ATLANTIS PRESS

Advances in Engineering Research, volume 197

Proceedings of the 2020 9th International Conference on Applied Science, Engineering and Technology (ICASET 2020)

Comparative Analysis on Technology of Soft Toundation Treatment of Dredger Fill in Water Transportation Engineering

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ABSTRACT

Through the analysis of the soft foundation treatment cases in Binzhou, Weifang, Rizhao, Tianjin and other coastal areas, and by referring to the case data in other areas, this paper compares and analyzes the technical applicability and economic rationality of the soft foundation reinforcement technology in the water transport project. The purpose is to select a suitable soft foundation treatment method for the north, especially in the coastal areas of north China.

Keywords: *Dredger fill, Soft foundation treatment, Comparative analysis.*

1. INTRODUCTION

Land reclamation is an important part of most hydraulic engineering construction process. It is an important way to solve the problem of shortage of land resources in coastal areas despite the rapid economic development. Because redger fill soil is a kind of soft soil with complex composition and special structure, the selection of treatment method of blow-fill soil should consider not only the characteristics of blow-fill soil itself, but also engineering technology and engineering characteristics. In addition, economy is also an important factor in choosing soft foundation reinforcement technology. Therefore, how to deal with the land fill efficiently and economically is the key to the land reclamation project.

The common methods of dredger fill soft foundation treatment include pile (superload) preloading, vacuum preloading, vacuum combined load preloading, sand filling and solidified soil, etc. In view of these treatment methods, this paper makes a comparative analysis on the technical applicability and economic rationality, so as to select a more suitable treatment method for the land foundation in the coastal areas of north China.

2. COMPARATIVE ANALYSISI OF TECHNICAL APPLICABILITY

The advantages of preloading are stable settlement rate, uniform settlement and good controllability. The disadvantage is that the design of the bearing capacity of the foundation often needs high pile load, need a lot of pile load; Long construction period; In the process of loading, it is easy to turn over the silt due to various human factors.

The advantage of vacuum preloading is that the stability problem will not occur due to the fast soil loading rate. The vacuum time is not affected by weather or climate. The disadvantage is that the soil settlement rate is not stable; The maximum vacuum degree can only reach 80KPa. After the vacuum preloading is completed, it is lower than the intersection elevation, so sand or soil is needed to make it higher.

Vacuum combined stack-load preloading is an improved construction process between vacuum preloading and stack-load preloading. When the foundation bearing capacity required by the design is greater than 80KPa, priority should be given to the use of vacuum combined stack-load preloading. The advantage is that the treatment depth is deep, and the bearing capacity of the treated foundation can be greater than 80KPa. After the vacuum preloading treatment, the pile load can be used to supplement the height. The disadvantage is that the construction process is more, the process is easy to cause mutual interference.

The two methods of sand filling and solidified soil can meet the owner's requirement of land formation as soon as possible, but the cost of treatment scheme is higher. In particular, due to the high cost of curing soil owners did not use, there is no available data for in-depth study. Sand filling soil when land, sand filling sand in strict accordance with the design requirements, sand soil diameter less than 0.075 mm viscosity content is less than 10%. Materials that do not meet the design requirements shall not be used in engineering; When filling, the height of filling shall be strictly controlled; After the completion of the filling, the filling area shall be levelled in time.

3. COMPARATIVE ANALYSISI OF ECONOMIC RATIONALITY

3.1 Economic Analysis of Stack-load Preloading Method

In Qingdao jiaozhou bay project around the seawall drainage board soft foundation processing as an example analysis the economic costs, as mentioned above sea wall around the drainage consolidation method is adopted, the horizontal drainage the 0.5-1.0 meters of grade macadam, vertical with specific construction process is: clear base - JingBa, geotextile laid - 0.5-1.0 meters laid grading macadam, playing a drainage plate coarse sand, on average, about 12 m in (to) - laying geogrid - open backfill rocks (2.0 m thick) - trough of 1.0 m - backfilling gravel soil backfill

gravel road ballast (1.5-2.0 m). The economic analysis is shown in table 1.

Table 1 Economic analysis of stack-load preloading method

Project name	unit	total	unit price
Mud covered with bamboo	100 square meters	2786.10	27.86
Lay geotextiles	100 square meters	3310.01	33.10
Lay a gravel cushion	100 square	14210.88	142.11
Plastic water drain board	100 meters	637.81	6.38
(Binzhou project 30,000 ton bulk cargo terminal rear land project plastic drainage plate)	Yuan/m	3.5	3.5
Stowage pre-loaded slag	100 square	7597.86	75.98
Stowage preloading and unloading of slag	100 square	1799.42	17.99

The market price of the above materials is the market price of Qingdao in 2011. For the project of jingwu laying, jingwu (2×2m) is much higher than the base price of 20 yuan/piece, which is not far different from the cost of 18.45 yuan/m2 of binzhou project (2 floors of jingwu laying) in 2012 after material price and fees are deducted. It can be considered that there is reference in the base price; Compared with the drainage plate of the rear land project of the 30,000-ton bulk cargo wharf in binzhou with similar working conditions, apart from the material and charging factors, the obvious difference is that the jiaozhou project has increased the equipment input (square barge 400T, tug power: 294kW(400hp)), so the construction price of water drainage plate in jiaozhou project is significantly higher.

Other vertical drainage technologies, such as ordinary sand Wells and bagged sand Wells, have not been economically analyzed because of their poor construction quality and unsatisfactory drainage effect.

Compared with the backland project stowage of the 30,000-ton bulk cargo terminal in binzhou with similar working conditions, except for the factors of materials and fees, the obvious difference is that the impact of offshore construction has been properly taken into account in the jiaozhou project (the impact of diving and other ships and aircraft has been increased), so the stowage preloading price of the jiaozhou project is relatively high.

Comprehensive described earlier, the jiaozhou bay project stack preloading drainage plate, an average of set about 12 meters in length, drain stack, on average, 1.5 meters thick, preloading 60 days, considering the construction process of preloading materials of secondary use, (about 30%) by the comprehensive utilization of statistics, through the above analysis, the jiaozhou bay project stack preloading drainage plate comprehensive unit price for: 364.08 yuan / ㎡.

3.2 Economic Analysis of Vacuum Preloading

In the soft foundation treatment scheme of binzhou project and rizhao project, the soft foundation treatment method related to vacuum preloading is adopted. Since the collected data of binzhou project are more comprehensive in terms of economic information, the analysis is carried out based on the vacuum preloading of binzhou project. The main processes of vacuum preloading in binzhou project can be divided into: laying geotextile, bamboo raft -- laying sand cushion -- inserting drainage plate -- laying and connecting horizontal drainage pipe, laying sealing membrane -- pumping and stopping the pump.The economic analysis is shown in table 2.

Table 2 economic analysis of vacuum residual pressure method

The name of the project	Analysis content	unit price
Two layers of wood	Labor costs, material costs (stone, wire, jingwu), indirect costs, profits, taxes	184,499.98 yuan / 10,000 m^2
Lay 2 layers of geotextiles	Labor costs, material costs (geotextiles, other materials), machinery use fees (crawler crane), indirect costs, profits, taxes	169200.03 yuan / 10,000 m^2
Overland sand bedding (not rolled)	Labor cost, material cost (medium coarse sand) machine use fee (power of crawler bulldozer ≤75kW(102hp), bucket capacity of wheel loader ≤ 2m3), indirect cost, profit, taxes	791,300 yuan / 10,000 m^3

Land hit plastic drainage board	Labor cost, material cost (shaped steel, plastic drainage plate, steel protective pipe, other materials) machinery use fee (driving door frame excitation force ≤8t, other ships), indirect cost, profit, taxes	24200 yuan / 10,000 m
Vacuum prepressure for 100 days	Labor cost, material cost (mountain clay, loess, plastic film, iron, hard plastic pipe, plastic copper core three-core transmission cable, plastic copper core three-core lighting cable, straw bag, filter cloth, nylon rope, other materials), machinery use fee (electric single-stage centrifugal pump, vacuum equipment, other ship machinery), indirect cost, profit, taxes	620,299.99 yuan / 10,000 m^2

In summary, the comprehensive unit price of primary vacuum preloading is:
Jingwu + geotextile + sand cushion + plastic drainage plate + geotextile + vacuum preloading =18.45+16.92+79.13+43.56+10.15+62.03=230.24 yuan/m^2.
The thickness of sand cushion is calculated according to 1.2 meters, and two layers of jingwu and geotextile are laid respectively. The depth of plastic drainage plate is 18 meters, and the vacuum preloading is 100 days. In the actual engineering application, the integrated unit price of each single item can be adjusted according to the construction technology adopted so that the integrated unit price of vacuum preloading can be estimated accurately.
The comprehensive unit price of shallow and deep vacuum preloading is as follows (referring to the project cost of binzhou port no.2 port basin service area) :
Braided fabric + geogrid + geotextile + plastic drainage board + geotextile + shallow vacuum preloading + sand cushion + plastic drainage board + deep vacuum preloading =15.48+12.56+
12.1+10.15+41.49+84.39+38.72+65.73=297.8 yuan/m^2
The woven fabric and geotextile are considered as double layers. The insertion depth of the shallow plastic drainage plate is 5 meters, the shallow vacuum preloading time is 60 days, the sand cushion is 0.8 meters thick, the depth of the deep plastic drainage plate is 16 meters, and the deep vacuum preloading time is 120 days.
Based on the analysis of the price difference between the drainage slab, laying geofabric and laying jingwu in the comprehensive unit price of vacuum preloading and the project of jiaozhou project, it can be considered that there is a comparability with that of jiaozhou project.

2.3 Vacuum Combined Stowage Preloading

In the collected project data, no records of the vacuum coupling and stack-load preloading methods were applied. However, according to the process, its comprehensive unit price can be inferred as follows: vacuum preloading coefficient × vacuum preloading comprehensive unit price + stack-load preloading coefficient × stack-load comprehensive unit price, and the two removal coefficients can be 0.6-0.8. Therefore, the comprehensive unit price of vacuum combined stack-load preloading method is: 397.13~529.5 yuan/m^2.

2.4 Sand Fill Soil

The comparison of the cost of vacuum preloading of sand filled soil and fill soil under the same working conditions is shown in the table below.

Table 3 comparison of vacuum preloading cost between sand-filled soil and filled soil

Serial	Project	Unit	Quantity	Unit	Price	Remark	Total Price
1	Sand fill soil						97510696
	Medium coarse sand cushion	square	127455	124.78	15903914		
	Plastic drain plate		1631432	5.67	9250220		
	Sand fill soil	square	726497	63	45769317		
	Sandy gravel	square	114710	120	13765208	0.9 m thick	
	Some ram		127455	50	6372782	Some ram it twice	
	Full of ram		127455	50	6372782	Full ram it twice	
	Site leveling		127455	0.6	76473		
2	Vacuum preloading of						92207123

	fill soil						
	Land reclamation	square	739459	12.13	8969640		
	Shallow and deep vacuum preloading		127455	77.93	40446278		
	Ground fill	square	258742		20163764		
	Yard road				22627421		

In the above engineering examples, the processing area of soft foundation engineering is 127,500 square meters. Therefore, in the same project, the cost of sand land reclamation is 5303,573/127,500 higher than that of vacuum preloading =41.60 yuan /m².

3.5 Construction Technology of Solidified Soil

After consulting with professional subcontractors, the construction cost of adopting solidified soil construction technology is about 2-3 times of that of vacuum prepressing soft foundation treatment. Because the cost is too high, the owner did not use or conduct in-depth research.

4. CONCLUSION

Based on the data of binzhou, rizhao, Qingdao and other projects, the comparative analysis of technical applicability shows that if the construction is not required to speed up and the site conditions are better, the methods of stowage preloading and vacuum preloading should be adopted. According to the comparative analysis of economic rationality, it is found that the comprehensive unit price is from high to low for solidified soil, vacuum combined stack-load preloading, stack-load preloading, sand-filled soil and vacuum preloading. In conclusion, the vacuum preloading method is preferred in the north China coastal area.

ACKNOWLEDGMENT

Technical and economic analysis of soft foundation treatment of dredger fill in binzhou port

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