

Proposal / Quality Improvement of Cast-in-place Concrete Pile

Cast-in-place Concrete Pile (Geotextile Form)



Sung Woon Construction Company, Korea

Bi-Directional Static Test for Bored Piles (Self-leveling Osterberg Cell Test)



Korea Inspection and Technical Corporation

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1. Cast-in-place Concrete Pile[Fabric Liner(Geotextile Form)]

◆ Completed view



◆ Inside hole



◆ Fixing Device

Before concrete placement



After concrete placement



2. Issues and solution of Bored Pile

| ◆Friction-supported Bored Pile | |
|---|---|
| ◆Key Issues | ◆Solution |
| <ol style="list-style-type: none">1. The length is excessive.2. Large quantities are required, resulting in high construction cost.3. The bearing capacity per pile is low.4. Verification of bearing capacity is difficult.5. Economic feasibility is reduced.6. Quality control is difficult. Mortar washout, and No bleeding water discharge.7. Integrity verification is difficult.8. The defect repair cost are high. | <ol style="list-style-type: none">1. Increase the friction coefficient.2. Increase shaft friction capacity.3. Accurate verification of bearing capacity.4. Perform a load transfer test. (single level)5. Eliminate sacrificial steel pipes in offshore works by maximizing natural conditions such as hydrostatic pressure.6. Prevent contact between fresh concrete and groundwater. Permeable formwork applied.7. Prevention of mortar washout and intrusion of surrounding soil.8. Integrity Grade "A" achieved. |

2.1 Enhance Shaft Resistance of Bored Piles

◆Objective

1. Maintain the roughness of pile shaft surface.
2. Increase the compressive strength of concrete.

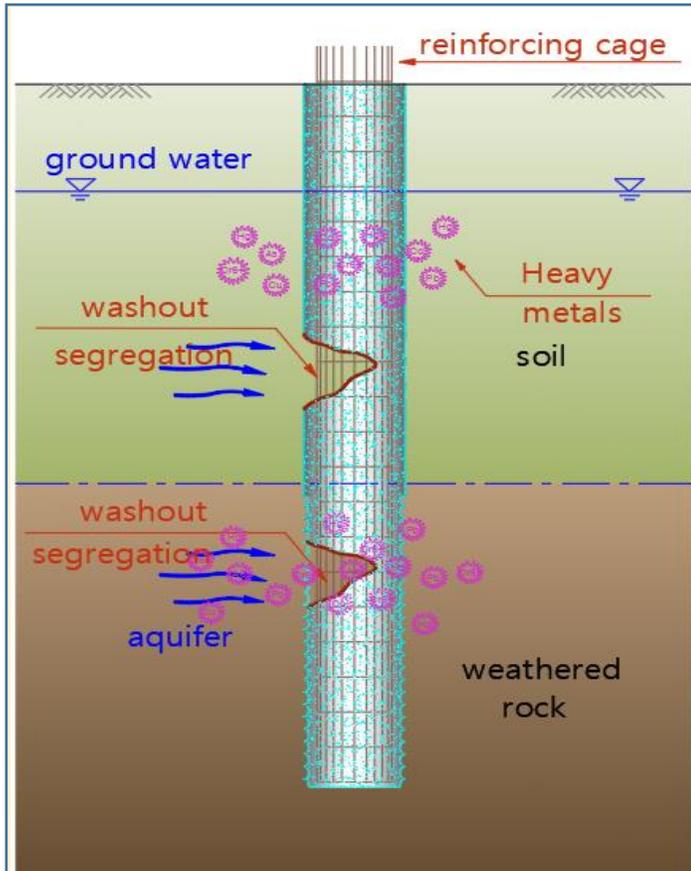
◆Execution Method

1. Minimize the use of sacrificial steel casing.
2. High-elongation geotextile formwork is used.
3. Prevent,
 - 3-1. Mortar washout due to groundwater flow,
 - 3-2. Ground water intrusion into fresh concrete,
 - 3-3. Soil intrusion into fresh concrete from the surrounding ground,
4. Discharge bleeding water by using permeable formwork.

◆**Suggestion** : In general soil layers, a geotextile formwork shall be installed. In deep water zone and soft soil layers($STP.N < 10$), the use of sacrificial steel casing is required.

3. Type of Cast-in-place Concrete Pile

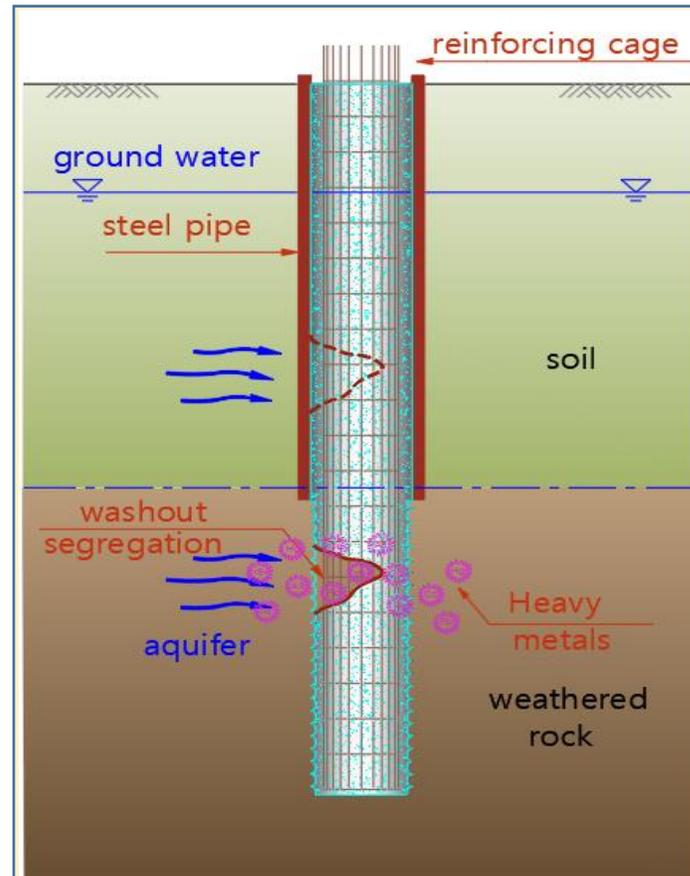
◆ Non-protected



◆ Washout : soil and weathered rock

◆ Heavy metals : soil and weathered rock

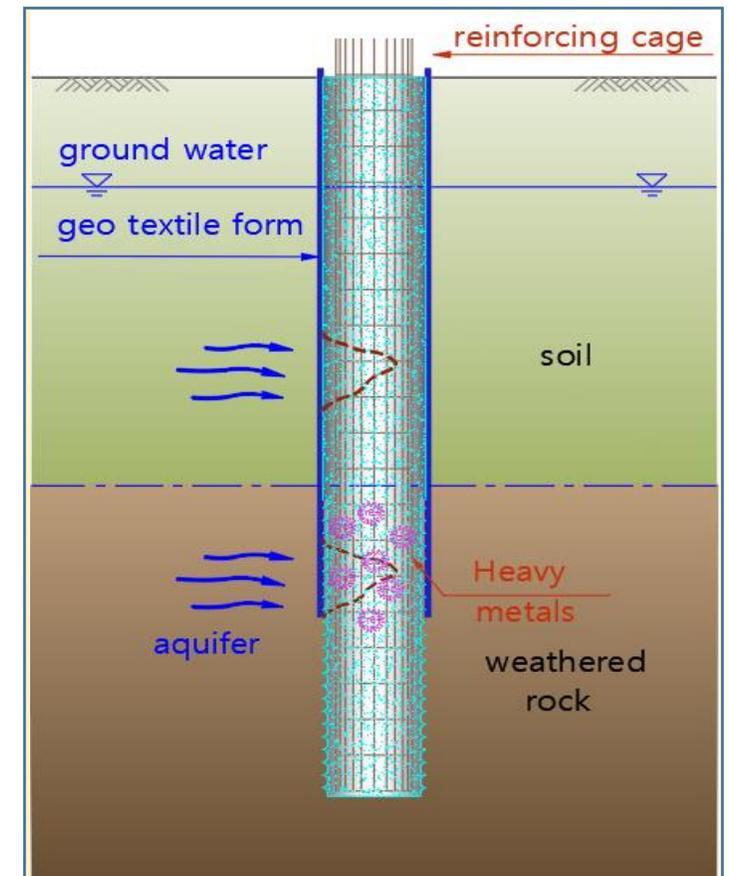
◆ Steel Pipe



◆ Washout : weathered rock

◆ Heavy metals : weathered rock

◆ Geotextile Form



◆ Washout : Nothing

◆ Heavy metals : Nothing

3.1 Comparison of Bored Pile Construction Methods

| ◆ Item | ◆ Unprotected | ◆ Sacrificial Steel Casing | ◆ Geotextile Formwork |
|---|--|---|---|
| <ul style="list-style-type: none"> ◆ Concrete compressive strength. ◆ Skin friction performance. ◆ Intrusion of surrounding ground. ◆ Intrusion of groundwater. ◆ Bleeding water discharge. ◆ Mortar washout. | <ul style="list-style-type: none"> ◆ Reduced ◆ Reduced ◆ Significant soil intrusion likely ◆ Groundwater freely intrudes. ◆ Not discharged. ◆ Highly likely due to groundwater flow. | <ul style="list-style-type: none"> ◆ Comparable to design strength. ◆ Limited improvement. ◆ Effectively prevented. ◆ Effectively blocked. ◆ Not discharged. ◆ Limited. | <ul style="list-style-type: none"> ◆ Improve compared to conventional methods. ◆ Enhanced due to improved surface condition and concrete quality. ◆ Prevented. ◆ Blocked while allowing controlled discharge. ◆ Selectively discharged through permeable formwork. ◆ Prevented. |

4.1 Standard Specification/Cast-in-place Concrete Pile

◆Original

2. Steel Shells and Pipes

The concrete shall be placed in one continuous operation from tip to cut-off elevation and shall be carried on in such a manner as to avoid segregation.

◆Alternative

2. Steel Shells and Pipes

The concrete shall be placed in one continuous operation from tip to cut-off elevation and shall be carried on in such a manner as to : ① avoid segregation, ② to prevent mortar washout due to groundwater flow, and ③ to prevent groundwater contamination by heavy metals contained in fresh concrete.

4.2 Standard Specification/Cast-in-place Concrete Pile

◆Original

3. Drilled Shafts

Other ground conditions where caving, squeezing or sloughing soils are present **require installations of steel casing or use of a slurry for support of the hole.**

Such conditions and techniques may result in losing of soil around the shaft, or **altering of friction resistance between the concrete shaft and surrounding soil.**

◆Alternative

3. Drilled Shafts

Other ground conditions where caving, squeezing or sloughing soils are present **require installations of steel casing or use of a slurry for support of the hole.**

Such conditions and techniques may result in losing of soil around the shaft, or **altering of friction resistance between the concrete shaft and surrounding soil.**

permanent casing does not necessarily reduce the shaft-soil frictional resistance, because the rough surface of the permanent casing can maintain adequate interface friction with the surrounding soil.

4.3 Standard Specification/Cast-in-place Concrete Pile

◆Original

It is preferred that drilled shafts be constructed in stable non-sloughing soil without excessive ground water,

If impossible, consider the following three different methods.

- a. The construction of the pile of shaft in wet condition while the walls of the excavation are **① stabilized by hydrostatic pressure of water or**

◆Alternative

It is preferred that drilled shafts be constructed in stable non-sloughing soil without excessive ground water,

If impossible, consider the following three different methods.

- a. The construction of the pile of shaft in wet condition while the walls of the excavation are **① stabilized by hydrostatic pressure of water, stabilized the excavation walls by maintaining a water head at least 4m higher than the surrounding groundwater level or**

4.4 Standard Specification/Cast-in-place Concrete Pile

◆Original

② a mineral slurry until the concrete is placed by tremie methods for the full length of pile.

Temporary casing shall be removed while the concrete remains workable

③ The use of a permanent casing which is left in place within the portion of the pile which is in unstable material.

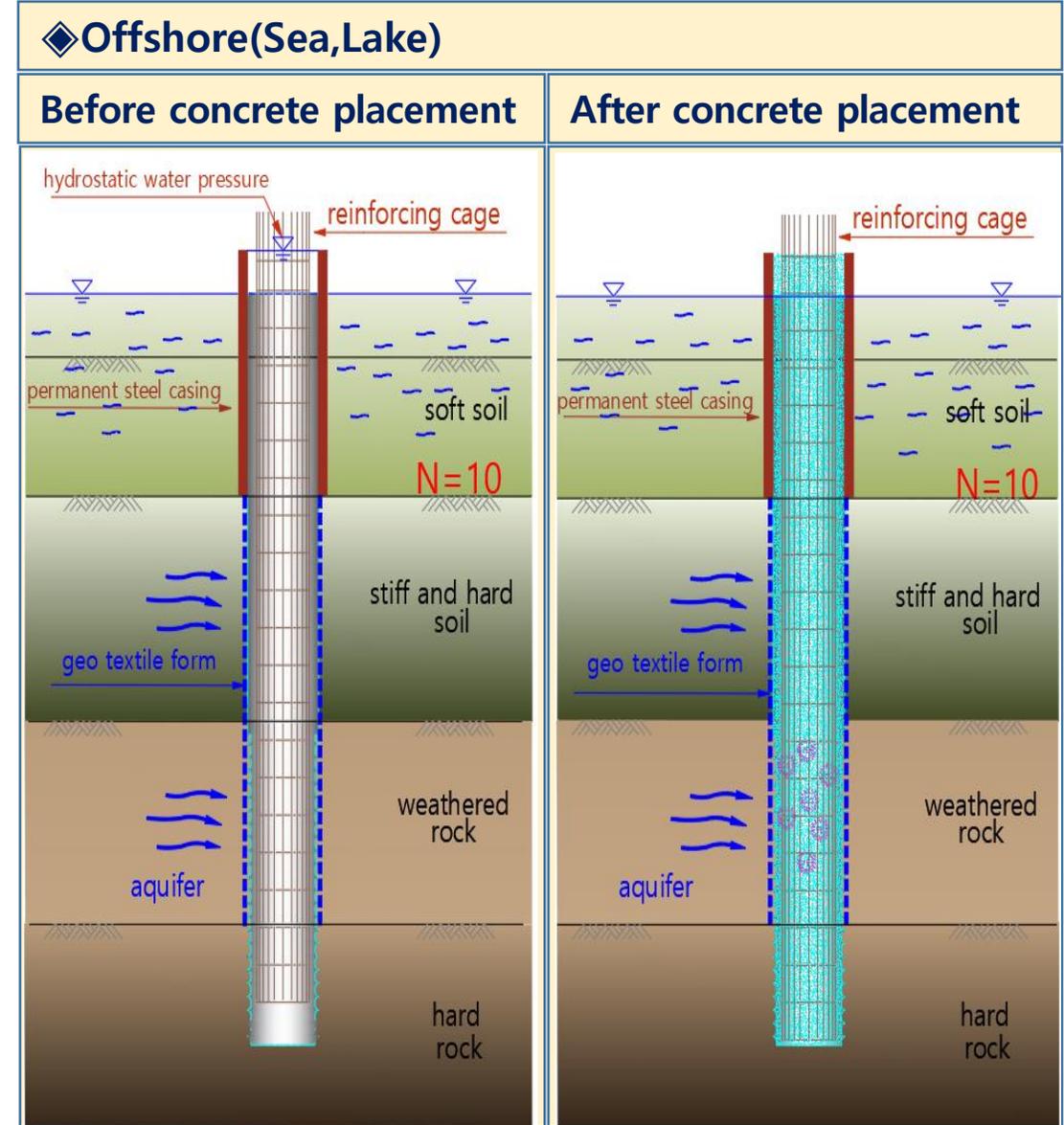
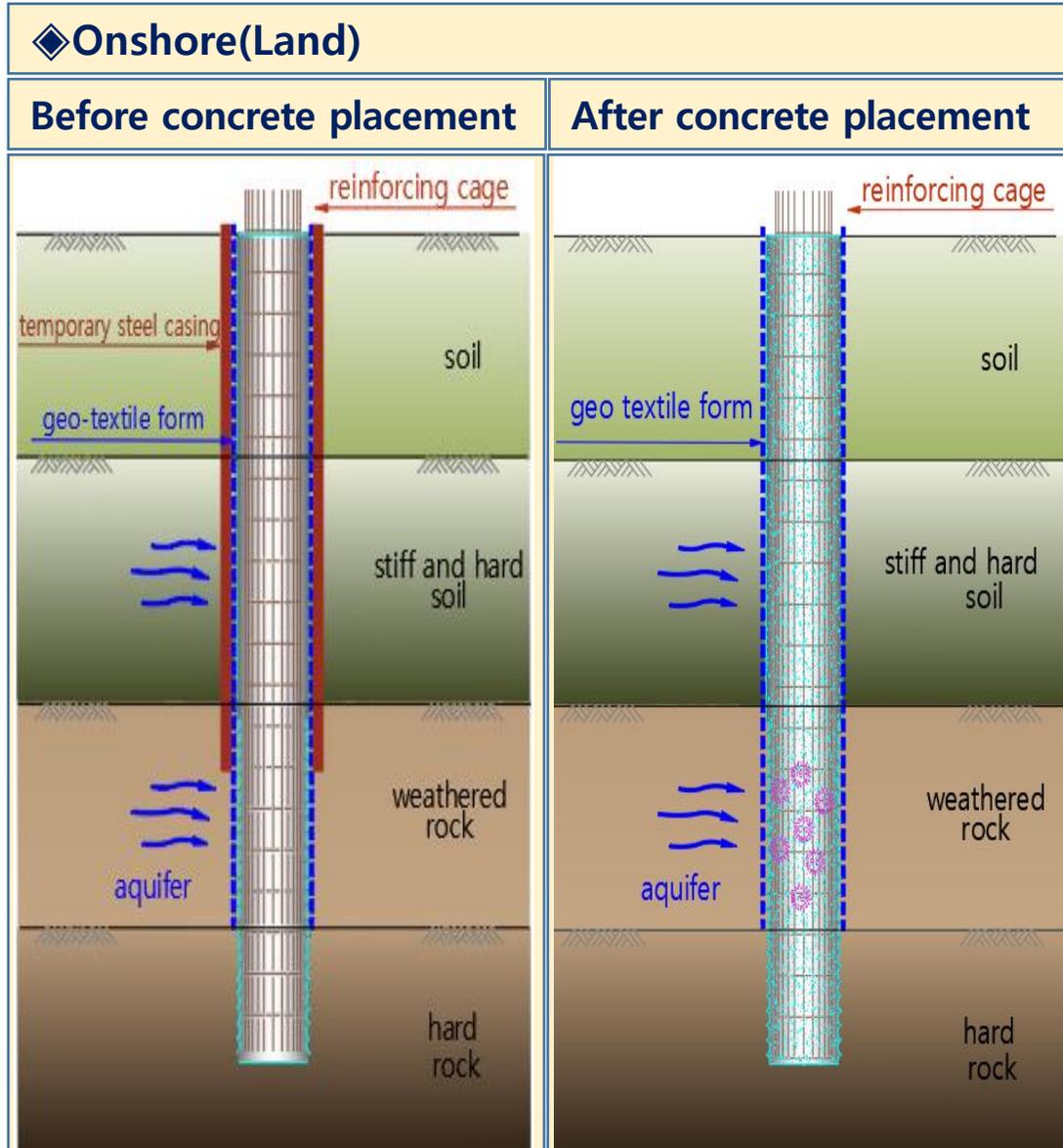
◆Alternative

② a mineral slurry until the concrete is placed by tremie methods for the full length of pile.

Temporary casing shall be removed while the concrete remains workable. Fresh concrete shall be adequately protected with formwork to prevent surrounding soil from intruding

③ The use of a permanent casing which is left in place within the portion of the pile which is in unstable material. The permanent casing shall be fabricated from ductile materials and shall be provided with a roughened exterior surface to ensure adequate interface friction. Steel pipe casings, due to their smooth surface and high stiffness, may result in reduced frictional resistance with surrounding soil.

5. Typical section of Cast-in-place Concrete Pile

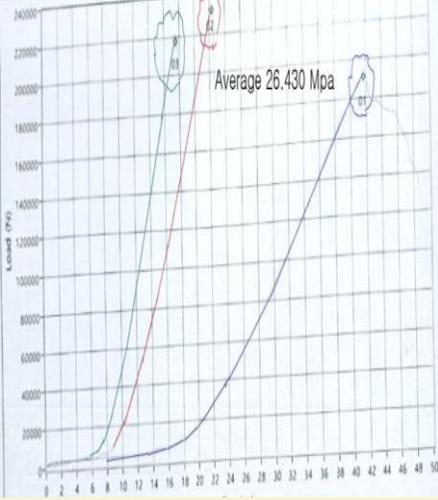
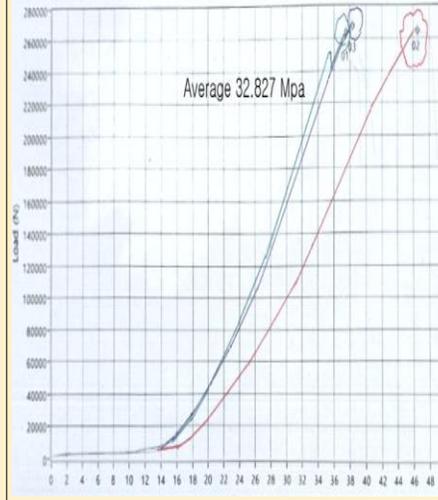


6. Effectiveness of Cast-in-place Concrete Pile

◆ Cast-in-place concrete pile with Geotextile formwork

- 1. Structural Stability** : Increased frictional resistance and friction coefficient due to enhanced surface roughness. [frictional coefficient : (steel pipe : 0.15.). (geotextile form work : 0.35)].
[extension rate : over 15%]. [coefficient of permeability : $10^{-2} \sim 10^{-4}$]
[seam strength : over 50% of the fabric tensile strength]
- 2. Concrete Quality and Quantity** : Compressive **strength increased by approximately 20%**.
As no contamination from surrounding water occurs, and Bleeding water discharge
Reduce the concrete quantity loss rate to below 4%(Unprotected,15%)
- 3. Integrity Grade "A"** : Mortar no washout and no contamination from surrounding soil sloughing.
because of protection by Geotextile formwork.
- 4. Environmental Performance** : No groundwater pollution from heavy metals(Cr^{6+} ,Hg,Pb) is observed.
Compared to steel pipe casing,Geotextile form reduces **Carbon emissions by approximately 70%**
- 5. Economic Feasibility** : Lower cost of geotextile formwork compared to steel pipes.
Geotextile form accounts for approximately 30% of the steel pipe price.
- 6. Constructability** : Easy application using existing equipment and manpower.

7. Comparison Table of Economic and Strength

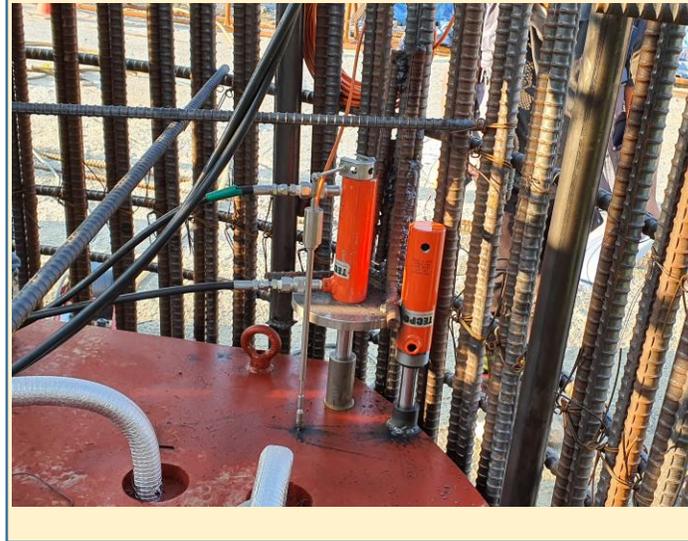
| ◆Economic Feasibility | | | ◆Compressive Strength | | |
|-----------------------|--|--|-----------------------|---|---|
| Item | Sacrificial Steel Casing | Geotextile Form | Item | Unprotected concrete | Protected Concrete |
| Dimension | D = 2,000 mm | | Test Method | Concrete Core Compressive Strength | |
| product Image |  |  | Test Result |  |  |
| Cost (PHP/m) | PHP 53,000 | PHP 17,300 | Average Strength | 26.4Mpa | 32.8Mpa |
| Difference (PHP/m) | PHP 35,700 / m | | Difference | 6.4Mpa(24% ↑) | |
| Assessment | <ul style="list-style-type: none"> ▶ The cost of geotextile formwork approximately 32% of that of sacrificial steel casing. ▶ For offshore construction, sacrificial steel casing is adopted in deep-water and soft ground where the N-value is below 10, while geotextile formwork is applied in general soil layers. | | Assessment | <ul style="list-style-type: none"> ▶ The compressive strength of protected concrete was 26% higher than that of the unprotected concrete. ▶ Bored piles with unprotected concrete must be designed with a 24% larger diameter or higher mix design strength, making them economically inefficient. | |

8. Bi-directional Static Load Test(Self-Leveling Osterberg Cell)

◆ Completed view



◆ Leveling device and adjust Jack



◆ Measurement of Level



9. Standard Specification/Bi-Directional Static Load Test

◆Original

TEST PILE PREPARATION

A single level bi-directional cell assembly will be installed in the test pile along with the necessary hydraulic system and instrumentation attached to the steel reinforcing cage.

◆Alternative

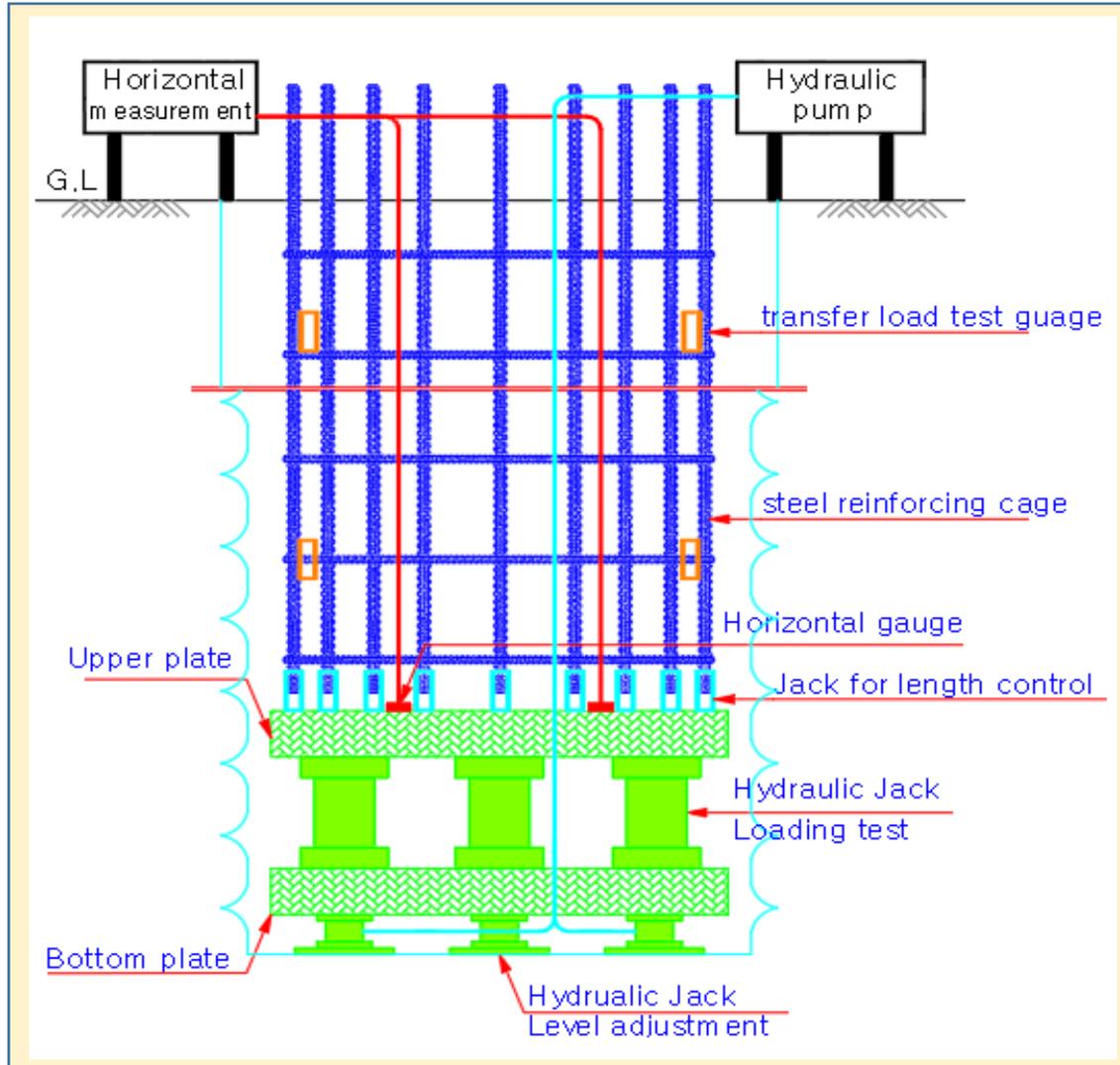
TEST PILE PREPARATION

A single level bi-directional cell assembly will be installed in the test pile along with the necessary hydraulic system and instrumentation attached to the steel reinforcing cage. **Inspection of a single-level bi-directional cell system shall be conducted twice :**

- ① Prior to installation of the reinforcing cage, and**
- ② At the bottom of excavation after placement of reinforcing cage, in accordance with the inspection procedure approved by the supervising engineer.**

10. Typical section and Effectiveness of Bi-directional Static Load Test

◆ Typical section

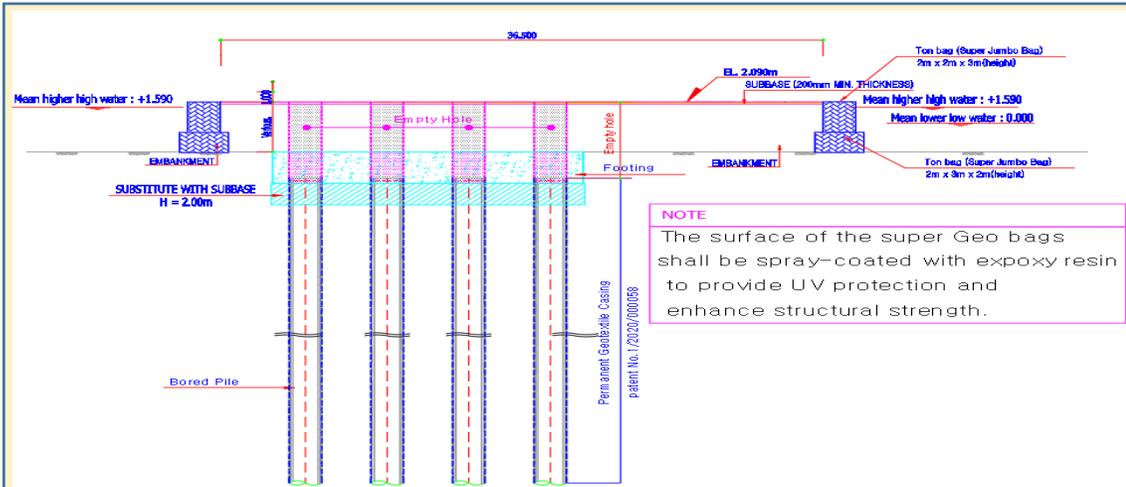


◆ Effectiveness

- 1. Accuracy Of test result**
: Installed a single level (horizontally)
- 2. Definitive verification of skin friction**
: load transfer test
- 3. Ensure structural safety**
: Prevention of settlement
- 4. Ensure economic feasibility**
: Optimum pile length
(Pile length adjustment base on test pile result)
- 5. Collection of design parameters**
: Comparison between design and construction results
(application of actual shaft friction to the design)

11. Construction access road using super Geobag

◆ Typical section



◆ Effectiveness

1. Structural stability

: Gravity Retaining Wall

2. Safety against wave action

: The unit weight of each bag exceeds 10 tons

3. Extension of Durability

: Epoxy resin surface treatment for UV protection

4. Economic feasibility

: Filling material using Soil or Soil cement

5. Eco-friendly construction method

: Materials free of heavy metals

6. Constructability

: Does not require skilled labor and specialized equipment

12. Certification

◆ Korea Patent

Cast-in-Place Concrete Patent



특허증
CERTIFICATE OF PATENT

특허 제 10-2000104 호
Patent Number

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발명의명칭 Title of the Invention
토목성유거부입을 이용한 지하의 수중구조물과 그 시공방법

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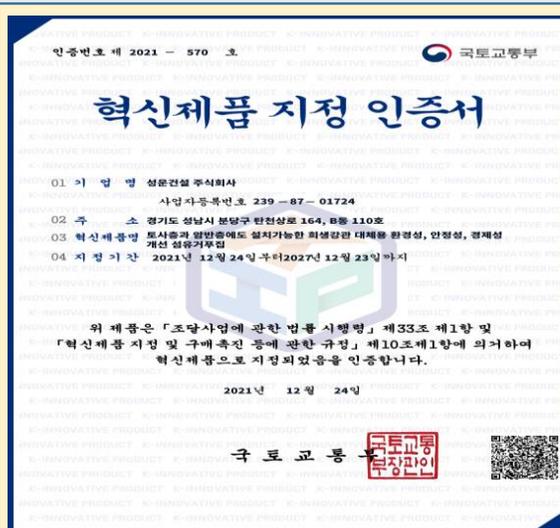
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경기도 용인시 수지구 대지로 49_203동1303호(죽전동,죽전퍼스트아파트)

위의 발명은 「특허법」에 따라 특허원부에 등록되었음을 증명합니다.
This is to certify that, in accordance with the Patent Act, a patent for the invention has been registered at the Korean Intellectual Property Office.

2025년 01월 21일

특허청장
COMMISSIONER
KOREAN INTELLECTUAL PROPERTY OFFICE
김완기

Innovative Technology Product



인증번호 제 2021 - 570 호
Innovation Certificate No.

국토교통부
Ministry of Land, Urban and Planning

혁신제품 지정 인증서

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사업자등록번호 239 - 87 - 01724

02 주소 경기도 성남시 분당구 탄현상로 164, B동 110호

03 혁신제품명 토사층과 암반층에도 설치가능한 대체용 환형성, 안정성, 경제성 개선 실용거부입

04 지정기간 2021년 12월 24일부터 2027년 12월 23일까지

위 제품은 「조달사업에 관한 법률 시행령」 제33조 제1항 및 「혁신제품 지정 및 구매촉진 등에 관한 규정」 제10조제1항에 의거하여 혁신제품으로 지정되었음을 인증합니다.

2021년 12월 24일

국토교통부
Ministry of Land, Urban and Planning

Super Geobag Patent



특허증
CERTIFICATE OF PATENT

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Registration Date

발명의명칭 Title of the Invention
이음부위의 안정강도를 향상시킨 토목성유를 활용한 초대형 마대 및 그 제작방법

특허권자 Patentee
용목사항안에 기재

발명자 Inventor
박서진(091017-*****)
경기도 용인시 수지구 대지로 49_203동1303호(죽전동,죽전퍼스트아파트)

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This is to certify that, in accordance with the Patent Act, a patent for the invention has been registered at the Ministry of Intellectual Property.

2026년 01월 05일

지식재산청
MINISTER
MINISTRY OF INTELLECTUAL PROPERTY
김용선

Bi-directional Static Test Patent



특허증
CERTIFICATE OF PATENT

특허 제 10-2193922 호
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발명의명칭 Title of the Invention
수평축상 및 수평축하가 용이한 양방향재하시험기 및 이를 이용한 시험방법

특허권자 Patentee
용목사항안에 기재

발명자 Inventor
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This is to certify that, in accordance with the Patent Act, a patent for the invention has been registered at the Korean Intellectual Property Office.

2024년 01월 15일

특허청장
COMMISSIONER
KOREAN INTELLECTUAL PROPERTY OFFICE
김완기

◆ Philippines Patent

Cast-in-Place Concrete Philippines Patent



LETTERS PATENT INVENTION

PATENT NO. 1/2020/000058

Having complied with the provisions of Republic Act No. 8293 and its regulations, this Office certifies that this Patent was granted on **8 June 2022** with a term until **19 February 2040**, unless otherwise earlier cancelled, lapsed, or forfeited.

This patent grants to the holder the right to restrain, prohibit any unauthorized person or entity from making, using, offering for sale, selling or importing a product (if a patented product) and importing any product obtained directly or indirectly from such process (if a patented process).

Patentee:
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Title of the Invention:
UNDERGROUND UNDERWATER STRUCTURE USING GEOTEXTILE FORM AND CONSTRUCTION METHOD THEREOF

Inventors:
PARK, Seo-Jin [Gyeonggi-do, KR]

Publication Date:
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Atty. LOLIBETH R. MEDRANO
Director of Patents

INTELLECTUAL PROPERTY OFFICE OF THE PHILIPPINES
Bureau of Patents