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ARTICLE

The Research on Treating Collapsible Loess by Down Whole Deep Compaction and Cement Fly-ash Gravel

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ABSTRACT

The treatment of loess foundation is always difficult. The analysis of its advantages and mechanism of treating loess foundation by CFG, on the base of project geology, through construction example, we suggest the compound plan by both DDC and CFG. The tests illustrates that the down hole deep compaction and cement-fly ash-gravel are effective foundation treatment method to eliminate the collapsibility of loess, increase the bearing capacity and improve the behavior of composite foundations.

1. Introduction

DDC method, also called deep dynamic compaction method, which is an effective method of ground treatment. When uses DDC technology to strengthen the foundation, infilling in the deep parts of foundation treatment, and carrying on high pressure and high compaction of tamping operation to strengthen foundation and eliminate construction waste and dregs.[1]

Both CFG pile and natural foundation belong to foundation category. CFG pile is not connected with the foundation directly, instead, they connect with each other through gravel or rubble, and the primary bearing stratum of CFG pile is in reinforced material.[6] The reinforcement mechanism of collapsible loess has three main aspects:

·Compaction effect

·Replacement

·The role of the pile

As an effective method of ground treatment, DDC method has been applicated commonly, so does the CFG pile, and reports about the deep research of both methods can be found everywhere.[2] But using DDC method and CFG pile to compositely treat collapsible loess foundation is not common, and through the field test research ,we found that using DDC method and CFG pile to treat together collapsible loess foundation developing an effect what is eliminating the collapsibility of collapsible loess, increasing bearing capacity of foundation, improv-

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ing the behavior of load-bearing capacity, reinforcement mechanism and reinforcement effect, which is better than using DDC method or CFG pile only, and this composite foundation treatment method has a certain practical significance.[5]

2. Project Information

The project is a high-rise residential building in Xining of Qinghai Province, which with a total gross floor area of 31272.31m^2,building height is 94.25m, site ground elevation is 2228.81~2241.37m. The region low-lying South High North ,and showing the distribution ladder, tilts to the North, and the landform unit belongs to the front of the third terrace of the south bank of Huangshui river. The distributions of the main strata of the site are as follows:

·Miscellaneous fill in the soil, noise, ingredients to powder soil are given priority to, soil is uneven and structure is loose, 0.30~8.00m.

·Grain filling, tan, brown give priority to with powder soil ingredients, soil structure than to loose, 0.18~6.50m.

·The loess shape soil, tan, brown give priority to with powder soil ingredients, groundwater level is saturated with exuviate, empty, needle with micro level bedding, shake vibration reaction medium, without burnish, dry low intensity, and toughness is low, according to the collapsibility coefficient and saturation is divided into 3-1 layer collapsible loess shape soil, 0.8~16.90m, 3-2 layer the collapsible loess shape soil, 0~11.00m, 3-3 layers of loess soil (saturated), 1.00~12.60m.

·Barely, noise, ingredients to metamorphic primarily, parent rocks by granitic gneiss, sandy slate and quartzite composition, particle size general 20~70mm, maximum can reach 130mm, grinding roundness for him round, local have 0.30m around the cementing, describes the thick gravel layer surface elevation for maximum 12.58m.

·Strongly weathered mudstone, brown give priority to with plastic, caesious, in part, hard structure most damage, 3 body strong structure and soil shape structure, soaking easily become soft, rock mass basic quality grades for extremely soft rock, exposing the thickness weigh.40~9.4m.

This construction site is III level self-respect collapsible venues, collapsible degree intense, venue bearing capacity, which doesn't suit for the engineering requirement. [8]

3. The Design Requirements

In this project, construction of CFG pile composite foundation soil pile DDC meal before eliminating upper collapsibility CFG pile forms for positive triangle, horizontal spacing 1200mm, row spacing, 1039mm 500mm, pile diameter pile length 2~12m, the pile strength of concrete, cement adopted for C25 resistant Portland cement sulfate. Pile tip resistant layer whereas for pebble layer, and entering the pebble layer is not less than 500mm. DDC pile decorate spacing way with CFG pile, horizontal spacing, 1039mm 1200mm row spacing, pore forming 400mm DDC pile hole fill grain soil, using 1.5~2.0 t heavy hammer will hole ramming 550mm, expansion to pile length less than 6m. DDC pile and CFG pile are obligate 500mm pile construction, completing in virtual 1000mm thick pile top laid the gradation sand pad within 5%, 10% of cement mixed lime, and exactly amount water, compaction coefficient is not less than following. Design of composite foundation of bearing capacity is not less than 450kpa characteristic value; the base is about natural elevation below ground 7.0m.

4. Field Test and Analysis of the Results

In order to check after DDC method and the comprehensive handling CFG pile composite foundation bearing capacity, after eliminating the effect of collapsibility compliance with design requirements, followed by a single pile composite foundation static load experiment and DDC pile body filler and between the quality of pile soil test, and according to the relevant requirements are evaluated.[7]

4.1 CFG Pile Composite Foundation Static Load Test

The single pile composite foundation bearing capacity test use the slow maintain load method, loading counterforce device according to the condition on site selection pressure heavy platform counterforce device, use 500t hydraulic jack add lotus, orthogonal diameter symmetry position decorate 4 big span displacement measurement root plan for settlement, choose diameter read 1.26m, area of 1.25m2 circular rigid pressure plates. Excavation trial pit, dig the soil to design elevation, using 150mm thick layer make level several problems, make its elevation and pile top design elevation consistent, and timely placed pressure plates, rack good counterforce platform and began to experiment. Loading grading, using auto-merging equivalent load, For maximum loading grading load of 1/10, of which the first level desirable grading load of 2 times, maximum loading not less than 900kpa. Each additional level load, before and after each measurement, remember a reverse subsidence, there was no 0.5 hours measure remember once, when in consecutive 2 hours, every hour of subsidence 0.10mm, less than that already became stable both sides sinking, can add to the next level load. And every class load time interval of which shall not be less than 2 hours.[3]

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This trial of composite foundation for 3 place single pile composite foundation static load test, the test result see Figure 1, Figure 2 and Figure. 3. By the graph shows, 3 groups areas of the p-s curve saw no obvious proportion boundaries, and because of this site points with powder soil primarily, therefore take s/d = 0.010, according to the relative deformation values determine bearing capacity, and the characteristic values greater than maximum loading pressure value shouldn't half done.[4]

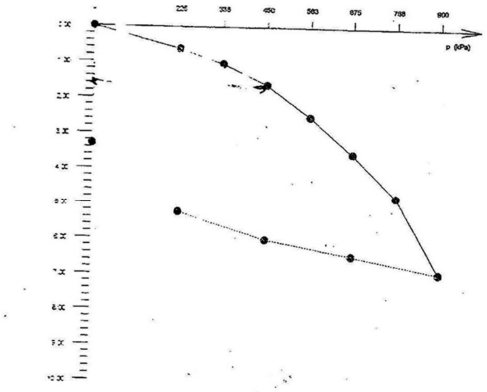

Figure 1. *p-s* curves of No.1 compound foundation

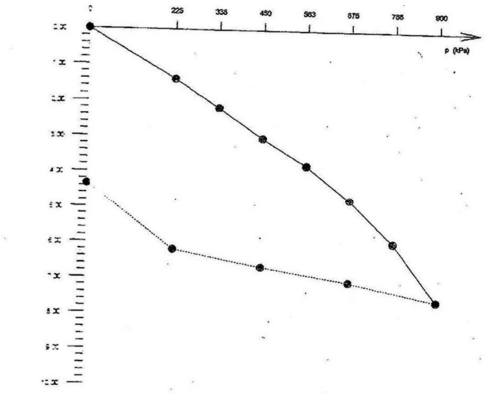

Figure 2. *p-s* curves of No.2 compound foundation

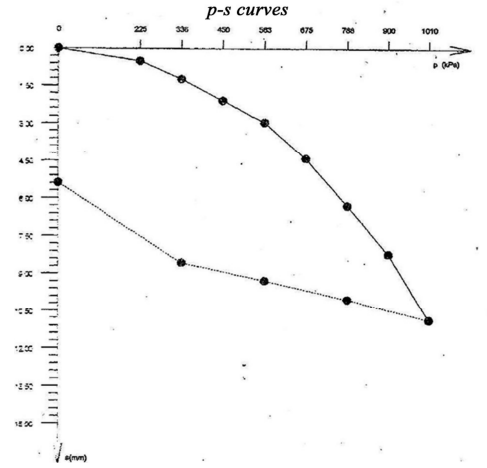

Figure 3. *p-s* curves of No.3 compound foundation

No.1 pile composite foundation sites (no 7-51, pile length 8.5m) the most damning jose 900kpa, maximum amount for the settlement is for 5.67mm, from p-s curve analysis, which is slow deformation, according to the building foundation treatment technology norms of JGJ79-2002 appendix A of a. 0.9 regulation, single pile composite foundation bearing capacity eigenvalue desirable for 450kpa.

No.2 pile composite foundation sites (# 11-45, the pile length 7.0m) the most damning jose 900kpa, maximum amount for the settlement is for 4.17mm. From p - the s curve analysis, which is slow deformation. According to the construction of foundation treatment technology norms of JGJ79-2002 appendix A of a. 0.9 regulation, single pile composite foundation bearing capacity eigenvalue desirable for 450kpa.

No.3 composite foundation sites (pile number 13-24, pile length 5.0m) the most damning jose 900kpa, maximum amount for the settlement is for 21.26mm. From p - the s curve analysis, which is slow deformation. According to the construction of foundation treatment technology norms of JGJ79-2002 appendix A of a. 0.9 regulation, single pile composite foundation bearing capacity eigenvalue desirable for 450kpa.

Above all, after DDC method after construction, CFG pile composite processing of composite foundation bearing capacity has been greatly improved, can satisfy the requirement of the project.

4.2 DDC Pile between Soil Collapsibility, Pile between Soil Confidential Coefficient and Pile Body Compaction Coefficient Test

Piles of soil dry density between pile top down since detection: 1.0m onwards, each 1m earth-gathering sample determination dry density, each 1m take 2 point, be in namely pile bore outside 100mm place 1 a.m. and pile bore the central distance between (1/2) place 1 point. Take and pile soil sample, do between mixture compaction tests, the result of soil pile between maximum dry density and optimum moisture content. The conversion between the averages obtained pile soil compaction coefficient and minimum confidential coefficient.

Pile body packing quality inspection: the pile top-down 1.0m onwards, each 1m earth-gathering sample determination dry density, each 1m take 2 point, be in namely pile hole pile hole edge 50 place from 1 point, pile hole center (namely 1/2) place 1 point. Take and pile body packing products, being the compaction test pile body filler, it is concluded that the maximum dry density and optimum moisture content. The conversion of pile body filler obtained average compaction coefficient. For the project in

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the open 2 DDC profile, test results are showed in Table 1.

Table 1

Exploratory Wells No.		T1	T3
Compaction coefficient	I	0.96	0.99
	II	0.88	0.92

***Notes*:** I representative pile body; II representative pile between soil

Pile between the collapsibility detection: the pile top-down 1.0m onwards, each 1m earth-gathering sample determination collapsible coefficient. For the project three place three piles DDC between soil profiles, the open experimental results as shown in Table 2.

Table 2. Comparison between related parameters of soil between piles before and after treating

situation	$\gamma_d / KN \cdot m^{-3}$	e	E_{s1-2} / MPa	δ_s
before	13.86	0.912	4.08	0.046
after	16.01	0.693	8.64	< 0.015

After the treatment of pile soil dry density between improve 16%, porosity ratio decreases 24%, compression modulus before 2.1 times for processing, explained through hole deep dynamic compaction pile after processing between soil compaction effect is good, greatly reduce the compressibility, bearing characters more uniformly and reliable.

5. Conclusion

Through the experimental study on the actual project, draws the following conclusion:

·Whole deep dynamic compaction method is an effective treatment method. After processing, the composite foundation bearing capacity can be easily achieve the design requirements, and much higher than the natural soil bearing capacity. It also can rise the compaction effect of soil between piles, so as to improve the bearing capacity of soil between piles, reduce soil compaction, greatly improve the bearing behavior of the foundation, and can effectively eliminate the collapsible loess foundation.

·After forced ramming, the characteristic value of bearing capacity of CFG pile composite foundation is bigger than estimated calculated value, it can not only meet the design requirement, but also can short the construction period and save economy.

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