

## Construction Technology Points of Large Diameter Bagged Concrete Bored Pile

Zhong-Jiqing<sup>1,a</sup>, Ding-Siyuan<sup>2,b</sup>, Li-Yawei<sup>3,c</sup> and Ye-Dan<sup>4,d</sup>

<sup>1</sup> School of Civil Engineering, Chang'an University, Xi'an 710061, China

<sup>2</sup> School of Civil Engineering, Chang'an University, Xi'an 710061, China

<sup>3</sup> China Construction First Group The Second Construction Co.,Ltd., Beijing 102600, China;

<sup>4</sup> School of Civil Engineering, Chang'an University, Xi'an 710061, China

<sup>a</sup>email275875497@qq.com, <sup>b</sup>email1067899495@qq.com, <sup>c</sup>email980311772@qq.com

<sup>d</sup>email1175735451@qq.com

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**Abstract.** Large diameter bagged concrete bored pile has entered into the project practical stage as a new technology that guarantee the concrete durability in saline soil area, there is no construction norms, standards and test methods for large diameter bagged concrete bored pile at present. According to the expressway construction experience from Chaerhan salt lake to Golmud, the material requirements and construction methods of Large diameter bagged concrete bored pile were summarized, the characteristics of construction were analysed, and construction technology control key points were put forward.

### Introduction

In inland saline soil areas, the bridge pile and pier under the action of multiple factors such as load, freezing and thawing, saline soil (brine) corrosion and dry-wet alternate composite degradation would suffer from serious corrosion if it do not been taken reliable corrosive protection measures, which greatly shorten the bridge whole life and road safety operation<sup>[1]</sup>. In resent years, there are many research and engineering measures in this field, however, the problem have never been solved fundamentally. So to prevent concrete especially the underground concrete project from corrosion is still the global problem failed to solve completely.

“Large diameter bagged concrete bored pile technology<sup>[2]</sup>” covers that concrete is piled up by composite anti-corrosive bag including the advantages of corrosion resistance, long life, high strength, wear resistance, etc. The composite anti-corrosive bag makes the reinforced concrete isolated with saline soil (brine), it has an significant effect on preventing the pile contacting corrosive materials such as underground water (brine) , ensuring the concrete bored pile from corrosion and prolonging the service life of pile. Engineering practice shows that the adoption of the large diameter bagged concrete bored pile technology reduces the requirement of the underground concrete engineering and the additional corrosion protection measures, meanwhile it reduces the engineering investment. It provides effective technology for large-scale construction of high-grade highway bridges in inland saline soil areas. The paper summarized key points of construction quality control about the bagged concrete pile on the basis of engineering practice<sup>[3-4]</sup>.

### Concrete mixture ratio control

The concrete used for large diameter bagged concrete bored pile in addition to conform to the requirements of the general material, it also should meet some special requirements, such as concrete should have the property of high strength, high performance, low permeability, narrowed the resistance to crack, freezing-thawing resistance and high density, etc. The concrete can meet the

above requirements though using polyethylene fiber with the property of high strength and high modulus. This kind of concrete formed by adding slag, fly ash, fiber ,rust inhibitor and dispersant according to certain proportion<sup>[5]</sup>.

Some specific requirements are as follows<sup>[6-7]</sup>: concrete strength grade is C50, the slump of fresh concrete is  $200 \pm 20$ mm, the slump loss is not greater than 10% in one hour, air content of concrete mixture is about 4.0% ~ 7.0%, water-cement ratio is 0.30. The recommended mix proportion of low permeability and high performance concrete is shown in table 1. In addition, the anti-corrosion factor of concrete which in natural brine or saline soil six months is no less than 0.90, the frost resistance in the natural brine can reach D300, the diffusion coefficient of free chloride measured according to 90d natural diffusion method is no more than  $10 \times 10^{-8} \text{cm}^2/\text{s}$ .

**Table 1 Materials consumption of the unit cubic concrete**

cement	fly ash	slag	micro-silica	sand	gravel	corrosion inhibitor	water reducer	air entraining agent	water
390	60	120	30	686	1074	13.2	12.26	0.3	186
0.65	0.10	0.20	0.05	1.14	1.79	0.022	0.0204	0.0005	0.31

### The production control of anti-corrosive bag

Special anti-corrosive geotextile bags are applied to large diameter bagged concrete bored pile, the materials of bag are composite geotextile (three cloth two membrane), geotextile uses high strength woven geotextile with polypropylene (quality is  $170 \text{g/m}^2$  per unit area), geomembrane uses high density polyethylene (HDPE film) material (quality is  $300 \text{g/m}^2$  per unit area)<sup>[8]</sup>. The design of anti-corrosive geotextile bag pile diameter and pile length based on the engineering practice, the anti-corrosive geotextile bag is shaped in a processing factory, the seam is welded at the factory, the complete of corrosive protection bag should be checked ex-factory and the pile should be coated geotextile as a whole in the process of transportation. General requirements of geotextile bag is 100 mm greater than the diameter of pile and longer than the design length(4000mm) of pile, which ensures the perfusion bored pile close contact with wall of hole, to protect pile head and make waterproof treatment upper. The seams lap welding and lap width of geotextile bags are not less than 200mm. The anti-corrosive bag has many characteristics, such as corrosion resistance, permeability resistance, high strength, wear resistance, long life. The appearance and inflate of all anti-corrosive bag should be checked ex-factory, anti-corrosive bag qualified shows surface smooth, uniform thickness, no bulge fluff, no scratch injury and no pollution. In addition, the quality of anti-corrosive bag should satisfy the provisions in table 2, 3.

**Table 2 main technical indexes of anti-corrosive bag**

serial number	items	unit	guideposts
1	mass area ratio	$\text{g/m}^2$	$\geq 900$
2	Thickness (single cloth)	mm	$\geq 0.8$
3	Tensile Strength (pile length direction)	kN	$> 100$
4	Stretch Rate (pile length direction)	%	$< 30$
5	Stretch Rate(radial direction)	kN	$> 75$
6	Stretch Rate(radial direction)	%	$< 30$
7	Trapezoidal Tear Strength	N	$> 1500$
8	Ball Bursting Strength	N	$> 10000$
9	Vertical Coefficient Of Permeability	cm/s	$\leq 8 \times 10^{-11}$

**Table 3 quality requirements of anti-corrosive bag**

serial number	items	quality requirements
1	Deviation of Longitude and Latitude	Error compared with nominal density in 100 mm does not allow more than 2 root deficiency
2	broken wire	The same cross section are not allowed to have more than two broken wires
3	spider web	Web should not be greater than 50 mm, meanwhile no more than three within $100 \text{m}^2$
4	seam	a. Not allowed to open and fracture; b. When diameter of anti-corrosive bag $< 120 \text{cm}$ , it allows 1 seam; when $\geq 120 \text{cm}$ , it allows 2 seams; c. Lap length not less than 200 mm

5	pocket opening	pocket opening of anti-corrosive bag is tidy, no tear and burrs
6	pocket edges	not allowed to appear continuous length more than 200 cm of burrs and loose edge

## Construction Process Control

The construction craft process of large diameter concrete bored pile: leveling of ground→ construction copy pay-off flat→bury the tube→check the pile location→drilling position→drilling →washing hole→production and installation of anti-corrosive bag→production and installation of reinforcing cage→installation catheter→Underwater Pouring Concrete→ treatment of pile head→ maintenance of pile head<sup>[9]</sup>. Specific construction process control measures as follows:

(1) When poring, the remnants should be removed out hole in time to avoid too much remnants that may result in phenomenon of buried hole.

(2) Make effective technical measures for preventing slumping hole and reaming, the time interval between hole and concrete pouring in the construction should be shorten as far as possible for the purpose of preventing the hole collapse.

(3) Pore-forming should be stopped when meets these situations including inclined hole, curved hole, hole collapse and flow-up of grout around protecting tube, measures should be taken before construction.

(4) To prevent the construction site and the surrounding environment being polluted, the scores of drill holes should be cleared in time. The water level in hole should be keep 1.5 ~ 2.0 m above groundwater or the river water level in case of hole collapse.

(5) The joint, connection, welding and lap length of steel, as well as stirrup spacing must conform to the specifications and design requirements. Ensuring the steel reinforcement cage be vertical to avoid deformation and fell apart.

(6) When pouring underwater concrete, catheter export should lower than the concrete surface for avoiding broken pile. A person should be arranged to measure the embedded depth and height difference of concrete internal and external constantly, to ensure the continuity of concrete pouring.

## Construction quality control of large diameter bagged concrete bored pile

Through construction practice, construction quality control points<sup>[10]</sup> of large diameter bagged concrete bored pile are summarized as follows:

### 4.1 quality control points of anti-corrosive bag

Anti-corrosive bag should be taken protective measures in the process of construction, such as transportation, installation and injection, etc. The bags should be checked before sinking, meanwhile, reservation length and protective measures need to be paid attention. The bottom beam of anti-corrosive bag chooses plastic and hemp rope with the feature of high strength and low elongation. Anti-corrosive bag need to avoid being pricked by implements in the process of construction and pouring concrete.

### 4.2 quality control points of pore-forming

Pore-forming must adopt reasonable and matching drilling rig, on the condition of ensuring the index of drilling hole diameter and depth, the verticality of pore-forming also should be assured. The specific gravity of slurry, sand content rate and determination of viscosity should be paid attention in the process of pore-forming, to make sure the quality of the hole wall and avoid collapse hole in saline soil area.

### 4.3 quality control points of injection and drainage

The method of injection and drainage is key control point for bored pile, on the choice of mechanical equipment for slurry system should obtain reliable performance, the rigor of the interface need to be payed attention during the installation, when everything runs normal the construction of bag can be undertaken. The balance of injection rate and drainage rate should be ensured on the condition of injection and drainage smoothly, which is beneficial to make the bag close to the hole wall under action of mud and facilitate the devolution of reinforcing cage.

## Conclusions

(1) Compared with pile foundation construction not in saline soil area, due to the use of anti-corrosive bag and working procedure of injection and drainage, the cost of large diameter bagged concrete bored pile is higher than that of ordinary concrete piles. However, related to prefabricated steel pipe pile and driven pile, the anti-corrosive bag has lower cost because of its no need for large special equipment. Although the fine particle soil is very common in Chaerhan salt lake area, but driving into steel pipe pile has an influence on anti-corrosive coating which directly affect the service life of pile foundation. The testing results showed that pile bearing capacity of large diameter bagged concrete bored pile satisfied the design requirements, and the use of anti-corrosive bag had less influence on bearing capacity.

(2) In order to isolate pile concrete and saline soil (brine) completely, meanwhile improve the existence environment of pile concrete, anti-corrosive bag was packaged outside the pile, this lead to complicated construction technology compared to the common bored pile. The construction period would be increased if the anti-corrosive bag was not fully open when negative pressure or head pressure is too small.

(3) At present, there is no construction norms, standards and test methods for large diameter bagged concrete bored pile, the construction process, quality control method and testing standard need to be made according to current specification, this increased the difficulty of the engineering quality control. The paper summarized the construction quality control points of large diameter bagged concrete bored pile, meanwhile put forward the guidance for construction technology standardization, the specific control measures and control index quantitative work.

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