top with weight can only increase the structure of the plate thickness or drop after pouring concrete)

By checking the local anti-floating arrangement location only need to add 450mm thick concrete (that is, the total thickness of the local baseplate is 950mm), as follows: (27+10.2+12.5+0.65x25)/(57.8+0.45x9.8) = 1.06

4.2 Using anti-floating anchor rod method (can be used spacing nxn)

According to the situation of the site, the anti-floating anchor rod is used to carry out the calculation of the basement resistance. Anti-floating anchor rod is used to resist floating anchor rod pulling force, pull-out force to take the pile body and soil friction and anti-floating pile tensile strength of the smaller value, this project by the pile and soil friction control. In order to increase the friction of the pile, the contact area between the anchor and the soil should be increased. In addition, because the basement floor is a flat raft foundation, if the single pile anti-pulling force is too large, the central load effect on the base plate is obvious, need to local strengthening of the base plate or change the structure of the bottom plate to bear the anti-pulling force, which will increase the cost. Therefore, the anti-floating anchor rod generally chooses the smaller pile diameter, and the pile with relatively small tensile strength of single pile is densely distributed. [4] The specific calculation is as follows:(1) The Test bolt (aperture 100,l=6m) characteristic value 40KN is arranged,

N= (40/(57.8x1.05-(27+10.2+12.5))) 0.5=1.95m

(2), with the anchor (aperture 150,l=6m) characteristic value 60KN is arranged,

N= (60/(57.8x1.05-(27+10.2+12.5))) 0.5=2.35m The above calculation shows that the two methods to carry out the anti-floating measures in the basement can achieve considerable results. In what way is it more in line with the actual situation of the project? Further comparative studies are needed.

5. The pressure weight method and the anti-floating anchor rod method comparison

5.1 Construction technology and period comparison

If the method of counterweight is used for construction, the construction process of the concrete is more mature, and the method is simple and easy to operate. As the project for the relocation of housing projects, the whole project period is more tense, and the rainy season is coming, if the excavation of the basement is not timely pouring backfill, will bring unnecessary trouble to the project. Therefore, the method can shorten the construction period of the whole basement. More importantly, because the anti-floating counterweight plate can be in the concrete after the initial coagulation can be carried out after the construction, so after the completion of the concreting of the floor of the steel bar lashing and formwork installation and construction, which can save a lot of time, and thus meet the project on the construction time requirements.

If the method of anti-floating anchor is used for the basement of the basic site of the geological drilling, the use of high-pressure grouting machine for cement perfusion, while the anchor rod parts need to be completed in advance of the project, the use of hoisting the way to carry out construction, and because of the high ground water level, water is more abundant, there are many stagnant And the drilling process will produce a lot of silt, will be a great inconvenience to the construction. The construction process requires a professional construction team to carry out the construction, due to the rainy season, the construction difficulty and increase day. In addition, after the pouring is completed, to combat the floating anchor to carry out nursing, when the age of 28 days after the arrival of the anti-pullout test, this point, undoubtedly extended the entire basement construction period.

According to the geological report, also found that the plot 10 meters-18.5 meters of depth, generally for silt rather than gravel or rock layer, considering the structural characteristics of the soil, the anchor rod into the course of the period, with the change of time and the long-term erosion of the ground water, the adhesion between the bolt and the soil will be weakened, in the longer run, will make the bolt part failure.

5.2 Follow-up

At present, the project has been used to carry out construction work, and has been initially completed, the results of on-site investigation is more satisfactory. However, when the members of the group looked back and thought again, a new idea was obtained, and further research was carried out, that is, the combination method of drainage Buck + counterweight method was used to design the anti-floating of basement floor.

Specific as follows: In the past, the method of passive anti-floating is used to check the model, in this way, combining the location of the project is adjacent to the lake, high water level and water-rich characteristics, the use of active precipitation, timely drainage, and then reduce the pressure, The water level of the wellhead is controlled in the outdoor elevation -4.0m, when the water level is higher than 4.0m, the water wells self-draining buck, and then reduce the effective level, reduce the pressure on the bottom plate, while increasing the thickness of the anti-floating counterweight, into the check, the board structure plate thickness of 400mm, anti-floating weight block thickness of 450mm,

Further reduce the cost of the entire basement and shorten the construction period. In the context of the three scenarios, the relative economic and technical comparisons are further carried out, as shown in table 3:

No.	Anti-floating solution	Estimating	Estimating	Business	
		costs/wanyuan	durations/d	impact	
1	Grouting of anchor rod static pressure steel pipe pile	522	60	considerable	
2	Concrete Counterweight	252	30	small	
3	Relief and counterweight of sluice	288	30	small	

Table 3 Economic comparison of each programme

By comparison, it can be found that the cost of the method is the lowest, while the active anti-floating scheme-drainage Buck + Counterweight method is the second low cost, and the construction period is relatively short, the method is more worthy to be carried out compared with the other.

6. Conclusion

In summary, due to the actual situation of the project, has adopted three kinds of anti-floating design methods to deduce, combined with the advantages and disadvantages of the first two methods, put forward a different from the traditional passive anti-floating third design method, the use of active anti-floating design method. Compared with the traditional anti-floating scheme, the active anti-floating design method shows good economic and technical advantages. As a new anti-floating design method, new technology and construction methods are used, which is worthy of further study and discussion by engineering and technical personnel.

References

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						Sonsitivit	Building (structure) foundation						
No.	Name Of Structures	Bottom layer ±0.00 Yellow Sea elevation (m)	Number of layers	Hight (m)	Struct ure type	y to differenti al settlement	Shape	Size m×m	Basic Design Level	Founda tion Buried depth(m)	Average base surface pressure (single column maximum load)	Basement or underground equipment condition	No tes
1	3-storey home	Detailed map	Basement 1 floor 3 Floors above ground	10.05	Fram ework	Sensitive	Rectang ular	Detail ed map	Yi	About 4.0	60kN/m ² (1700kN)	Basement 1 floor	
2	4-storey home	Detailed map	Basement 1 floor 4 Floors above ground	13.05	Fram ework	Sensitive	Rectang ular	Detail ed map	Yi	About 4.0	75kN/m ² (2350kN)	Basement 1 floor	
3	5-storey home	Detailed map	Basement 1 floor 5 Floors above ground	16.05	Fram ework	Sensitive	Rectang ular	Detail ed map	Yi	About 4.0	100kN/m ² (3000kN)	Basement 1 floor	

Table 1 List of the features of the proposed building (structure)