Registration No.0107537000939

# ITALIAN-THAI DEVELOPMENT PUBLIC COMPANY LIMITED

**Date:** 11 July 2017

**Ref No. :** ITD/CP-03&04/NKDM/MS0004

NKDM Association
House No. 8/B, Road No. 29
Gulshan-1, Dhaka-1212, Bangladesh
Telephone No. +880-2-9894986/87
Facsimile Nmber: +880-2-9894974

For the Attention of: Mr. Takayuki FUJITOMI
Acting Team Leader

**Subject:** **Submission of the Method Statement for Bored Pile Construction**
Consolidated Contract for Contract No. CP-03 "Construction of Viaducts and Elevated Stations (Uttara North, Uttara Center, Uttara South, and Pallabi) between Uttara North and Pallabi", and Contract No. CP-04 "Construction of Viaducts and Elevated Stations (Mirpur 11, Mirpur 10, Kazipara, Shewrapara and Agargaon) between Pallabi and Agargaon" for MRT LINE 6.

Dear Sir,

Pursuant to Particular Specifications, Part 02, Sub-Clause 2, 4, and 5 we would like to submit for your kind approval the Method Statement for Bored Pile Construction so that we can further take the required actions.

Your kind attention and favourable response would be highly appreciated.

Yours faithfully,
For and on behalf of
**Italian-Thai Development Public Company Limited**

Thawit Yuenyong
Project Manager

Encl. 1) Method Statement for Bored Pile Construction 48 Pages

CC: Md. Aftabuddin Talukder, Project Director of DMRTDP

Procedure for Submission of Documents

# SUBMITTAL FORM

| Submittal No. | | | | | | | Date: |
|---|---|---|---|---|---|---|---|
| ITD | MS | CP03-04 | Location | Type | No. | Rev. | 11 July 2017 |
| | | | ALL | GN | 0004 | 01 | |

Purpose ☐ R ☑ A ☐ Inf. ☐ Rec.

To : Mr. Takayuki FUJITOMI

Title : Method Statement for Bored Pile Construction

Discipline : Method Statement

Spec. Section/Clause: Particular Specifications, Part 02, Sub Clause 2, 4 and 5

CC : Mr. Syed Ahmed

Sub-Contractor/Supplier: _____

| For Contractor Use | | | For Employer or Employer's Representative Use | | | | | |
|---|---|---|---|---|---|---|---|---|
| Item No. | Description | Rev. | Date Received : Review Status | | | | Date Returned | Employer / Rep |
| | | | NONO | NOO | NONOC B | NONOC C | | |
| 1 | Method Statement for Bored Pile Construction | 01 | | | | | | |
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All items submitted have been checked, reviewed and co-ordinated by the Contractor. They are in conformance with the requirements of the Contract Document, except as noted, and are approved by the Contractor for this Project.

Detailed Comment Review Attached Ref.No.:

Reviewed and Status Confirmed By:

( )

Prepared by :

(Mr. Withoon Jiradamkoeng)

Date : 11/07/2017

Reviewed and Approved :

(Mr. Thawit Yuengoke)
Project Manager

Date :

Title:

Date:

Note :

Purpose
R = For Review
A = For Approval
Inf. = For Information
Rec = For Record

NONO : Notice of No Objection
NOO : Notice of Objection (With 'A' Comments)
NONOC : Notice of No Objection with Comments (With 'B' and/or 'C' Comments)
Note: Acceptance of ER does not relieve the Contractor of its Contractual Obligations

MASS RAPID TRANSIT DEVELOPMENT PROJECT IN DHAKA
(LINE) (VI)
CONTRACT CP-03 & CP-04

# METHOD STATEMENT
# FOR
# BORED PILE CONSTRUCTION

**Document No. ITD/CP03-04/MS/ST005, Rev. 01**

**PREPARED BY:**

**ITALIAN-THAI DEVELOPMENT PUBLIC COMPANY LIMITED**

ITALIAN-THAI DEVELOPMENT PUBLIC COMPANY LIMITED

# DHAKA MASS RAPID TRANSIT DEVELOPMENT PROJECT
# CONSTRUCTION OF VIADUCT AND ELEVATED STATIONS
# CONTRACT No. CP-03 & CP-04

**ITD DOCUMENT NO.:** ITD/CP03-04/MS/ST005

**REVISION:** 01

**TITLE:** METHOD STATEMENT FOR BORED PILE CONSTRUCTION

## AUTHORISATION

| Prepared by: | Reviewed by: | Approved by: |
|---|---|---|
| (Mr. Withoon Jiradamkoeng)<br>QA Engineer<br>Date: 11/07/2017 | (Mr. Wisan Kittichaikulkit)<br>QC Manager<br>Date: 11/07/2017 | (Mr. Thawit Yuenyong)<br>Project Manager<br>Date: 13/7/17 |



## AMENDMENT/RELEASE RECORD

| Revision No. | Issue Type | Description of Amendment/Release | Effective Date |
|---|---|---|---|
| 01 | C | For Employer's Representative's approval | July , 2017 |
| | | | |
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| | | | |
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Type of Issuing: "A" For Acknowledgement & Information & Reference; "R" For Internal Review & Comment; "C" For Employer's Representative's approval; "U" For Internal Using and/or replacing the existing one.

# CONTENTS

## 1.0 GENERAL/SCOPE

This set of documents describes the procedure for bored pile construction including relevant materials and equipment to be executed for Dhaka Mass Rapid Transit Development Project, Contract No. CP-03 & CP-04.

Work shall be done according to this method statement and the use of materials, tools and equipment stated herein in order to achieve a quality of work pursuant to relevant specification and working procedure.

Relevant operatives and staff/engineers shall be throughly trained in the methods and skills required prior to performing their tasks.

## 2.0 SPECIFICATIONS AND REFERENCE DOCUMENTS

Relevant specifications are contained in Work Requirement, Section XI: Specification – Particular Specifications, Part 02, as follows:

a. Sub Clauses 2: Bored Cast in situ Pile Foundation
b. Sub Clauses 4: Concrete for Structure
c. Sub Clauses 5: Reinforcement for Structures

## 3.0 MATERIALS

### 3.1 Stabilizing Fluid

#### 3.1.1 Polymer Slurry

Ionic synthetic polymer based drilling slurry may be used.

The slurry will be prepared by mixing fresh water with appropriate polymer.

The fresh slurry shall have the following properties;

| Material | Quality | Unit |
|---|---|---|
| Polymer per $m^3$ of slurry | 0.5-0.8 | Kg |
| pH | 8-12 (by pH Dispenser) | - |
| Viscosity | 30-50 | sec |

The main characteristics of the polymer slurry at various stages during the construction process will be as follows:

| Compliance Values | |
|---|---|
| **Property** | **Prior to Concreting** |
| Density | <1.05 g/ml |
| Viscosity | 40 - 90 sec. |
| pH | 8-12 |

### 3.1.2 Bentonite Slurry

The slurry will be prepared by mixing fresh water with the appropriate bentonite power, complying with Specification The American Petroleum Institute Standard 13A, or equivalent approved by the Employer's Representative(s).

It is expected that the slurry will have the following composition (1 cubic metre):

| Material | Quality | Unit |
|---|---|---|
| Water | 970-985 | l |
| Bentonite | 40-60 | Kg |

The main characteristics of the bentonite during the construction process will be as follows:

| Compliance Values | |
|---|---|
| **Property** | **Range of Results at 20°C** |
| Density | <1.10 g/ml |
| Viscosity | 30-50 sec. |
| Sand Content | < 3 % |
| pH | 9.5-12 |

## 3.2 Concrete and Reinforcement

The characteristics of concrete and reinforcement will be as per Contract Documents, Work Requirement, Section XI: Specification – Particular Specifications, Part 02, Sub Clauses 4: Concrete for Structure. It will have a minimum compressive strength as per specification requirements.

### 3.2.1 Spacers

The spacers will be normally made of concrete as shown on the drawing. The shape will be made as circled, and will be submitted prior to commencement of the works.

## 3.3 Binding Wire

Reinforcement binding wire shall be best black annealed mild steel wire, approximately 1.6 mm in diameter.

# 4.0 RESOURCE, EQUIPMENT AND FACILITIES

The equipment for this operation shall be listed as follows:

## 4.1 Crane

Mechanical Crawler Crane (50 to 70 Tons capacity) will be used for lifting & logistics supports.

## 4.2 Rotary Equipment

Pile boring will be carried out by Self Erecting Hydraulic Rotary Rig or Mechanical Rotary Rig.

The equipment consists of a rotary table which imparts a rotary movement to a kelly bar to the bottom which attached a drilling tool (bucket or auger).

## 4.3 Cage Installation

A service crane of appropriate load capacity will be used to install the reinforcing steel cage.

## 4.4 Tremie Pipe

The tremie pipe will be composed by steel pipe elements, with inner diameter of 150 mm for concreting of pile of smaller diameter ( 500mm to 800 mm) and inner diameter 200-300 mm for concreting of pile diameter (900 mm to 2200 mm). They will be connected to each other through either threaded or rope joint couplings. The stem will be topped by a funnel.

## 4.5 Slurry Mixing and Storage Plant

Generally, the plant will be placed within the limits of the working areas. The following equipment will be used for preparation and storage of the slurry:

a. Mixer, i.e. Soilmec BE10-ED 8-10 $m^3$/hr capacity and/or similar;
b. Tanks for the hydration;
c. Tanks for the regeneration; and
d. Circulation pumps (to maintain the slurry in agitation).

The tanks are interconnected with pipes and connected to the excavation with pipes and pumps, in order to maintain constant the level of the slurry into the excavation. The amount of reserve slurry will be sufficient to allow the excavation of bored pile with a safe stock.

## 4.6 Survey Tools

Relevant survey tools are Theodolite, Level, Measuring Steel Tape and Staff.

## 4.7 Personal Protective Equipment

Relevant Personal Protective Equipment is Helmets, Safety Shoes, Goggles, Reflective vest and Masks.

## 4.8 Sonic Borehole Measurement Test (Called “Koden Test”)

Technical literature on Koden Ultrasonic Drlling Monitor can be found within Attachment 5.

## 5.0 PROCEDURE

Survey marks, to control the position of each pile shall be set and approved before starting boring operations.

A reasonable firm and level area is required for the piling plant. A plan of the site layout, including stabilizer slurry plant, office areas and areas required for the stockpiling of materials etc. shall be submitted for approval prior to the commencement of the works.

### 5.1 Preparation

#### 5.1.1 Site Installation

Prior to the commencement of the Works, where it is deemed necessary, a platform suitable to bear all the equipment involved in the construction of the bored pile will be installed. This platform will consist of a reinforced-concrete slab or steel decking platform.

Site facilities for the construction of the bored piles shall be installed, including areas required for polymer plant, cage fabrication and storage.

#### 5.1.2 Setting Out

Prior to each setting out phase, the availability of updated and accepted construction drawings will be checked. Survey marks to control the position of each pile shall be set out and approved before commencement of boring operations.

#### 5.1.3 Reinforcing Cage Fabrication

The steel reinforcement cages will be constructed according to the relevant specifications contained in Work Requirement, Section XI: Specification – Particular Specifications, Sub Clauses 5: Reinforcement for Structures. The steel cages will be assembled and properly stored close to the fabrication area. The handling and placing of cages will be performed by means of a crawler crane of suitable lifting capacity. The cage elements will be joined together with u – clips and/or tie wire, mechanical coupler as required by approved construction technical drawing.

During fabrication, careful controls will be carried out to ensure the cage is installed within the allowable specification tolerances.

#### 5.1.4 Rotary Equipment

Pile boring Rig will be rotary mount on suitable crawler crane and/or carried out by a fully hydraulic self – erecting Hydraulic rig.

The equipment consists of a rotary table which imparts a rotary movement to a kelly bar to the bottom which attached a drilling tool (bucket or auger).

### 5.2 Construction of Bored Pile

#### 5.2.1 Temporary Casing Installation

After setting out of the pile location by a surveyor, a temporary casing will be installed prior to the excavation to support the upper layer of weak soil.

Casing installation will be performed by Hydraulic Rotary Rig itself and hydraulic vibrohammer will be used if necessary.

The vertical accuracy of the casing will be checked during the installation process with a level device.

### 5.2.2 Drilling Process

The bored holes will be stabilized with a temporary casing in the upper soft layer and with slurry from bottom of casing until final depth.

During the boring operations, the drilling tool is rotated and lowered into the ground. As it digs into the soil, the bucket or auger gradually fills with the soil and when it is full, the kelly bar and drilling tool are lifted and the drilling tool emptied.

After the temporary casing has been installed, boring will commence with auger and will continue with same until the bottom of the temporary casing. The bored hole will then be filled up with bentonite slurry before advancing the drilling process.

Boring will be continued to the final depth using a bucket. The buckets are designed in such a way to prevent excessive suction when lifting the tool.

The level of the fluid in the excavation shall be maintained so that the fluid pressure always exceeds the pressure exerted by the soils and external ground water.

Special care must be taken in the horizontal position of the crane/rigs and vertical positioning of the kelly bar to ensure that vertical drilling will be achieved.

### 5.2.3 Final Pile Toe Level Measurement

Control and measure the bulging, necking, inclination and final pile toe level by Sonic Borehole Measurement Test (Koden test).

The result shall be presented by the contractor on diagrams showing clearly the scale of the measurements.

### 5.2.4 Pile Base Cleaning

Before placing concrete, measures shall be taken to ensure that there is no accumulation of sediment at the base of the boring which could impair the free flow of concrete from the tremie pipe.

a. Bentonite Slurry

A sample of the bentonite suspension shall be taken from the base of the boring using a sampling device.

If the density of the suspension exceeds 1.25 g/ml the placing of concrete shall not proceed.

In this event the quality of the mud shall be modified by the use of air - lifting and desanding devices.

The bentonite desanding units are specially designed for separation of sand, silty and organic particles in the mud recovery system.

The sediment from the slurry can be efficiently eliminated by the combined operation of the hydrocyclone and vibroscreening system of the desanding equipment.

b. Polymer Slurry

In case of Polymer slurry, cleaning tools will be used for base cleaning. Polymer usually helps to settle solid soil particle to bottom in 30 minutes and sedimented solid soil and sand can be removed from bore hole bottom with cleaning bucket by Hydraulic Rotary Rig.

### 5.2.5 Discharging of Spoil

The spoil will be discharged nearby the pile location into soil tanks and then removed from the site to the approved disposal area.

### 5.2.6 Installation of Reinforcement Steel Cage and Sonic Pipe

The steel cage preassembled in as many sections as needed and complete with the appropriate spacers and stiffeners will be lowered into the hole by a service crane.

The amount, type and size of steel will be according to the approved drawing and specifications.

Lap splices as shown in the drawings shall be connected by U-clips, tie wire and mechanical coupler as required by approved construction technical drawing.

The vertical sonic pipe diameter 50 mm. exactly parallel steel pipes shall be inserted and fastened to the inside of the reinforcement cage before concreting. The elevation of the bottom ends of the pipes must be such that they are embedded in concrete, and do not protrude below the base of the pile.

The number and spacing of vertical sonic logging pipe are depend on size of bored pile and are summarized as below table.

| Bored Pile Diameter | No. of Tube | Tube Spacing (Degree) |
|---|---|---|
| 1,000 mm. | 3 | 120 |
| 1,200 mm. | 3 | 120 |
| 1,500 mm. | 4 | 90 |
| 1,800 mm. | 4 | 90 |
| 2,000 mm. | 6 | 50 |

### 5.2.7 Concreting

The pouring operation is a very important aspect of the pile execution and must be performed with special care. The flow of concrete must be constant. The tremie pipe must be submerged to the minimum depth of 2 m. in the mass that has already been poured.

Concreting will proceed continuously until the designed head of pile level is achieved, and sufficiently thereafter to allow for subsequent cutting back to sound concrete at the head level.

At the completion of concreting the temporary casing will be withdrawn by the Vibrohammer.

## 6.0 SAFETY PROVISIONS

a. Movement of heavy equipment shall be done under close supervision of highly skill person when working close to near-by traffic.

b. Suitable Personal Protective Equipment (PPE) of all workforce will be enforced.

c. All trailers, truck mixer and mobile cranes used for piling work must be driven carefully.

d. All persons entering the construction areas must be induced in accordance with the safety plan procedure.

e. Cutting piles and rebar must be carefully operated. Gloves must be used during pile cut-off.

f. All operatives must wear safety belts during working at height.

g. All operatives being outdoors must stop working during heavy raining and lightning periods.

h. Defective equipment must be properly rectified or not to be used.

## 7.0 ENVIRONMENTAL PROVISIONS

### 7.1 Environmental Aspect

a. Cleaning team to be available in case of slurry spill on the road surface.

b. Public shall be constantly informed about noise produced by heavy equipments.

### 7.2 Environmental Concerns for Bentonite Slurry within Stockpile

a. In general, any spoil stockpiled at the site shall have a limited concentration of bentonite slurry within it, as said slurry in general, is removed back to the bentonite storage tanks during the production process and disposed.

b. It is also intended that any stockpile of spoil on site will be kept to a minimum and in any case removed to the officially designated dumping area as soon as is practically possible. This shall be achieved by ensuring a sufficient supply of dump trucks to carry out this removal at the required times.

c. However, for any stockpile of spoil, the following controls will be effected to ensure no seepage of bentonite to the surrounding area:

   1. Any large concentration of bentonite within the stockpile shall be mixed into the spoil with a backhoe for reducing the risk of seepage.
   2. A barrier around the stockpile will be constructed to prevent seepage. It is intended that such a barrier would consist of sandbags.
   3. For any seepage that may occur, sufficient drainage would be provided to allow the slurry to be collected and later disposed of in accordance with our disposal method statement above.

It shall be ensured that no slurry shall seep into and/or be disposed of in existing stream courses and drains.

## 9.0 ATTACHMENTS

Attachment 1 : Inspection and Test Plan for Bored Pile Construction

Attachment 2 : Inspection Sheet for Bored Pile

Attachment 3 : Working Sequence

Attachment 4 : Field Testing of Drilling Mud

Attachment 5 : Sonic Borehole Measurement Test

Attachment 6 : Cross-Hole Sonic Logging Test

# ATTACHMENT 1

## INSPECTION AND TEST PLAN FOR BORED PILE CONSTRUCTION

# ITD

| | |
|---|---|
| Project : | The Dhaka Mass Rapid Transit Development Project<br>Contract No. CP-03 & CP-04 |
| Item Description : | N/A |
| Location/Area : | N/A |
| Storage Location: | N/A |
| Specification N : | Work Requirement, Section XI: Specification – Particular Specifications, Part 02,<br>Sub Clauses 2: Bored Cast in situ Pile Foundation, Sub Clauses 4: Concrete for Structure, |
| | Sub Clauses 2: Bored Cast in situ Pile Foundation, Sub Clauses 4: Concrete for Structure, |

## INSPECTION AND TEST PLAN

**FOR**

**METHOD STATEMENT FOR BORED PILE CONSTRUCTION**

| | |
|---|---|
| Quality System | : ISO 9001 |
| Document Type | : Controlled |
| Date | : July 11, 2017 |
| Prepared by | : Ms. Naruemon Jantawanumas |
| Approved by | : Mr. Wisan Kittichaikulkit |
| ER Approved | : N/A |

| No. | Activity | Inspection and Tests Required | Frequency of Inspection/Test | Inspection Activity | | | | Document | | Acceptance Criteria |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Subcont. | Vendor | ITD | ER | Form Checklist No. | Verification/Acceptance Sign Off By | |
| 1 | Pile Setting Out | - Setting out | Each pile | X | N/A | X | W/O | ITD/CP03-04/MS/ST005/04 | Survey Team | No tolerance permitted |
| 2 | Temporary Casing Installation | - Horizontal position | Each pile | X | N/A | X | W/O | ITD/CP03-04/MS/ST005/01,04 | Foreman | - 100 mm for bored pile larger than 1.00 m diameter |
| | | | | | | | | | | - 50 mm for bored pile 1.00 m diameter or less |
| | | - Vertical position | Each pile | X | N/A | X | W/O | ITD/CP03-04/MS/ST005/01,04 | Foreman | 1 : 100 |
| 3 | Polymer Slurry and Bentonite Slurry Additive (Range of Results at 20°C) | - Polymer | Daily check | X | N/A | X | W/O | ITD/CP03-04/MS/ST005/01 | Slurry Site Lab | 0.5-0.8 kg/m3 |
| | | - Bentonite | Daily check | X | N/A | X | W/O | ITD/CP03-04/MS/ST005/01 | Slurry Site Lab | 40-60 kg/m3 |
| | | - Water of bentonite | Daily check | X | N/A | X | W/O | ITD/CP03-04/MS/ST005/01 | Slurry Site Lab | 970-985 litre/m3 |
| | | - Density of Polymer | Daily check | X | N/A | X | W/O | ITD/CP03-04/MS/ST005/01 | Slurry Site Lab | <1.05 g/ml |
| | | - Density of bentonite | Daily check | X | N/A | X | W/O | ITD/CP03-04/MS/ST005/01 | Slurry Site Lab | <1.10 g/ml |
| | | - Viscosity of bentonite | Daily check | X | N/A | X | W/O | ITD/CP03-04/MS/ST005/01 | Slurry Site Lab | 30-50 sec. |
| | | - Sand content of bentonite | Daily check | X | N/A | X | W/O | ITD/CP03-04/MS/ST005/01 | Slurry Site Lab | <3 % |
| | | - pH of bentonite | Daily check | X | N/A | X | W/O | ITD/CP03-04/MS/ST005/01 | Slurry Site Lab | 9.5-12 |
| 4 | Pile Boring | - Allowable pile position | Recently Cast Piles | X | N/A | X | W/O | ITD/CP03-04/MS/ST005/01 | Foreman | As shown on the drawings |
| | | - Rig positioning at the top of temporary casing | Recently Cast Piles | X | N/A | X | W/O | ITD/CP03-04/MS/ST005/01 | Foreman | Auger centered to casing |
| | | - Slurry level | All times | X | N/A | X | W/O | ITD/CP03-04/MS/ST005/01 | Foreman | At least at ground level |
| | | - End of boring at final depth | Recently Cast Piles | X | N/A | X | W/O | ITD/CP03-04/MS/ST005/01 | Foreman | More than theoretical depth |
| 5 | Boring Log | - Collect soil sample collecting | Every 1.0-2.0 m depth | X | N/A | X | W/O | Boring log recard | Engineer | Soil profile conpare with original boring log |
| 6 | Pile Base Cleaning | - Sand content (Pile desanding) | Recently Cast Piles | X | N/A | X | W/O | ITD/CP03-04/MS/ST005/01 | Engineer/Foreman | <3 % |

| Symbol | Legend | Symbol | Legend |
|---|---|---|---|
| H | Mandatory Hold Point-Hold Until Approved | D | Document or Record Required |
| W/O | Witness Point-Optional | X | Subcontract Inspection |
| W | Witness Point | R | Review Point |
| S/..... | Surveillance Point - Random ITP/Each Quantity | N/A | Not Applicable |
| N | Notify ER (Request for Inspection) | | |

# ITD

Project : The Dhaka Mass Rapid Transit Development Project
Contract No. CP-03 & CP-04
Item Description : N/A
Location/Area : N/A
Storage Location: N/A
Specification N : Work Requirement, Section XI: Specification – Particular Specifications, Part 02,
Sub Clauses 2: Bored Cast in situ Pile Foundation, Sub Clauses 4: Concrete for Structure,
Sub Clauses 2: Bored Cast in situ Pile Foundation, Sub Clauses 4: Concrete for Structure,

## INSPECTION AND TEST PLAN

**FOR**

**METHOD STATEMENT FOR BORED PILE CONSTRUCTION**

Quality System : ISO 9001
Document Type : Controlled
Date : July 11, 2017
Prepared by : Ms. Naruemon Jantawanumas
Approved by : Mr. Wisan Kittichaikulkit
ER Approved : N/A

| No. | Activity | Inspection and Tests Required | Frequency of Inspection/Test | Inspection Activity | | | | Document | | Acceptance Criteria |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Subcont. | Vendor | ITD | ER | Form Checklist No. | Verification/Acceptance Sign Off By | |
| 7 | Sonic Borehole Measurement Test (Koden Test) | - Verticality test (verify record, print out record for each pile number) | Recently Cast Piles | X | N/A | X | W/O | ITD/CP03-04/MS/ST005/01 | Engineer | 1 : 100 |
| 8 | Base of borehole | - Dimension and the condition of the bottom of borehole | Before installation of reinforcement | X | N/A | X | W/O | ITD/CP03-04/MS/ST005/01 | Engineer/Foreman | As shown on the drawings |
| 9 | Steel Cage fabrication | | | | | | | ITD/CP03-04/MS/ST005/01 | | |
| | - Steel material reception on steel yard | - Type Quantity & Quality | As required by Method Statement for quality control for rebar | X | N/A | X | W/O | ITD/CP03-04/MS/ST005/01 | Foreman | As shown on the drawings |
| | - Steel Bars Cutting and Bending | - Bending Radius | Once each cage type | X | N/A | X | W/O | ITD/CP03-04/MS/ST005/01 | Foreman | As shown on the drawings |
| | - Steel Cage Elements Assembling | - Steel Bar position | Each cage element | X | N/A | X | W/O | ITD/CP03-04/MS/ST005/01 | Foreman | As shown on the drawings |
| | - Cage Identification and Temporary stocking | - Identification | Each Cage | X | N/A | X | W/O | ITD/CP03-04/MS/ST005/01 | Foreman | As shown on the drawings |
| | - Loading and Transportation to site | - Cage pile number | Each Cage | X | N/A | X | W/O | ITD/CP03-04/MS/ST005/01 | Foreman | As shown on the bar cut list |
| 10 | Steel cage Installation | | | | | | | | | |
| | - First Cage Element | - Cage pile number | Each Element | X | N/A | X | W/O | ITD/CP03-04/MS/ST005/01 | Foreman | As specified |
| | - Other Cage Element | - Cage pile number | Each Element | X | N/A | X | W/O | ITD/CP03-04/MS/ST005/01 | Foreman | As specified |

| Symbol | Legend | Symbol | Legend |
|---|---|---|---|
| H | Mandatory Hold Point-Hold Until Approved | D | Document or Record Required |
| W/O | Witness Point-Optional | X | Subcontract Inspection |
| W | Witness Point | R | Review Point |
| S/..... | Surveillance Point - Random ITP/Each Quantity | N/A | Not Applicable |
| N | Notify ER (Request for Inspection) | | |

# ITD

Project : The Dhaka Mass Rapid Transit Development Project
Contract No. CP-03 & CP-04
Item Description : N/A
Location/Area : N/A
Storage Location: N/A
Specification N : Work Requirement, Section XI: Specification – Particular Specifications, Part 02,
Sub Clauses 2: Bored Cast in situ Pile Foundation, Sub Clauses 4: Concrete for Structure,
Sub Clauses 2: Bored Cast in situ Pile Foundation, Sub Clauses 4: Concrete for Structure,

## INSPECTION AND TEST PLAN

**FOR**

**METHOD STATEMENT FOR BORED PILE CONSTRUCTION**

Quality System : ISO 9001
Document Type : Controlled
Date : July 11, 2017
Prepared by : Ms. Naruemon Jantawanumas
Approved by : Mr. Wisan Kittichaikulkit
ER Approved : N/A

| No. | Activity | Inspection and Tests Required | Frequency of Inspection/Test | Inspection Activity | | | | Document | | Acceptance Criteria |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Subcont. | Vendor | ITD | ER | Form / Checklist No. | Verification/Acceptance Sign Off By | |
| | - Cage hanging from Temporary casing by appropriate followers | - Final position | Every pile | X | N/A | S | W/O | ITD/CP03-04/MS/ST005/01 | Foreman | As shown on the drawings |
| 11 | Sonic Logging Tubes | - Number and diameter of tube | Every Pile | X | N/A | X | W/O | ITD/CP03-04/MS/ST005/01 | Foreman | Ø 50 mm. |
| | | - Connection of tube | Every Pile | X | N/A | X | W/O | ITD/CP03-04/MS/ST005/01 | Foreman | Fully connected |
| 12 | Base of borehole | - Dimension and the condition of the bottom of borehole | After installation of reinforcement | X | N/A | X | W/O | ITD/CP03-04/MS/ST005/01 | Engineer/Foreman | As shown on the drawings |
| 13 | Covering up inspection | Work completed | Before concrete being placed | X | N/A | X | W/O | ITD/CP03-04/MS/ST005/01 | NKDM | All items complete with drawings |
| 14 | Concrete placement | | | | | | | | | |
| | - Concrete order | - Composition, grade (Verify delivery ticket with concrete order form, and slump test) | As required by quality control on concrete work | X | N/A | X | W/O | ITD/CP03-04/MS/ST002/01, ITD/CP03-04/MS/ST005/02 | Foreman | As shown on the drawings/approved mixed design |
| | - Tremie pipes install-Funnel + Concrete platform | - Composition of tremie pipes | Every Pile | X | N/A | X | W/O | ITD/CP03-04/MS/ST005/02 | Foreman | As specified |
| | - Concrete placement | - Workability-slump tes | Every 30 $m^3$ | X | N/A | X | W/O | ITD/CP03-04/MS/ST005/02 | Foreman | As specified |
| | - Withdrawal of tremie pipes | - Level of concrete | Every tremie pipe | X | N/A | X | W/O | ITD/CP03-04/MS/ST005/02 | Foreman | 2.0 - 6.0 m under the surface of concrete |
| | | - Concrete final level | After concrete level has been achieved as marked by survey team | X | N/A | X | W/O | ITD/CP03-04/MS/ST005/02, 03 | Foreman | Overcasting above (C.O.L) to ensure uncontaminated concrete at (C.O.L) |
| | - Temporary Casing extraction | - Extract temporary casing | Concrete final level | X | N/A | S | W/O | ITD/CP03-04/MS/ST005/01, 02, 03 | Foreman | Overcasting above (C.O.L) to ensure uncontaminated concrete at (C.O.L) |
| 15 | - Sonic Logging Test | - Completeness of borepile | Every Pile | X | N/A | X | W/O | Sonic logging test result | Engineer | Refer to relevant specification |

| Symbol | Legend | Symbol | Legend |
|---|---|---|---|
| H | Mandatory Hold Point-Hold Until Approved | D | Document or Record Required |
| W/O | Witness Point-Optional | X | Subcontract Inspection |
| W | Witness Point | R | Review Point |
| S/..... | Surveillance Point - Random ITP/Each Quantity | N/A | Not Applicable |
| N | Notify ER (Request for Inspection) | | |

# ATTACHMENT 2

## INSPECTION SHEET FOR BORED PILE

# Inspection Sheet for Bored Pile

☐ Main Line ☐ Station ☐ Others: _____

Location: _____ Date: _____

Drawing No./Rev.: _____ Footing No.: _____ Pile No.: _____

Pile Diameter: _____ m. Pile Length: _____ m. Pier No.: _____

Casing Length: _____m. Theoretical Boring Length: _____ m. Actual Boring Length: _____m.

## Quality Control Checklist for Setting Out Record

| Ref. | Chainage | Point No. | Azimut | Distance (m) | Coordinates | | ΔN (mm) | ΔE (mm) | Deviation (mm) |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | N = Y | E = X | | | |
| Setting Out and/or Design | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| As Built | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |

Note: _____

N
W E
S

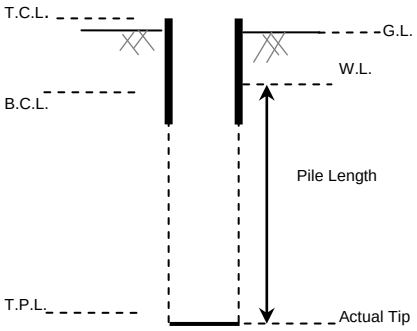
***Boring*** Boring Machine :_____

Casing Installation Date:_____ Time: _____ To Date:_____ Time: _____

Start Boring Date:_____ Time: _____

Finish Boring Date:_____ Time: _____

1) Existing Ground Level (G.L.) _____ msl
2) Top Casing Level (T.C.L.) _____ msl
3) Lower Casing Level (B.C.L) _____ msl
4) Working Level (W.L.) _____ msl
5) Theoretical Pile Tip Level (T.P.L.) _____ msl
6) Expected Pile Depth from T.C.L. _____ m
7) Actual Pile Depth from T.C.L. _____ m




Polymer brand: _____ Bentonite brand: _____

| Stabilization Mat. | Polymer Slurry | | | Bentonite Slurry | | | |
|---|---|---|---|---|---|---|---|
| Stabilization Mat. Test | Density (g/ml) | Viscosity (sec.) | pH | Density (g/ml) | Viscosity (sec.) | pH | Sand Content (%) |
| Fresh | < 1.05 | 40-90 | 8-12 | < 1.10 | 30 - 50 | 9.5 - 12 | < 3 |
| | | | | | | | |
| Prior to Concreting | < 1.05 | 40-90 | 8-12 | < 1.10 | 30 - 50 | 9.5 - 12 | < 3 |
| | | | | | | | |

Sonic Borehole Measurement Test (Bulging, Necking, Inclination, Dimensions and Depth) ☐ Yes ☐ No

Pile Toe Cleaning Date: _____ Time: _____ To Date:_____ Time: _____

Base of borehole Test (Dimension and the condition of the bottom of borehole, before and after installation of reinforcement) ☐ Yes ☐ No

***Steel Cage Installation***

Steel Cage Checked with Drawing No. _____ Earthing Checked as drawing ☐ Yes ☐ No

Sonic Logging Pipe Checked as drawing ☐ Yes ☐ No Total Steel Cage Weight _____ Kgs.

Length of Hanging Bars: _____ m. Dowel : _____ m. Steel Cage Final Level (S.C.L.) _____ m.

Installation Date: _____ Time: _____ To Date: _____ Time: _____

| The Contractor : | NKDM : |
|---|---|
| _____ Date :_____ By Site Engineer (Piling Subcontractor) | _____ Date : _____ Inspector |
| _____ Date : _____ Agreed by Chief Site Engineer (Main Contractor) | _____ Date : _____ Engineer |

# Concrete Placement Record

☐ Main Line ☐ Station ☐ Others: _____

Location: _____ Date: _____

Drawing No./Rev.: _____ Pile No.: _____ Pile Diameter: _____ m.

Pier No.: _____ Pile Length from W.L.: _____ m. Actual Boring Length from T.C.L: _____m.

**Tremie Pipes Installation**

***Tremie Pipes*** Qty. of Sets_____ Diameter (inner) _____ mm. Length per Piece _____ m. Total Length _____m.

**Concrete Placement**

Start Time: _____ hrs. Top of Temp. Casing Level: _____ msl. Expected Concrete Depth from T.C.L : _____ m

Finish Time: _____ hrs. Working Level (W.L.): _____ msl. Actual Concrete Depth from T.C.L: _____ m

Duration: _____ hrs. Actual Pile Tip Level: _____ msl. Final Concrete Level (F.C.L): _____ msl.

Supplier: _____ Theoretical Pile Volume: _____ $m^3$. Concrete Actual Volume: _____$m^3$

Grade: _____ Overcast : _____ %

| Truck No. | Delivery Ticket No. | Time | | | | Volume ($m^3$) | Cumulative Vol. ($m^3$) | Concrete Depth from T.C.L. (m) | Tremie Pipe Length (m) | Slump (mm.) | Temp ($^oC$) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | From Plant | Pouring Time | | | | | | | | | |
| | | | Arrival | Start | Finish | | | | | | | |
| 1 | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | |
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| 10 | | | | | | | | | | | | |
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| 27 | | | | | | | | | | | | |
| 28 | | | | | | | | | | | | |
| 29 | | | | | | | | | | | | |
| 30 | | | | | | | | | | | | |

**Removal of Temporary Casing** ☐ Safety Slings Installation ☐ Correct Shackle Installation

From concrete placement period to complete removal of temporary casing

Complete Date: _____ Time: _____ hrs, Total: _____ hrs (Complete removal of casing)

Remarks: _____

| The Contractor : | NKDM : |
|---|---|
| _____ Date :_____ By Site Engineer (Piling Subcontractor) | _____ Date : _____ Inspector |
| _____ Date : _____ Agreed by Chief Site Engineer (Main Contractor) | _____ Date : _____ Project Engineer |

# Concrete Placement Record

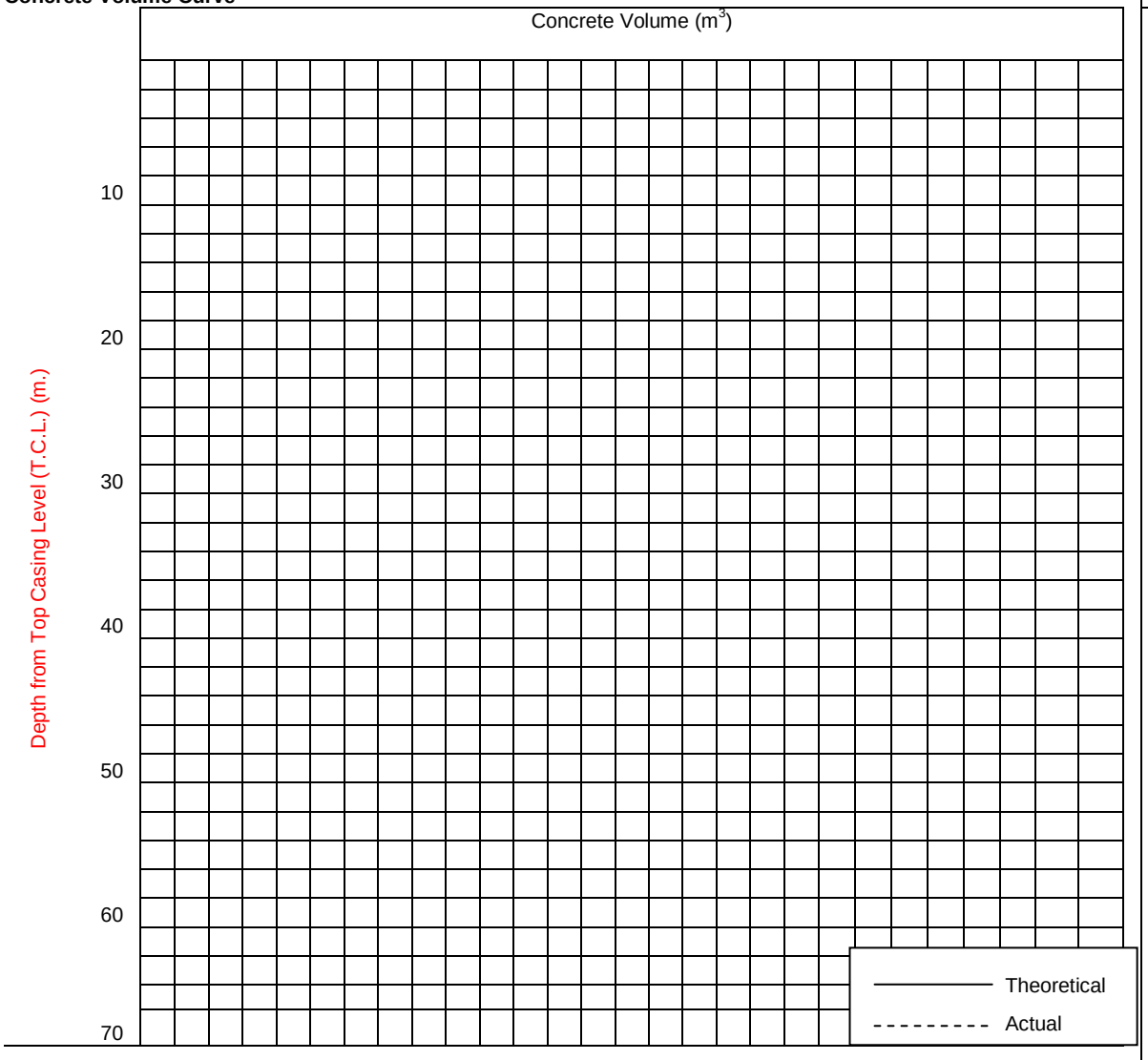
☐ Main Line ☐ Station ☐ Others: _____

Location: _____ Date: _____

Location: _____ Pier No.: _____ Drawing No./Rev.: _____

Pile No.: _____ Pile Diameter: _____ mm

**Concrete Volume Curve**




**Soil Profile**

Remarks: _____

_____

| The Contractor : | NKDM : |
|---|---|
| _____ Date :_____<br>By Site Engineer (Piling Subcontractor) | _____ Date : _____<br>Inspector |
| _____ Date : _____<br>Agreed by Chief Site Engineer (Main Contractor) | _____ Date : _____<br>Project Engineer |

# Setting Out Record of Bored Piles

☐ Main Line ☐ Station ☐ Others: _____

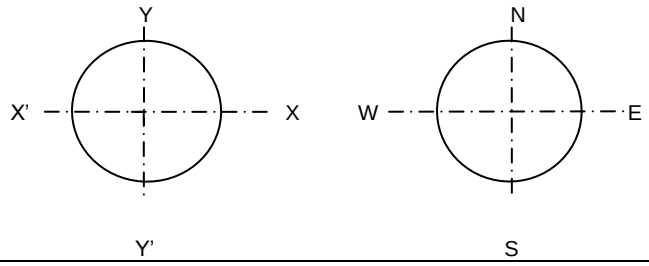
Location :_____

Starting Date: _____ Pile No.: _____ Pier No.:_____

Drawing No./Rev. _____ Total Length: _____ m. ☐ Day Shift ☐ Night Shift

| | Ref. | Chainage | Point No. | Azimut | Distance (m) | Coordinates N = Y | Coordinates E = X | △N (mm) | △E (mm) | Deviation X (mm) | Deviation Y (mm) | Verification and Agreement | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Setting Out as per Drawing | | | | | | | | | | | | ITT's Surveyor. | Name: | Date: |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | ITD's Surveyor. | Name: | Date: |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| As Built | | | | | | | | | | | | ITT's Surveyor. | Name: | Date: |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | ITD's Surveyor. | Name: | Date: |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |

Notes : _____




| Equipment | Ref. No. |
|---|---|
| Theodolite(s) | |
| Level(s) | |
| Tape(s) | |
| Staff | |

The Contractor :

_____ Date : _____
By Site Engineer (Piling Subcontractor)

_____ Date : _____
Agreed by Chief Site Engineer (Main Contractor)

NKDM

_____
Inspector

Date :_____

# ATTACHMENT 3

## WORKING SEQUENCE

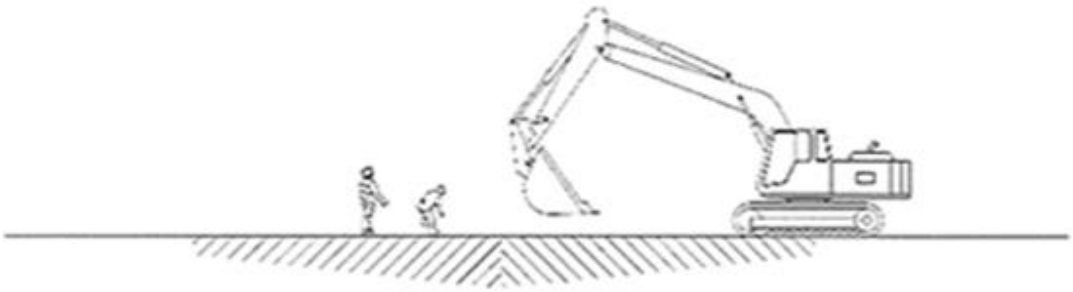


Fig. 1 Clearing Obstruction

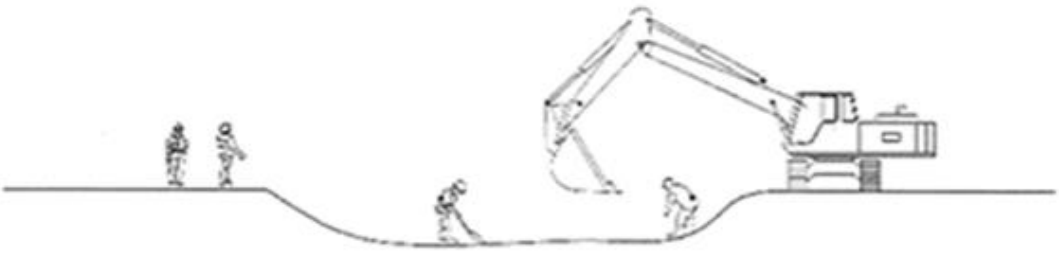


Fig. 2 Clearing Obstruction

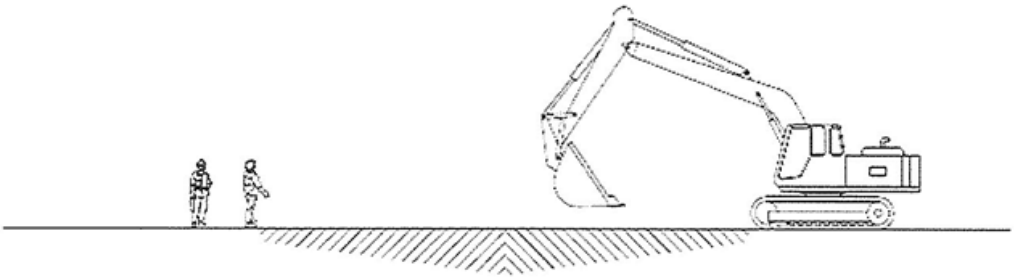


Fig. 3 Backfilling Work

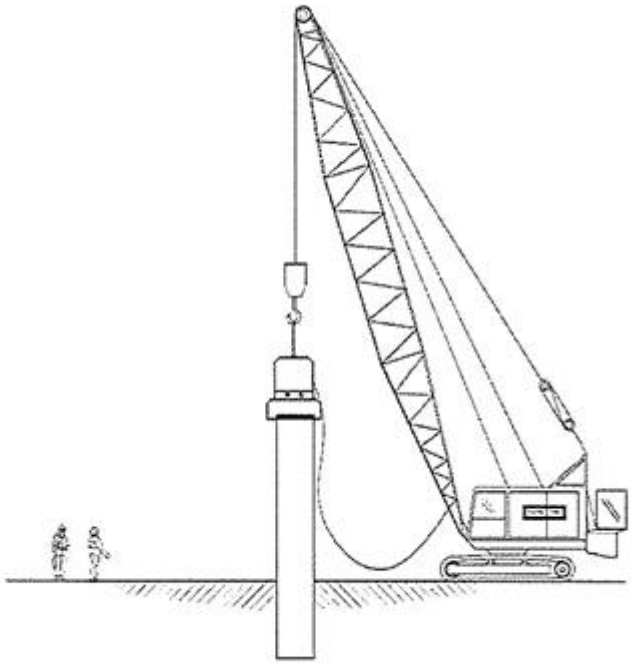


Fig. 4 Installation of Temporary Casing by Vibro Hammer

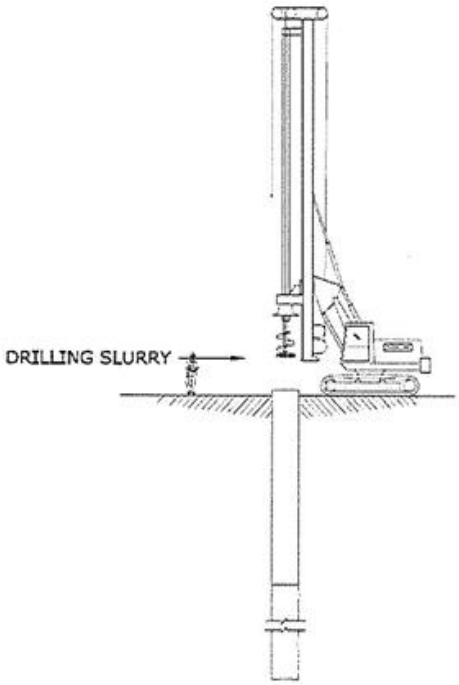



Fig. 5 Excavation of Pile under Drilling Slurry to Founding Level

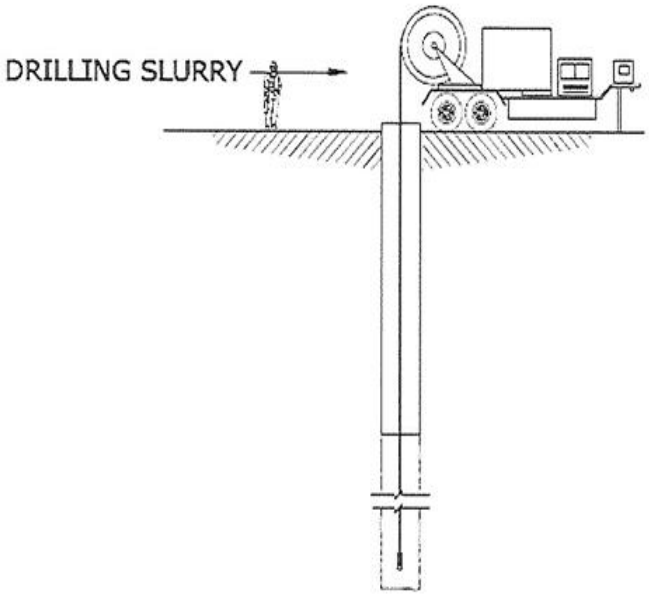



Fig.6 Desanding of The Pile (If used Bentonite Slurry)

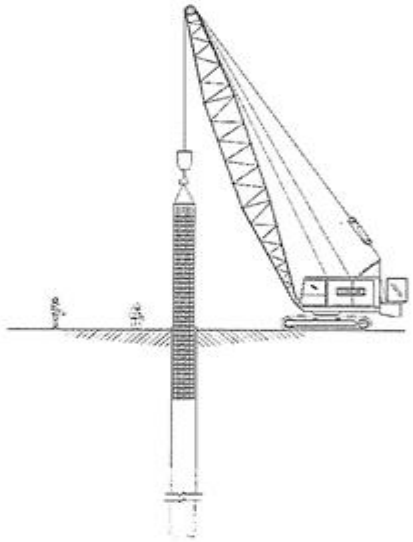


Fig. 7 Installation of Steel Cages

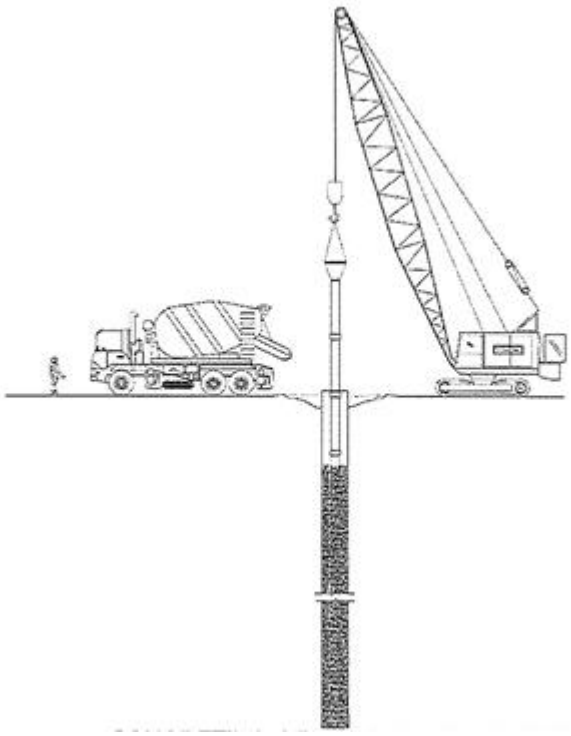


Fig. 8 Concreting of Pile Via Tremie Pile

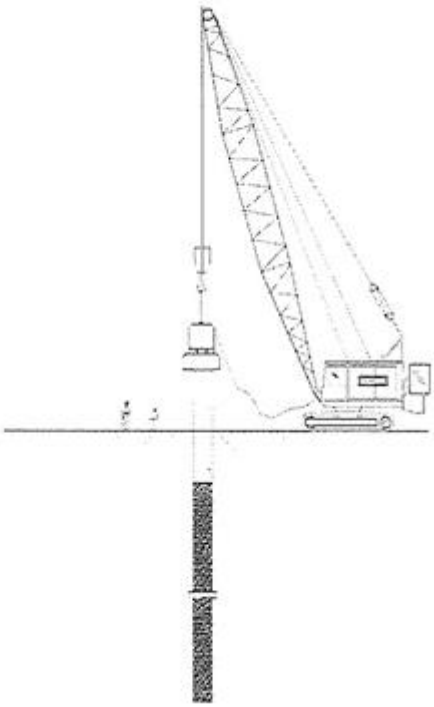


Fig. 9 Extraction of Temporary Casing by Vibro Hammer

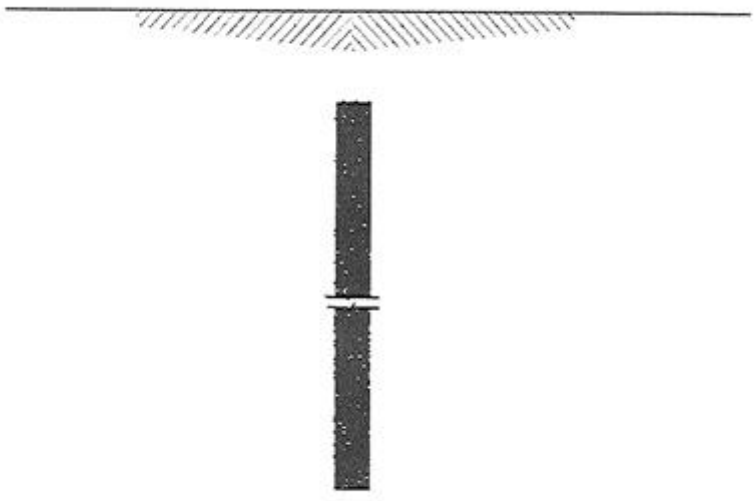


Fig. 10 Bored Pile Complete

# ATTACHMENT 4

## FIELD TESTING OF DRILLING MUD

LAVIOSA LIVORNO

APPARATUS AND PROCEDURE

FOR THE

# FIELD TESTING OF DRILLING MUD

GRUPPO LAVIOSA

# VISCOSITY

**- DESCRIPTION -**

The following instruments are used to measure viscosity and/or gel strength of muds.

1. Marsh funnel - a simple device for indication of viscosity on a routine basis.

2. Direct-indicating viscometer - a mechanical device for measurement of viscosity at varying shear rates.

## MARSH FUNNEL

STOP WATCH, MARSH FUNNEL VISCOMETER AND GRADUATED CUP

./.

**- EQUIPMENT -**

A Marsh funnel is calibrated to outflow one liter of fresh water at a temperature of 25°C in 28 seconds. A graduated cup is used as a receiver.

a) Marsh funnel
Specification

Funnel cone
Length .....: 305 mm
Diameter .....: 152 mm
Capacity to bottom of screen.....: 1500 $cm^3$

Orifice
Length .....: 50,8 mm
Inside diameter .....: 4,7 mm

Screen
Has 1,6 mm openings and is fixed at a level 19 mm below top of funnel.

b) Graduated cup : one liter

c) Stopwatch

**- PROCEDURE -**

Cover the funnel orifice with a finger and pour freshly sampled mud through the screen into the clean upright funnel. Fill until fluid reaches the bottom of the screen.
Remove finger and start stopwatch. Measure the time for mud to fill to one liter mark of the cup.
Report the time to nearest second as Marsh funnel viscosity.

## DIRECT-INDICATING VISCOMETER

**- EQUIPMENT -**

Direct-indicating viscometers are rotational types of instruments powered by an electric motor or a hand crank. Mud is contained in the anular space between two concentric cylinders. The outer cylinder or rotor sleeve is driven at a constant rotational velocity (rpm). The rotation of the rotor sleeve in the fluid produces a torque on the inner cylinder or bob, and a dial attached to the bob indicates displacement of the bob.
Instrument constants have been adjusted so that plastic viscosity and yield point are obtained by using readings from rotor sleeve speeds of 300 rpm and 600 rpm.

./.

# S A N D

**- DESCRIPTION -**

The sand content of mud is the volume percent of particles larger than 74 microns. It is measured by a Sand-Content Set.

**- EQUIPMENT -**

a) 200 Mesh sieve, 63,50 mm in diameter.
b) Funnel to fit sieve.
c) Glass measuring tube marked for the volume of mud to be added. The tube is graduated from 0 to 20 percent in order to read directly the percentage of sand.

SAND-CONTENT SET

./.

**- PROCEDURE -**

Fill the glass measuring tube with mud to the "mud mark". Add water to the next mark. Close the mouth of the tube and shake vigorously.
Pour the mixture onto the clean, wet screen. Discard the liquid passing through the screen. Add more water to the tube, shake and again pour onto the screen. Repeat until the tube is clean. Wash the sand retained on the screen to free it of any remaining mud.
Put the funnel upside down over the top of the sieve. Slowly invert the assembly and insert the tip of the funnel into the mouth of the glass tube. Wash the sand into the tube by playing a fine spray of water through the screen. Allow the sand to settle. From the graduations on the tube, read the volume percent of the sand.

**- RESULTS -**

Report the sand content of the mud in volume percent.

# DENSITY

# (MUD WEIGHT)

**- DESCRIPTION -**

This test procedure is a method for determining the weight of a given volume of liquid. Mud weight may be expressed as pounds per gallon (lb/gal), pounds per cubic foot ($lb/ft^3$), grams per cubic centimeter ($gr/cm^3$), or kilograms per cubic meter ($Kg/m^3$).

**- EQUIPMENT -**

The MUD BALANCE is the instrument generally used for mud weight determinations. The MUD BALANCE is designed such that the mud cup, at one end of the beam, is balanced by a fixed counterweight at the other end, with a sliding-weight rider free to move along a graduated scale. A level-bubble is mounted on the beam to allow for accurate balancing.

**- PROCEDURE -**

The instrument base should be set on a flat, level surface.

Fill the clean, dry cup with mud to be tested; put the cup on the filled mud cup and rotate the cup until it is firmly seated. Insure that some of the mud is expelled through the hole in the cup in order to free any trapped air or gas.

Holding cup firmly on mud cup (with cup hole covered), wash or wipe the outside of the cup clean and dry.

Place the beam on the base support and balance it by moving the rider along the graduated scale. Balance is achieved when the bubble is under the center line.

Read the mud weight at edge of the rider toward the mud cup.

**- PROCEDURE CALIBRATION -**

The instrument should be calibrated frequently with fresh water. Fresh water should give a reading of 8,3 lb/gal or 62,3 $lb/ft^3$ or 1 $gr/cm^3$ or 1000 $Kg/m^3$. If it does not, adjust the balancing screw or the amount of lead shot in the well at the end of the graduated arm as required.

./.

**- CALCULATION -**

Report the mud weight to the nearest 0,1 lb/gal or 0,5 lb/ft$^3$ or 0,01 gr/cm$^3$ or 10 Kg/m$^3$.

MUD BALANCE AND CASE

# HYDROGEN - ION DETERMINATION

**- DESCRIPTION -**

The degree of acidityor alkalinity of drilling mud is indicated by the Hydrogen-Ion concentration which is commonly expressed in terms of pH. A perfectly neutral solution has a pH of 7,0. Alkaline solution have pH readings ranging from just above 7 for slight alkalinity to 14 for the strongest alkalinity, while acid solutions range from just below 7 for slight acidity to less than 1 for the strongest acidity. The pH measurement is used as an aid in determining the need for chemical control of the mud as well as indicating the presence of contaminants such as cement, gypsum etc.. The optimum pH for any drilling mud is dependent upon the type of mud being used.

**- EQUIPMENT -**

Hydrion pH Dispenser


HYDRION pH DISPENSER

./.

**- PROCEDURE -**

Remove about 3 cm strip of indicator paper from hydrion pH dispenser which is judged to be within the range required, and place it gently on the surface of the mud.

Allow sufficient time to elapse for the paper strip to soak up filtrate and change color (from a few seconds to a couple of minutes).

Match the color of the strip with the Chart on the side of the dispenser from which the strip was taken and read the pH of the mud.

If the color is off the scale and cannot be matched, repeat the test with a different indicator strip judged to be closer to the pH range required.

**- RESULTS -**

Report pH in units 0 to 14 to the nearest 0,5 estimated pH.

# ATTACHMENT 5

## SONIC BOREHOLE MEASUREMENT TEST

## SPECIFICATIONS

### Recorder Unit

| | | | | | |
|---|---|---|---|---|---|
| Measuring system | | | Ultrasonic echo sensing system | | |
| Recording system | DM-602 | | Direct recording in two directions (X-X' or Y-Y') | | |
| | DM-604 | | Direct recording in four directions (X-X' and Y-Y') | | |
| Recording paper | | | Electrosensitive recording paper 250 mm x 20 m (DMP-250) | | |
| Measuring range (radius) | | | 0.5 m | 1.0 m | 2.0 m | 4.0 m |
| | | Shift 0 % | 0 to 0.5 m | 0 to 1.0 m | 0 to 2.0 m | 0 to 4.0 m |
| | | 50 % | 0.25 to 0.75 m | 0.5 to 1.5 m | 1.0 to 3.0 m | 2.0 to 6.0 m |
| | | 100 % | 0.5 to 1.0 m | 1.0 to 2.0 m | 2.0 to 4.0 m | 4.0 to 8.0 m |
| Paper feed rate | Constant speed | | 7.5 mm/min, 15 mm/min, 30 mm/min and 60 mm/min | | | |
| | Synchronized with the depth | 1/40 | 25 mm/m of sensor up/down movement | | | |
| | | 1/50 | 20 mm/m of sensor up/down movement | | | |
| | | 1/100 | 10 mm/m of sensor up/down movement | | | |
| | | 1/200 | 5 mm/m of sensor up/down movement | | | |
| Measuring accuracy | | | ±0.2 %, F.S. | | | |
| Depth mark | | | A depth mark is printed every 1 m and depth is automatically printed numerically every 5 m | | | |
| PC display and storage | | | Serial data output provided (RS 232C cable: option) | | | |
| Power supply protection circuit | | | Equipped with two built-in non-fuse breakers (2 A and 8 A), a leakage breaker (20 A) and an overvoltage protection circuit | | | |
| Power supply | | | 100 VAC, 50/60 Hz | 110 VAC, 50/60 Hz | 220 VAC, 50/60 Hz | 440 VAC, 50/60 Hz |
| Power consumption | | | 500 VA (At 100 VAC) | 700 VA (At 110 VAC) | 700 VA (At 220 VAC) | 700 VA (At 440 VAC) |
| Operating temperature | | | -10 to +50 °C (14 to 122 °F) | | | |

### Winch Unit

| | |
|---|---|
| Up/down speed | 0 to 20 m/min |
| Up/down movement distance | 100 m maximum |
| Bottom and casing sensing system | Automatic sensing by limit switch |
| Operating temperature | -10 to +50 °C (14 to 122 °F) |

### Standard Configuration

| | | | |
|---|---|---|---|
| Recorder unit | DMR-602 (DM-602) | Contained in an aluminum box | 47 kg |
| | DMR-604 (DM-604) | Contained in an aluminum box | 47 kg |
| Power supply (Built into Recorder unit) | DMT-000 | For 100 VAC, contained in an aluminum box | 10 kg |
| | DMT-001 | For 110 VAC, contained in an aluminum box | 10 kg |
| | DMT-002 | For 220 VAC, contained in an aluminum box | 10 kg |
| | DMT-003 | For 440 VAC, contained in an aluminum box | 12 kg |
| Winch unit | DMW-001A (DM-602) | With a sensor unit and cable | 121 kg |
| | DMW-002A (DM604) | With a sensor unit and cable | 121 kg |
| Connnecting cable | CW-558 | With 15-pin connectors | 10 m |
| AC power cable | CW-71 | With 3-pin connectors | 10 m |
| Spare parts kit | | Included in tRecorder unit | 1set |
| Operation manual | 93170152 | Contained in Recorder unit | 1 |
| Brief operaton card | for DM-602 | Contained in Recorder unit | 1 |
| | for DM-604 | Contained in Recorder unit | 1 |

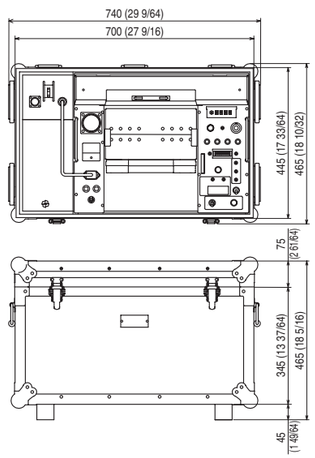
### Spare Parts List

| | | | |
|---|---|---|---|
| Recording paper | DMP-250 | 250 x 20 mm (A3-560) | 2 |
| Recording stylus | DMS-001 | Included in a vinyl bag | 2 |
| Current feed stylus | DMS-002 | Included in a vinyl bag | 2 |

### Optional Item

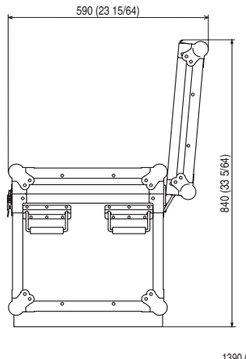
| | | |
|---|---|---|
| RS 232C output port | CW-384 | Output connector: D-Sub 25 pin |

## DIMENSIONS AND WEIGHT

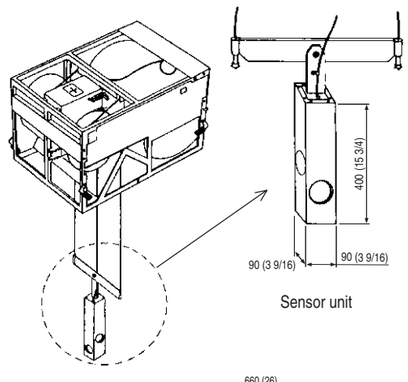



Weight: 57 kg (126 lb) (for 100/110/220 VAC)
59 kg (130 lb) (for 440 VAC)

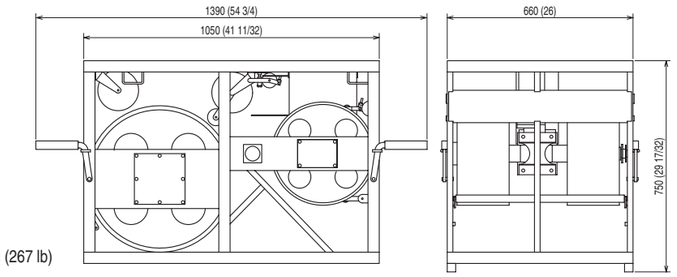
Recorder Unit
DMR-602 (DM-602)
DMR-604 (DM-604)




Winch Unit
DMW-001A (DM-602)
DMW-002A (DM-604)




Sensor unit




Weight: 121 kg (267 lb)

Unit: mm (inch)

* Specifications subject to change without notice.


**KODEN ELECTRONICS CO., LTD.**
**OVERSEAS DEPT.**
5278 UENOHARA, UENOHARA-MACHI, KITATSURU-GUN
YAMANASHI-KEN, 409-0112 JAPAN
TEL : +81 554 20-5865
FAX : +81 554 20-5880
E-MAIL: overseas@koden-electronics.co.jp
**www.koden-electronics.co.jp**


**Certified to ISO 9001 ( TÜV PRODUCT SERVICE )**

| Safety precaution | To ensure proper and safe use of the equipment, please carefully read and follow the instructions in the OPERATION MANUAL. |
|---|---|

FOR DETAILS, PLEASE CONTACT:


ODM602/604-00 02 X SI 2Y1
PRINTED IN JAPAN


KODEN

# Ultrasonic Drilling Monitor

# DM-602/604

*KODEN promotes intelligent foundation work.*

- Deeper excavation measurement in high accuracy
- Clear recording even in slurry contaminated with dirt and sand
- High quality excavation work reducing time and cost

**www.koden-electronics.co.jp**

# The DM-602/604 helps improve the quality of a drilled hole and reduces working time and cost!

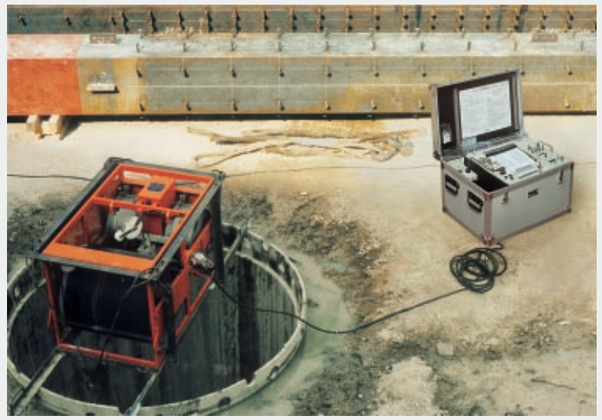
## General

Recent progress and development in foundation engineering has resulted in great strides in excavation techniques. By using artificial slurry of high density and specific gravity, deeper excavation has been made possible. The DM-602/604 series Drilling Monitor system has been developed in compliance with the user's needs arisen from the recent construction environment to accurately measure and record the shape of a drilled hole of greater depth. It can be easily positioned and set up for measurement to provide quick and accurate recordings of excavations. The DM-602/604 series Drilling Monitor provides the following advantages.

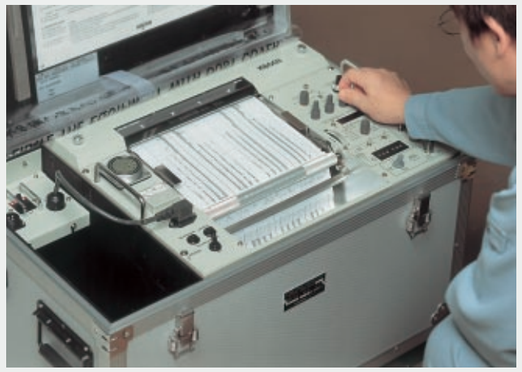
- Helps improve the quality of a drilled hole and reduces working time and cost.
- Provides on site records of the perpendicularity of drilled holes and the shape of cross sections in high accuracy.
- Provides numerical measurement data that can be easily imported into various Windows applications (Excel, Word, Power Point, etc) for work reports, etc. (Option)

## Features

- The DM-602/604 supplies clear records of a drilled hole even in slurry, heavily contaminated with dirt and sand.
- The DM-602/604 supplies clear and precise records thanks to its unique signal processing technique that discriminates wall echoes from the noise.
- The DM-602/604 has the facility to cancel the oscillation line echo that often prevents very close echo recordings.
- The sensor device is automatically controlled to stop at the casing and at the bottom of the hole. An emergency return function is also included.
- Depth range mark, depth mark, drilled hole mark, date, time, etc. can be printed on the recording paper.
- Limit switches are provided to avoid possible wire breakage or entanglement of the wire and cable.
- The recorded result can be output to an external PC via a built-in RS 232C output port. (Option)
- A non-fuse circuit breaker is used for circuit protection, eliminating the need for cumbersome fuse replacement at the construction site.



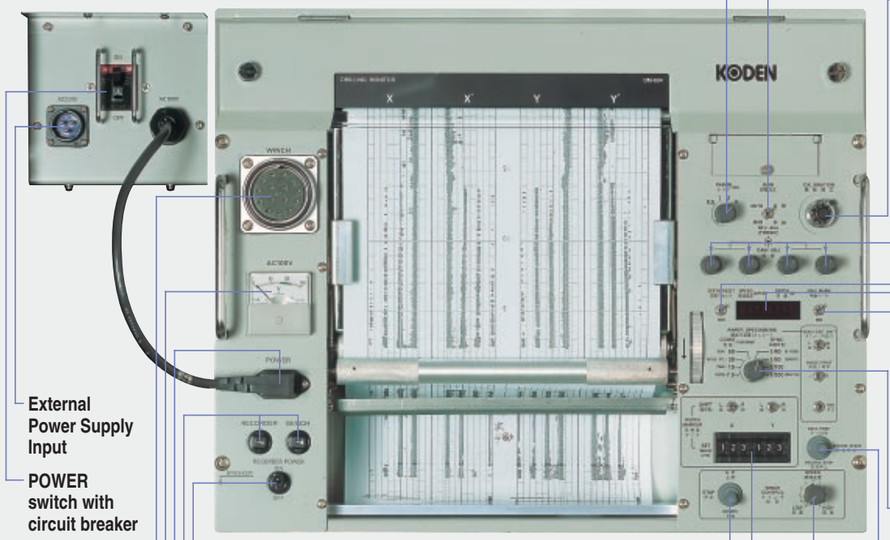
The winch unit and recorder unit on site



Recording the echo of a drilled hole

## Main controls/switches

(Photograph shown is DM-604 operation panel)




**External Power Supply Input**

**POWER switch with circuit breaker**

**WINCH connector**

**Voltage meter**

**POWER connector**

**Non-fuse breaker**

**RECORDER POWER switch**

**RANGE switch**
Used for switching the measuring range (radius) in four steps of 0.5m, 1m, 2m and 4m.

**GAIN switch**
Used for switching the gain control method to AUTO or MANUAL

**CALIBRATION control**
Used for calibrating the distance between the sensor and the wall face to the actual measured distance.

**STC control (outer control)**
Used for adjusting or eliminating irregular reflections near the oscillation line.

**GAIN control (inner control)**
Used for adjusting the receiving gain.

**DEPTH RESET switch**
Used to reset the depth record to 0 m.

**SPEED/DEPTH display window**
Used to display the speed and the depth of the sensor.

**MANUAL MARK switch**
As long as it is set to ON, the manual mark is recorded on the recording paper.

**PAPER SPEED switch (MENU)**
Used to change the paper speed in 4 steps in CONSTANT and PROPORTIONAL speed modes.

**DATA PRINT/RECORD START & STOP switch**
Used to start and stop recording as well as print text data.

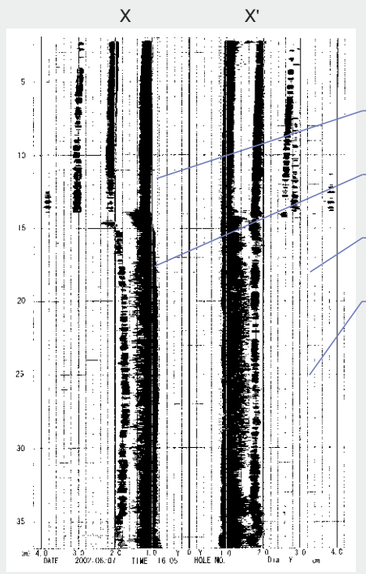
**UP/STOP/DOWN switch**
Used for selecting sensor movement between up, down or stop.

**WINCH UP/DOWN SPEED control**
Used for controlling the sensor up or down speed (turning it to the right increases the speed).

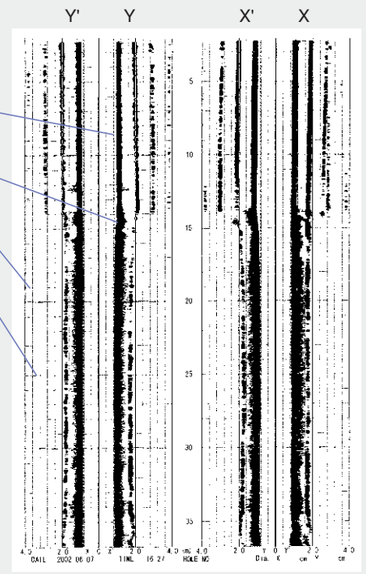
**DRILLING HOLE MARK WIDTH switch**
Used for setting the reference value (diameter) of the drilling hole on the wall face (in cm).

## Recording Examples

DM-602




DM-604




Drilling hole mark

Wall face

Depth mark (in 1-meter intervals)

Depth mark (in 5-meter intervals)

# ATTACHMENT 6

## CROSS-HOLE SONIC LOGGING TEST

# METHOD STATEMENT
# ON
# CROSS-HOLE SONIC LOGGING TEST

# CROSS-HOLE SONIC LOGGING TEST

## 1) INTRODUCTION

The Sonic Coring (Logging) technique is used to detect defects in cast-situ bored piles, caissons, barrettes and diaphragm walls. Such tests can produce economic integrity survey of each pile to complement the more expensive capacity testing which is restricted to small percentage piles.

When cast-in-situ piles are constructed, the following defects may occur :-

- Honeycombing due to inadequate vibration.
- Segregation due to over vibration and improper concrete placement methods.
- Washout of cement due to groundwater flow.
- Cracks in the pile shaft due to shrinkage.
- Inclusion of foreign material causing contamination of the concrete.
- Necking and arching of the pile due to collapse of side walls during withdrawal of the temporary casings.

## 2) THE EQUIPMENTS

The **Pile Dynamics' Cross-Hole Analyzer, CHA** (Version 2004.0010 A) consists of one (1) transmitter, one (1) receiver and depth sensor interfaces, storage display, keyboard, data storage, DC power supply modules all housed in a sturdy resin case. Operation is menu driven and very user friendly. A meter wheel and application specific probes complete the down-hole logging system.

Fig. 1 Main unit and Transducer

## 3) METHODOLOGY

The presence of these defects affects the acoustic properties of the piles and can be detected by the sonic coring technique which measures the propagation time of 'sonic' waves across access tubes inserted into the pile body.

In homogeneous concrete, free of defects and variations in quality, the velocity of 'sonic' wave propagation is constant. The sonic coring technique works by way of detecting any acoustical irregularities on the sonic profiles between the access tubes. For example, a sudden increase in 'sonic' wave travel time indicates localized areas of relatively lower quality concrete. A total loss of sonic profile' indicates the presence of a major irregularity caused very poor quality concrete, a crack or a void along the path between the access tubes.

## 4) ACCESS TUBES

Access tubes must be installed before the construction of the drilled shaft. The tubes are typically 40-50 mm in diameter, and are tied to the rebar cage to ensure close to vertical positions of the tubes. **PVC** or **Steel Tubes** can be used however steel tubes is favor due to good bonding. The tubes must be filled with water prior to concrete placement or immediately after placing the concrete to ensure good tube-concrete bonding. The tubes must extend about 1 m above the top of the shaft to compensate for the water displaced by the source, receiver and cables.

At least two tubes are needed to perform the test. For a good coverage of the test shaft, we recommend the following number of tubes to be installed:

| ***Shaft Diameter*** | ***Recommended Number of Tubes*** | ***Tube Spacing*** |
|---|---|---|
| | | |
| | | |
| | | |

The concrete in the shaft should normally be allowed at least 7 days to cure prior to testing. If PVC tubes are used, testing should be done within 30 days after the concrete placement. No limit for steel tube as the steel tubes bond better than PVC tubes over a longer time.

## 5) TEST PROCEDURES

To begin the test, the probes are positioned at the bottom of the access tubes in the pile (see Fig 1). They are then raised simultaneously up the tubes. The time of propagation of the pulse at each level as the probes are raised is recorded on a printer. The signals are displaced on the horizontal axis and the depth of the emitter and

receiver on the vertical axis. If there is a delay in signal transmission, it indicates the zones of porous concrete, soil inclusion and/or other defects are present. The delay of the signal causes a shift in the depth/pulse time plot which can be seen on the printout.

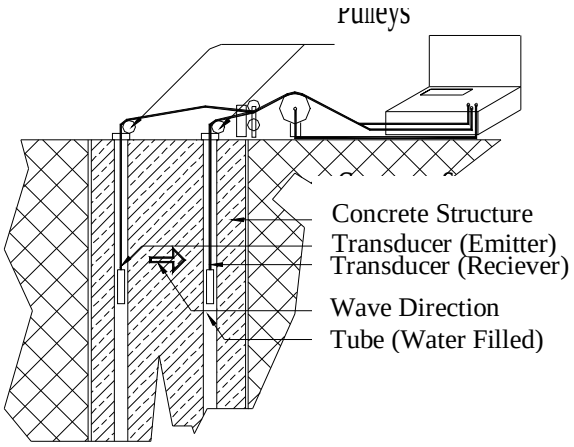



***Fig. 2***
***Schematic of system setup***

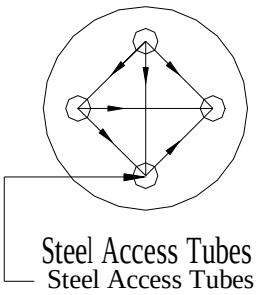



***Fig. 2.1***
***Schematic of Typical scan configuration***

## 6) TEST RESULTS

The test report shall be included the graphical plot of delay time to show the homogeneity of the concrete as shown in Figure 3.

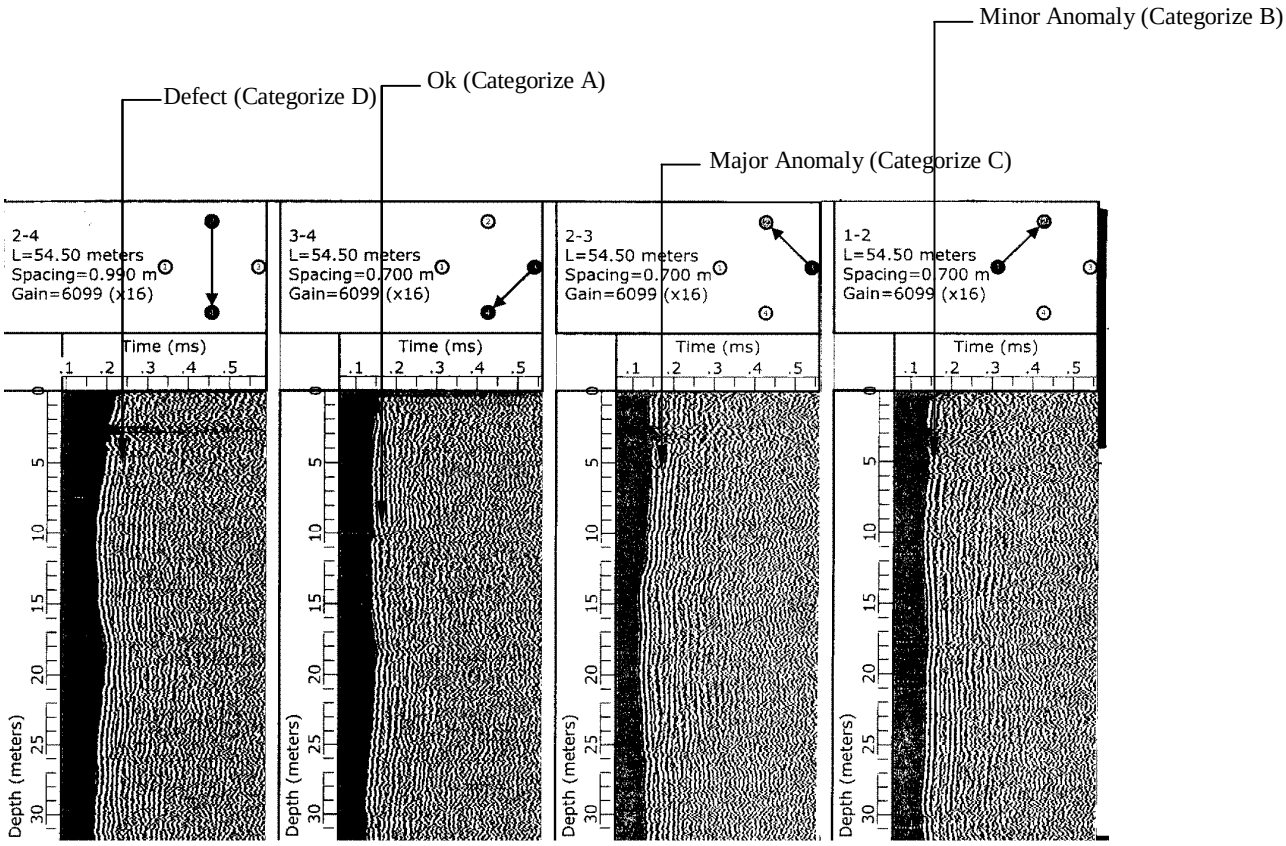



*Fig. 3. Example of test results*

## 7) ADDITIONAL TESTS

In area where defect are identified by the sonic logging test, additional test **"Fan shaped test"** and **"Single hole test"** and be performed to better define the defect.

This addition test has capabilities to identify the defect location and also estimate the size of defect (% of total area)

## 8) INTERPRETATION OF TEST RESULTS

Following is a description of the main factors affecting the signal in as practical terms as possible.

The test result consists of two components, a) signal delay from the transmitter to the receiver and b) relative signal strength at the receiver.

a) The signal delay depends mainly on:
   - a1) the wave speed and
   - a2) the length of the physical path (from the transmitter to the receiver)

b) The relative signal strength at the receiver depends mainly on:
   - b1) the length of the physical path,
   - b2) the cross section of the physical path and
   - b3) the physical properties of the path, mainly its damping.

**The general rules are:**

| | **Deviation** | **Result** |
|---|---|---|
| a1) | lower wave speed | increased delay |
| | higher wave speed | decreased delay |
| a2) | longer path | increased delay |
| | shorter path | decreased delay |
| b1) | longer path | weaker signal |
| | shorter path | stronger signal |
| b2) | smaller cross section | weaker signal |
| | greater cross section | stronger signal |
| b3) | greater damping | weaker signal |
| | smaller damping | stronger signal |

Base on our past experience on almost 1000 pile in past 10 years and the results from coring inspection the criteria for interpretation has been developed.

Each single sonic logging profile shall be categorized in to one of five categorizes as follows

**A:** No or slight increase in transmission (traveling) time not more than 10% for any length of the pile other than caused by the bending of tubes shall be considered as **"Homogeneous Concrete".**

**B:** Minor increase in transmission (traveling) time more than 10% but not more than 25% other than caused by the bending of tubes shall be considered as **"Minor Anomaly".**

**C:** Transmission (traveling) time more than Item "B" but still the transmission (traveling) time can be defined, other than caused by the bending of tubes shall be considered as **"Major Anomaly".**

**D:** Where no Transmission (traveling) time can be defined i. E, no signal observed shall be considered as **"Defect".**

**I:** Where no clear signal observed or cannot be categorized for the above items, the pile shall be re-logged at a later date and then re-categorized.

**Every single <u>Pile</u> can be categorized as follows using interpretation of the profiles and their combination as shown in Table. 01.**

**P:** **Pile O.K** (Accepted)

**R.** **Investigation is Recommended** (Investigation can be carried out in the following order)

1) By Graphical Analysis (fan shaped analysis)
2) By Low Strain test
3) By coring at least 50 mm in diameter to the recommended depth at the recommended position

**F:** **Pile Not O.K** (Not Accepted)

**Table. 01 Profile Combinations and their Result**

| Profiles | Result |
|---|---|
| Not more than three profiles show B and others A | P |
| Only a single profile show C and others A or B | |
| Any single profile show D | F |
| More than two profiles show C | |
| All other combinations not mentioned above shall need Investigation | R |
| More than one profile show I shall need Investigation | |

**<u>Note</u>** **1:** *The profile interpretation should be at the same depth.*
**2:** *When the anomalies are found in profiles relating to a particular tube, then the anomaly shall probably be localized to that particular tube at the depth.*

## 9) LIMITATIONS AND RECOMMENDATIONS

It should recognized that sonic coring tests are intrinsically indirect and there are no simple criteria to ‘pass’ or ‘fail’ piles on the basis of these tests alone. The sonic coring technique, however, provides a cost-effective screening test to identify piles which have imperfections within their acoustic integrity the may have some structural significance. Such piles normally warrant further investigation and engineering evaluation.

It is recommended that the test results should be evaluated in conjunction with pile construction records and site investigation reports which can often indicate the possible causes and physical nature of acoustical irregularities.