



**ReCAP**  
Research for Community Access Partnership



## Ground Improvement for Khulna Soft Clay Soil

*Interim Laboratory Test Report*



**Mott MacDonald Ltd.**

*AFCAP Project Reference Number: BAN2082A*

**February 2017**

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A typical rural road in Bangladesh: (source unknown)



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## Abstract

This Interim Laboratory Test Report presents the methodologies employed and initial factual findings of site investigation field visits undertaken at 7 No. rural road sites between the 28<sup>th</sup> of January and the 5<sup>th</sup> of February 2017.

The 7 No. sites were selected from an initial list of 35 No. locations presented in the Inception Report and were selected as they were seemingly representative of 7 No. common features / key road failure issues as identified in the Field Situation Analysis Report.

At each site, in-situ testing was conducted using a Panda 2 Probe which is a manually operated variable energy input dynamic cone penetrometer. Soil samples were also taken from various levels within the highways earthworks for standard geotechnical laboratory classification.

## Key words

Bangladesh, Khulna, Rural roads, Soft Clays, Organic Soil, Earthworks, Settlement, embankment failure, Ground Improvement, Infrastructure research, Transport services research)

## **RESEACH FOR COMMUNITY ACCESS PARTNERSHIP (ReCAP)**

### ***Safe and sustainable transport for rural communities***

ReCAP is a research programme, funded by UK Aid, with the aim of promoting safe and sustainable transport for rural communities in Africa and Asia. ReCAP comprises the Africa Community Access Partnership (AfCAP) and the Asia Community Access Partnership (AsCAP). These partnerships support knowledge sharing between participating countries in order to enhance the uptake of low cost, proven solutions for rural access that maximise the use of local resources. The ReCAP programme is managed by Cardno Emerging Markets (UK) Ltd.

**See [www.afcap.org](http://www.afcap.org)**

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## Acronyms, Units and Currencies

\$	United States Dollar (US\$ 1.00 ≈ provide conversion to local currencies)
ADB	Asian Development Bank
AFCAP	Africa Community Access Partnership
ASCAP	Asia Community Access Partnership
GPS	Global positioning system
RECAP	Research for Community Access Partnership
UK	United Kingdom (of Great Britain and Northern Ireland)
UKAid	United Kingdom Aid (Department for International Development, UK)
MM	Mott MacDonald
LGED	Local Government Engineering Department
ToR	Terms of Reference

## Contents

Abstract	3
Key words	3
Acknowledgements	4
Acronyms, Units and Currencies	4
<b>1 Executive summary</b> .....	<b>8</b>
<b>2 Introduction</b> .....	<b>9</b>
2.1 Background to Project	9
2.2 Research objectives	9
2.3 Project Methodology	10
2.3.1 <i>Inception Report</i>	10
2.3.2 <i>Field Situation Analysis Report</i>	10
2.3.3 <i>Field and Laboratory Testing</i>	11
<b>3 Summary of Field Visits undertaken during Task 3 Field &amp; Laboratory Testing</b> .....	<b>12</b>
3.1 Schedule of Sites	12
3.1 Rationale behind the selection of the 7 No. Sites visited	12
3.2 Description of sites	13
<b>4 Field Work Methodologies</b> .....	<b>14</b>
4.1 General	14
4.2 In-Situ Testing	14
4.2.1 <i>Panda 2 Probe</i>	14
4.2.2 <i>Shallow hand-excavated pits</i>	16
4.3 Laboratory Testing	17
4.3.1 <i>Laboratory Test Standards</i>	17
<b>5 Field and Laboratory Test Results</b> .....	<b>18</b>
5.1 Panda Probe Results	18
5.2 Interpretation of Probe Test Results	19
5.3 Laboratory Test Results	19
5.3.1 <i>Draft Laboratory Test Results</i>	19
<b>6 Concluding remarks</b> .....	<b>20</b>
<b>Appendix A: Cone Resistance Vs Depth Plots</b> .....	<b>21</b>
<b>1 Site 3 Assasuni 287042008: Test 1</b> .....	<b>22</b>
<b>2 Site 3 Assasuni 287042008:Test 2</b> .....	<b>23</b>
<b>3 Site 3 Assasuni 287042008: Test 3</b> .....	<b>24</b>
<b>4 Site 10 Dumuria – Site A 247302001: Test 1</b> .....	<b>25</b>
<b>5 Site 10 Dumuria – Site A 247302001: Test 2</b> .....	<b>26</b>
<b>6 Site 10 Dumuria – Site A 247302001: Test 3</b> .....	<b>27</b>
<b>7 Site 11 Dumuria – Site B 247303003: Test 1</b> .....	<b>28</b>
<b>8 Site 11 Dumuria – Site B 247303003:Test 2</b> .....	<b>29</b>
<b>9 Site 11 Dumuria – Site B 247303003:Test 3</b> .....	<b>30</b>
<b>10 Site 12 Rupsa 47752009:– Test 1</b> .....	<b>31</b>
<b>11 Site 12 Rupsa 247752009:Test 2</b> .....	<b>32</b>
<b>12 Site 12 Rupsa 247752009: Test 3</b> .....	<b>33</b>
<b>13 Site 15 Terokhada – Site A 247942010: – Test 1</b> .....	<b>34</b>
<b>14 Site 15 Terokhada – Site A 247942010: Test 2</b> .....	<b>35</b>
<b>15 Site 13 Terokhada – Site B 247942003: Test 1</b> .....	<b>36</b>
<b>16 Site 13 Terokhada – Site B 247942003:Test 2</b> .....	<b>37</b>
<b>17 Site 13 Terokhada – Site B 247942003: Test 3</b> .....	<b>38</b>
<b>18 Site 21 Mongla 201582003: Test 1</b> .....	<b>39</b>
<b>19 Site 21 Mongla 201582003: Test 2</b> .....	<b>40</b>
<b>20 Site 21 Mongla 201582003– Test 3</b> .....	<b>41</b>
<b>21 Site 21 Mongla 201582003 – Test 4</b> .....	<b>42</b>

**Appendix B: Sample descriptions – draft.....43**  
**Appendix C: Laboratory Test Results.....48**

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## 1 Executive summary

This Interim Laboratory Test Report presents the draft site investigation information and data recorded from 7 No. site investigations undertaken as part of the *Ground Improvement for Khulna Soft Clay Soil* project. The interim Laboratory Test Report forms part of the Task 3 in a series of seven key milestones in the delivery of the project:

1. Inception Report and Literature Review;
2. Field Situation Analysis Report;
- 3. Field and Laboratory Testing;**
4. Laboratory Test Report;
5. Draft Report;
6. Stakeholder Workshop;
7. Final Report.

A list of 35 No. sites of rural road infrastructure in Khulna Region (and other areas) were identified during the Task 1 Inception Report and Literature Review. Sites visits were made, with the observations and photographs presented in the Task 2 Field Situation Analysis Report.

Within the Field Situation Analysis report, these 35 No. sites were appraised using a list of assessment criteria and were reduced to a finalised site list of 7 No. locations that were deemed representative of the apparent common features / key failure mechanisms of the roads, which were as follows:

- Differential settlement adjacent to structures
- Erosion / over-steepening of the embankment slopes
- Longitudinal cracking towards the edge of the road pavement
- Lateral spreading of the embankments
- Poor road surface conditions / potholes are widespread
- Retaining wall / structure deformation

Examples of the above features were presented along with an initial assessment of the likely cause of failure in the Task 2 Field Situation Analysis Report

These 7 No. indicative sites were then subject to site investigation comprising in-situ testing and trial pitting including collection and scheduling of soil samples for laboratory geotechnical testing.

This Interim Laboratory Test Report issued in accordance with Task 3 details the methodologies employed for the site investigation works and presents initial factual data. It forms an interim version of the Task 4 Laboratory Test Report.

Upon completion of geotechnical laboratory testing, the Final Laboratory Test Report will be issued as deliverable for Task 4.

## 2 Introduction

### 2.1 Background to Project

There are major concerns for the resilience of rural road embankments exposed to an aggressive coastal environment, in areas of high flood risk and where embankments are often constructed on soft soil deposits with high compressible organic content. It is noted that the severity of the problem, where road embankments and structures can experience settlement failures relatively early in their lifespan; and the scale of the problem, with over 4500km of village roads; 800km of upazila roads, and 475km of union roads – combine to provide a context where the right interventions can have a high impact.

There is a large body of existing research, including the three projects mentioned in section 1.3 of the Terms of Reference; some research, such as geological and hydrological studies, that are specific to the Khulna region; and further international studies, research projects, and innovative engineering projects that have addressed the issues of durability, settlement and seismic behaviour for infrastructure founded on soft and compressible soils.

This study intends to collate the relevant findings from this existing research, to understand the effectiveness and limitations of existing ground improvement techniques implemented in Khulna region, and to develop appropriate recommendations to overcome the typical construction challenges for road embankments and structures in Khulna region.



### 2.2 Research objectives

The specific objective of this project identified in the ToR is *'to establish a cost effective ground improvement technique(s) which will be applicable in Khulna and other similar regions which have soft soils'* and this is to be supported by improvements to understanding in the following particular technical research area:

- The characteristics of the soil in the Khulna Region;
- The existing level of knowledge related to these soils;
- Identification of the status of the structures in the Khulna Region and identify factors that are causing deterioration;
- The spatial differences for the deterioration and the possible reasons behind such differences;
- Recommendations of the remedial measures to existing structures and guidelines for ground improvements for the construction of new rural roads in the study region.

## 2.3 Project Methodology

The Project Methodology involves the following key tasks:

1. Inception Report and Literature Review; [**complete**]
2. Field Situation Analysis, including some diagnostic field tests; [**complete**]
3. Field and laboratory testing [**complete – this report concludes**]
4. Laboratory Test Report
5. Draft Report;
6. Stakeholder Workshop;
7. Final Report;

The deliverable for each task of the project is a technical report as agreed in terms of reference in the contract. The progress of completed and current phases is summarised in the following Sections.

### 2.3.1 Inception Report

Following completion of Task 1, the Inception Report was submitted in September 2016. A summary of the work completed is listed below: -

- Initial stakeholder meetings
- Review of publications and academic research on the geology of the Khulna Region;
- Review of work undertaken so far to investigate the impact of soft ground on the structures in Khulna regions and elsewhere in Bangladesh under similar settings);
- Review of the different types of ground treatment methods available worldwide and those that have been used in Khulna Region;
- Review of the structures and locations available for inspection and investigation and identification of preferred structures for testing and further investigation;

The Inception Report also provided an outline of the plan of work for the Field Situation Analysis task.

### 2.3.2 Field Situation Analysis Report

Following completion of Task 2, the Field Situation Analysis report was presented in November 2016. A summary of the work completed is detailed below: -

- Of the 35 No. sites identified for inspection during the Inception Report, 21 No. sites were visited and appraised. It was not possible to visit all sites identified due to access and logistical issues.
- A broad review of a wide range of the sites was undertaken to present an overview of the existing field situation and with the purpose of selecting a limited number of appropriate sites for more detailed investigation during Task 3 (Field and Laboratory Testing).
- Information relating to the sites was recorded using pro-forma to record common data including:
  - Earthwork characteristics; length, height, slope angle, adjacent land;
  - Sources of water; hydrology, drainage;
  - Construction details; drainage, pavement, highway layout;
  - Highway structures; bridges, culverts, walls;
  - Observed condition; settlement, differential settlement, structural distress, drainage issues;

- The field observations were reported in the Field Situation Analysis report, and 7 No. sites were identified for further detailed investigation.
- The 7 No. sites identified were as follows:
  1. Assasuni, Satkhira, Road 287042008
  2. Dumuria, Khulna (a), Road 247302001
  3. Dumuria, Khulna (b), Road 247303003
  4. Rupsha, Khulna, Road 247752009
  5. Terokhada, Khulna (a), Road 247942010
  6. Terokhada, Khulna (b), Road 247942003
  7. Mongla, Bagerhat, Road 201582003
- A program of SI was developed for the 7 No. sites in order to support the development of more detailed understanding of ground models through the following detailed Field and Laboratory testing stage (Task 3).

The methodology for the Field Situation Analysis stage is presented in the Field situation analysis report.

### 2.3.3 Field and Laboratory Testing

The Task 3 Field and Laboratory testing at the 7 No. proposed sites identified in the field situation analysis report was undertaken between 28<sup>th</sup> January and 5<sup>th</sup> February 2017. The site visits and investigative works, were conducted by two Engineers from Mott MacDonald in conjunction with assistance from the local LGED Engineers and their labour force. The methodologies employed and initial results obtained during the Field and Laboratory Testing are the subject of this Task 3 *Interim* Field and Laboratory Testing Report.

### 3 Summary of Field Visits undertaken during Task 3 Field & Laboratory Testing

#### 3.1 Schedule of Sites

The sites that were visited during January and February 2017 to undertake site investigation works are presented in Table 3.1. The site numbering is consistent with the numbering presented in the Field Situation Analysis Report.

Table 3.1: List of sites visited during January /& February field visits

Site Number	District	Sub district	Road ID	Description / name
3	Satkhira	Assasuni	287042008	Kadakati GC - Protapnagar GC via Goaldanga Bazer road
10	Khulna	Dumuria	247302001	Maguraghona UP Office (R&H)-Notun (Maguraghona & Aroshnagar) Bazar Road
11	Khulna	Dumuria	247303003	Baliakhali bazar (Tipna R&H)-Kadamtola bazar-Madartala Bazar via Sovna UP Office Road
12	Khulna	Rupsha	247752009	Khulna Mongla H/way Kudir Battala-Khajadanga - Hatamtala-Lockpur GC Mongla road via Shamontasena Nutun hat.
15	Khulna	Terokhada	247942010	Nalamara R & H-Katenga GC via Kakdi & Abnali Road.
13	Khulna	Terokhada	247942003	Harikhaly R&H to Patlahat Growth Centre.
21	Bagerhat	Mongla	201582003	Mongla- Joymonir goal GC via Chila GC, BaddaiaMary Bazar.

#### 3.1 Rationale behind the selection of the 7 No. Sites visited

Based on the 21 No. site visits undertaken and the observations made during the Field Condition Analysis, the sites presented in Table 3.2 were recommended for more detailed investigation in Task 3; Field and Laboratory Testing. The reasons for selecting the 7 No. sites are presented in Table 3.2. These sites were considered representative of the geometry, features and defects observed and it was considered that they would yield further useful information for interpretation of deformation mechanisms and development of practical solutions.

Table 3.2: Rationale behind the sites selected for detailed investigation in Task 3

Site Number	Description / reason for
3	To review and assess reasons for loss of edge support, poor surface conditions, and over-steep slopes / erosion.
10	Investigate the causes of longitudinal cracking
11	Investigate the spreading behaviour and poor road surface conditions
12	Review the condition of the retaining wall, bridge approaches and loss of edge support to the highway
15	Investigate the poor road surface conditions, deformation of retaining wall and steep side-slopes
13	Investigate the loss of support / slope instability at highway edge
21	Investigate bridge approach and differential settlement. Retaining wall supports.

### **3.2 Description of sites**

The 7 No. sites chosen for further investigative work come under several Sub Districts. General descriptions of the Sub Districts, and site descriptions are provided in the Field Situation Analysis Report.

## 4 Field Work Methodologies

### 4.1 General

Based on the findings of the Task 1 Inception Report and Literature Review, the field observations made during the Task 2 Field Situation Analysis and on our investigation into commercially available plant and testing facilities summarised in the Inception Report, a programme of limited ground investigation and laboratory testing was proposed for the 7 No. sites.

Field work took the form of in-situ testing using a Panda 2 Probe and shallow hand excavated pits, from which samples were retrieved for geotechnical laboratory testing.

### 4.2 In-Situ Testing

#### 4.2.1 Panda 2 Probe

The Panda 2 Probe is a variable energy input dynamic cone penetrometer used to gain information from ground conditions in relation to soils investigation or compaction. It is portable (total weight of 20kg) which allow for single person operation with no enabling works required where bound layers are not found on surface. The Panda 2 Probe is also suitable for use in conjunction with core sampling to ascertain ground resistance or compaction values in underlying unbound layers.

##### 4.2.1.1 How does the Panda 2 Probe work?

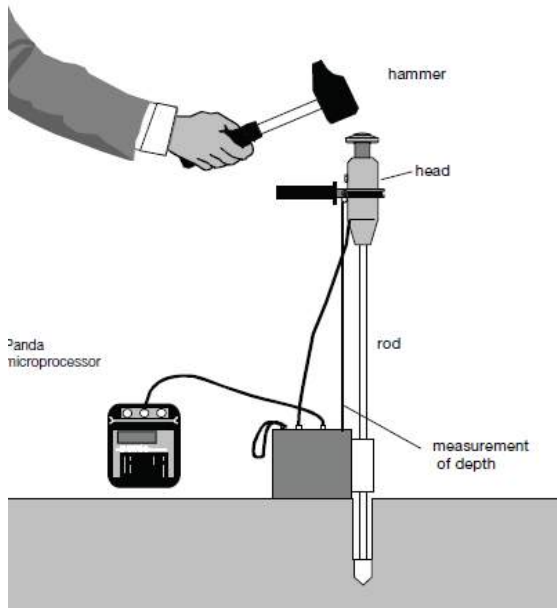
The Panda is a light-weight dynamic cone penetrometer, which uses variable energy and can be operated by one man to test soils to a depth of up to 6m below ground level. The device is hammered into the ground and records material resistance which can be conveyed in results applicable to client requirements such as MPa, KN, CBR, psi, etc.

The Panda 2 device consists of three main components known commonly as:

1. **The Anvil;** This part of the device is where strain gauges are built-in to record strike effort from hammer blow.
2. **Dialogue Terminal (DT);** This part of the device is where the operative can input and extract data in relation relevant site or sounding.
3. **Central Acquisition Unit (CAU);** The critical information for each sounding is returned from this unit in relation to overall depth, resistance, and strike distance.

The Panda 2 Probe apparatus is illustrated in Figure 2.

**Figure 1 - Panda 2 Probe Set-Up**



Source: courtesy of Sol-Solution

#### 4.2.1.2 The principle behind the Panda 2 Probe apparatus

The test is carried out by driving a cone (2, 4 or 10cm<sup>2</sup>) on the end of a set of rods using a fixed weight hammer. For each blow of the hammer a microprocessor records the speed of impact of the hammer and hence calculates the amount of energy used. The microprocessor uses the depth of penetration and energy for each blow of the hammer to calculate the dynamic cone resistance ( $q_d$ ) and records and displays the values for  $q_d$  along with the corresponding depth.

Measurements recorded by the microprocessor can be analysed using this software which allows the data to be presented in various formats. The software includes an extensive database of soils and materials from which to classify identified materials. The basic output is a plot of depth vs cone resistance.

#### 4.2.1.3 Panda 2 Probe Test Locations

A schedule of Panda 2 Probe test locations is presented in Table 4.1.

:

Table 4.1: Schedule of locations for Panda Probe testing.

Site Number	Site Name	Area	Test Number	Final Depth (mbgl)	Embankment Height (m)	Test Location Co-ordinates (N,E)
3	Assassuni	Road 287042008	1	4.7	1.2	22.59198, 89.21208
			2	4.7	1.2	22.59184, 89.21209
			3	4.5	1.1	22.59137, 89.21211
10	Dumuria A	Road 247302001	1	4.9	1.8	22.80609, 89.42352
			2	3.7	2.0	22.80494, 89.42290
			3	4.5	1.6	22.80522, 89.42314
11	Dumuria B	Road 247303003	1	4.5	1.6	22.7819, 89.377570
			2	4.2	1.6	22.78181, 89.37769
			3	4.8	0.9	22.78158, 89.37742
12	Rupsa	Road 247752009	1	4.6	0.4	22.78648, 89.62713
			2	4.5	1.5	22.78648, 89.62698
			3	4.8	1.8	22.78714, 89.62774
15	Terokhada A	Road 247942010	1	4.5	2.2	22.93618, 89.66647
			2	4.6	2.1	22.93614, 89.66649
13	Terokhada B	Road 247942003	1	4.6	5.0	22.91289, 89.7049
			2	4.6	5.0	22.91286, 89.70498
			3	4.6	5.0	22.91294, 89.70477
21	Mongla A & B	Road 201582003	1	4.5	0.5	22.44176, 89.61001
			2	4.5	0.5	22.44187, 89.60997
			3	4.5	0.48	22.44218, 89.60809
			4	4.5	0.48	22.44219, 89.60775

#### 4.2.2 Shallow hand-excavated pits

To provide samples for laboratory geotechnical testing, 3 No. shallow hand excavated trial pits were formed at each of the 7 No. study sites. The trial pits were excavated by LGED Labourers under the direction and supervision of Mott MacDonald Engineers. Trial pits were formed at both the top and bottom of the road embankments where conditions allowed. Soil samples were retrieved from varying positions within the earthwork embankments.

All samples retrieved were stored in air-tight zip-lock™ bags out of direct sunlight and extremes of temperature before being sent the ProSoil Foundation Consultant's<sup>1</sup> laboratory in Dhaka to undergo geotechnical laboratory testing.

A schedule of samples taken and depth is presented in Table 4.2 together with a schedule of tests undertaken. Soil sample descriptions taken in the field are provided in Appendix B.

<sup>1</sup> Details about ProSoil Foundation Consultant: [www.prosoil.org](http://www.prosoil.org)

Table 4.2: Schedule of samples taken for laboratory geotechnical testing.

Site Number	Sample No.	Sample Depth (mbgl)	Sample Co-ordinates	Location of trial pit on earthwork	Test Schedule Notes
3	1.	0.3	22.59198, 89.21208	Bottom	Atterberg limits Particle Size Analysis
	2.	0.0	22.59184, 89.21209	Top	none
	3.	0.3	22.59137, 89.21211	Top	none
10	1.	0.25	22.80609, 89.42352	Top	Atterberg limits Particle Size Analysis
	2.	0.25	22.80494, 89.42290	Top	Atterberg limits Particle Size Analysis
	3.	0.3	22.80522, 89.42314	Top	Atterberg limits Particle Size Analysis
11	1.	0.2	22.7819, 89.377570	Bottom	Atterberg limits Particle Size Analysis
	2.	0.3	22.78181, 89.37769	Top	Atterberg limits Particle Size Analysis
	3.	0.3	22.78158, 89.37742	Top	Atterberg limits Particle Size Analysis
12	1.	0.3	22.78648, 89.62713	Top	Atterberg limits Particle Size Analysis
	2.	0.3	22.78648, 89.62698	Bottom	Atterberg limits Particle Size Analysis
	3.	0.3	22.78714, 89.62774	Top	Atterberg limits Particle Size Analysis
15	1.	0.3	22.93618, 89.66647	Top	Atterberg limits Particle Size Analysis
	2.	0.3	22.93614, 89.66649	Top	Atterberg limits Particle Size Analysis
13	1.	0.3	22.91289, 89.7049	Top	Atterberg limits Particle Size Analysis
	2.	0.3	22.91286, 89.70498	Top	Particle Size Analysis
	3.	0.3	22.91294, 89.70477	Top	Particle Size Analysis
21	1.	0.25	22.44176, 89.61001	Top	Atterberg limits Particle Size Analysis
	2.	0.25	22.44187, 89.60997	Top	none
	3.	0.3	22.44218, 89.60809	Top	Particle Size Analysis
	4.	0.3	22.44219, 89.60775	Top	Particle Size Analysis

### 4.3 Laboratory Testing

#### 4.3.1 Laboratory Test Standards

The testing of samples retrieved from the site works has been conducted in accordance with the applicable American Society for Testing Materials (ASTM) standard for soil testing;

- ASTM D2487 - 11 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
- ASTM D422-63 Standard Test Method for Particle-Size Analysis of Soils ASTM

## 5 Field and Laboratory Test Results

### 5.1 Panda Probe Results

Panda probe results plots are provided in Appendix A. There are 21 No. plots for the 7No. sites which show cone resistance (in MPa) against depth for each test site. Table 5.1 below provides a summary of results.

Table 5.1: Summary of Panda Probe Results.

Site Number	Site Name	Test Number	Final Depth (mbgl)	Embankment Height (m)	Summary of Penetration
3	Assassuni	1	4.7	1.2	Reduction in soil strength below road surface from 0 to 0.9 mbgl, before steady increase to end of probe
		2	4.7	1.2	Sharp increase at shallow depth (in road formation) followed by reduction in soil strength below road surface from 0.1 to 0.9 mbgl, before steady increase to 2.0m where strength levels to end of probe
		3	4.5	1.1	General drop in soil strength to 1.5mbgl, before rising to a steady resistance value at 2.0mbgl.
10	Dumuria A	1	4.9	1.8	General slight rise in soil strength to 2.0m then levels off to end of probe.
		2	3.7	2.0	General slight rise in soil strength to 2.0m then levels off to end of probe.
		3	4.5	1.6	Reduction in soil strength below road surface from 0.3 to 0.9 mbgl, before steady increase to end of probe
11	Dumuria B	1	4.5	1.6	Variable strength within the embankment, levelling off to a consistent value from 1.0mbgl to the end of the probe.
		2	4.2	1.6	General slight rise in soil strength to end of probe.
		3	4.8	0.9	Reduction in soil strength below road surface from 0 to 0.7 mbgl, before steady increase to 2.0m then levels off to end of probe.
12	Rupsa	1	4.6	0.4	General slight rise in soil strength to end of probe. Zone of reduced strength from 0.6 to 0.9mbgl
		2	4.5	1.5	Reduction in soil strength below road surface from 0 to 0.7 mbgl, before steady increase to 3.0m then slight reduction to end of probe.
		3	4.8	1.8	Reduction in soil strength below road surface from 0.1 to 0.9 mbgl, before steady increase to 1.8 m then levels off to end of probe.
15	Terokhada A	1	4.5	2.2	Reduction in soil strength below road surface from 0.3 to 1.5 mbgl, before steady increase to end of probe.
		2	4.6	2.1	Slight reduction in soil strength below road surface from 0.2 to 1.3 mbgl, before steady increase to end of probe.
13	Terokhada B	1	4.6	5.0	Slight reduction in soil strength below road surface from 0.0 to 2.4 mbgl, before sharp, than steady increase to end of probe.
		2	4.6	5.0	Reduction in soil strength below road surface from 0.0 to 0.9 mbgl, before levelling off to 2.0m, then steady increase to end of probe.
		3	4.6	5.0	General slight rise in soil strength to end of probe.
21	Mongla A & B	1	4.5	0.5	Reduction in soil strength below road surface from 0.1 to 0.4 mbgl, before steady increase to 2.0 m then levels off to end of probe.
		2	4.5	0.5	General slight rise in soil strength to end of probe.
		3	4.5	0.48	Reduction in soil strength below road surface from 0.2 to 0.7 mbgl, before increasing to 2.0m, then levelling off to end of probe
		4	4.5	0.48	Reduction in soil strength below road surface from 0.2 to 0.8 mbgl, before slight increase to end of probe

## 5.2 Interpretation of Probe Test Results

Full interpretation of the results will be provided in the Final Field and Laboratory Test Report submitted in Task 4.

## 5.3 Laboratory Test Results

### 5.3.1 Draft Laboratory Test Results

Draft laboratory test results from of the samples gathered during the site visit stage are presented in Appendix C. A summary of the test results are provided in Table 5.2.

Table 5.2: Summary of test results

Site Number	Sample No.	Sample Depth (mbgl)	Visual Classification USCS* Classification	Liquid Limit LL (%)	Plastic Limit PL (%)	Plasticity Index PI (%)
3	1.	0.3	Clay CH - Fat Clay	52	28	24
	2.	0.0				
	3.	0.3				
10	1.	0.25	Clay CL - Lean Clay	47	21	26
	2.	0.25	Clay CL - Lean Clay	49	21	28
	3.	0.3	Clay CL - Lean Clay with Sand	46	20	26
11	1.	0.2	Clay CH – Fat Clay with Sand	52	25	27
	2.	0.3	Clay CH - Fat Clay	58	25	33
	3.	0.3	Clay CH - Fat Clay	59	25	34
12	1.	0.3	Clay CL – Lean Clay	44	23	21
	2.	0.3	Clay CL – Lean Clay	48	20	28
	3.	0.3	Clay CH - Fat Clay	54	25	29
15	1.	0.3	Clay CL – Lean Clay	41	21	20
	2.	0.3	Clay CL – Lean Clay	42	21	21
13	1.	0.3	Clay CL – Lean Clay	43	27	17
	2.	0.3	Clay CH - Fat Clay	56	24	32
	3.	0.3	Fine Sand SM – Silty Sand			
21	1.	0.25	Clay CH – Fat Clay with Sand	54	21	33
	2.	0.25				
	3.	0.3	Clay CL – Lean Clay	41	24	17
	4.	0.3	Fine Sand SM - Silty Sand			

\* Unified Soil Classification System

Description of the test results and interpretation of will be provided in the Final Field and Laboratory Test Report submitted in Task 4.

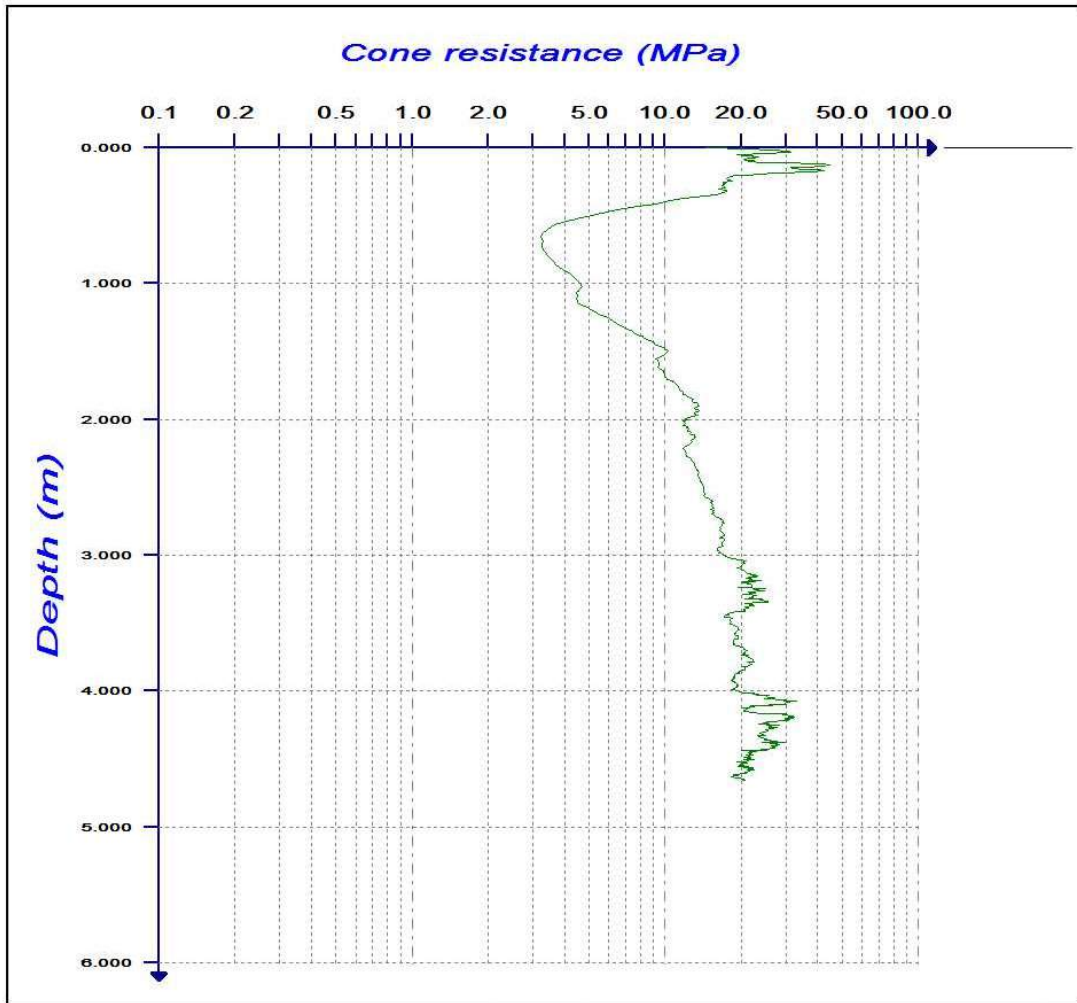
## **6 Concluding remarks**

This Interim Laboratory Test Report has presented the factual results from field investigations at 7No. sites. The results are a combination of in situ testing and laboratory testing to characterise the soils present at each site.

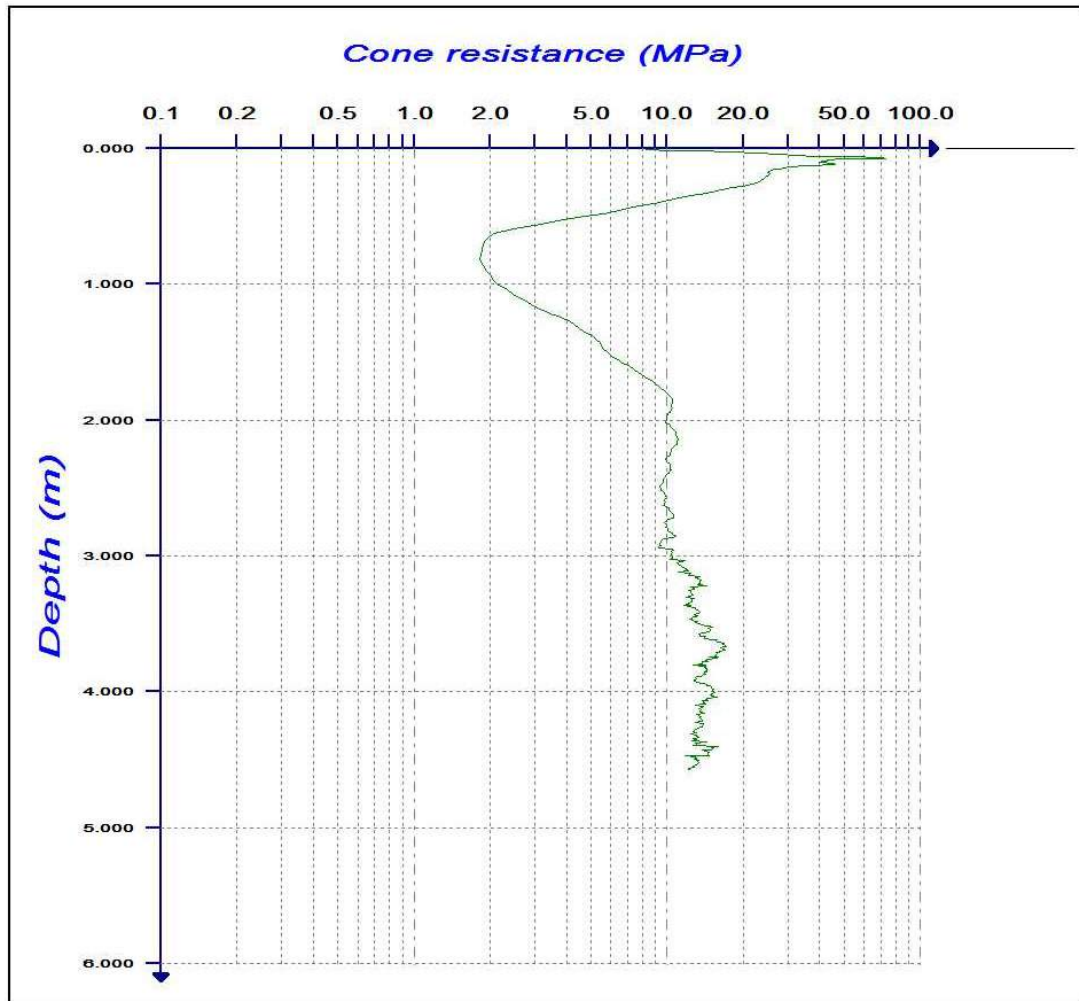
As part of Task 4, the results will be used to develop observational ground models for each of the sites to help better understand the failure mechanisms at each site before identifying remedial treatments or operational procedures in Task 5 that can mitigate failure in the future.

**Appendix A: Cone Resistance Vs Depth Plots**

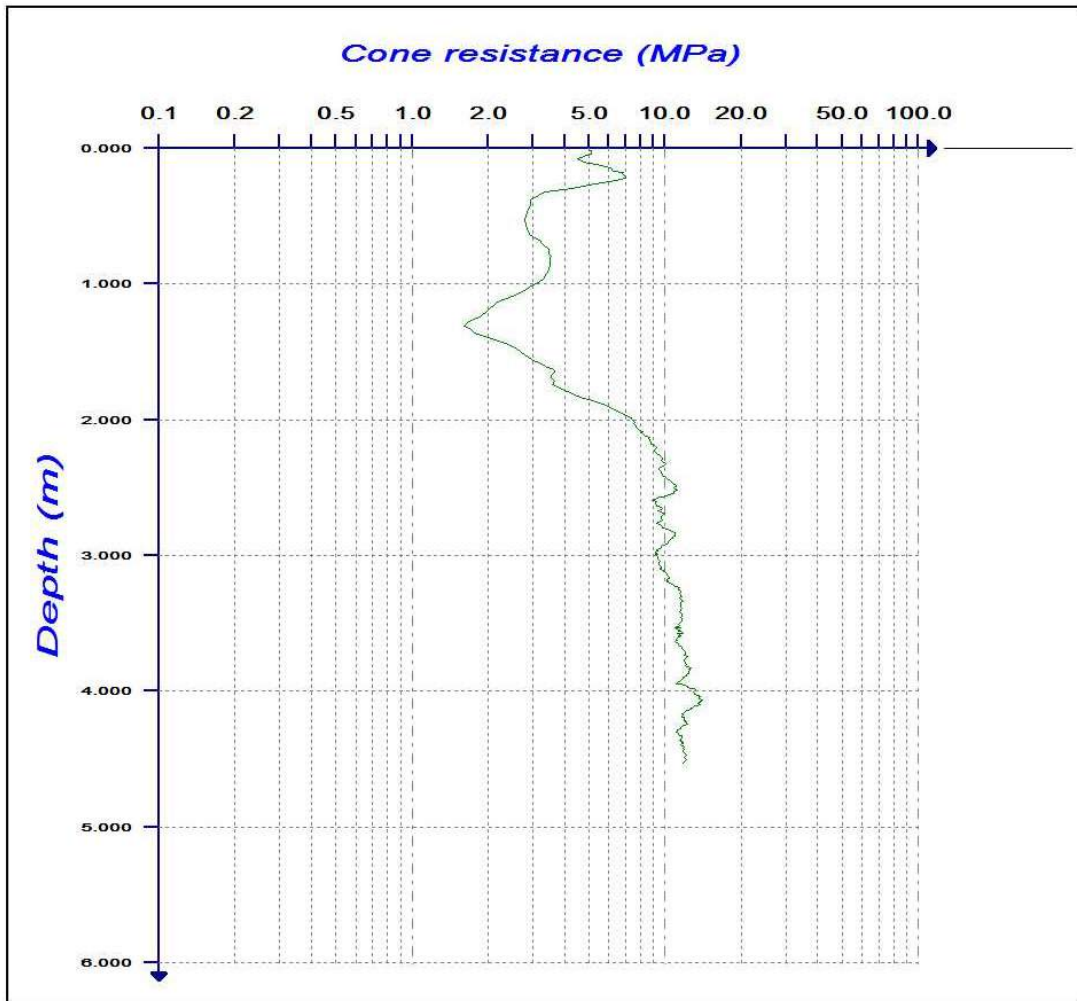
# 1 Site 3 Assasuni 287042008: Test 1



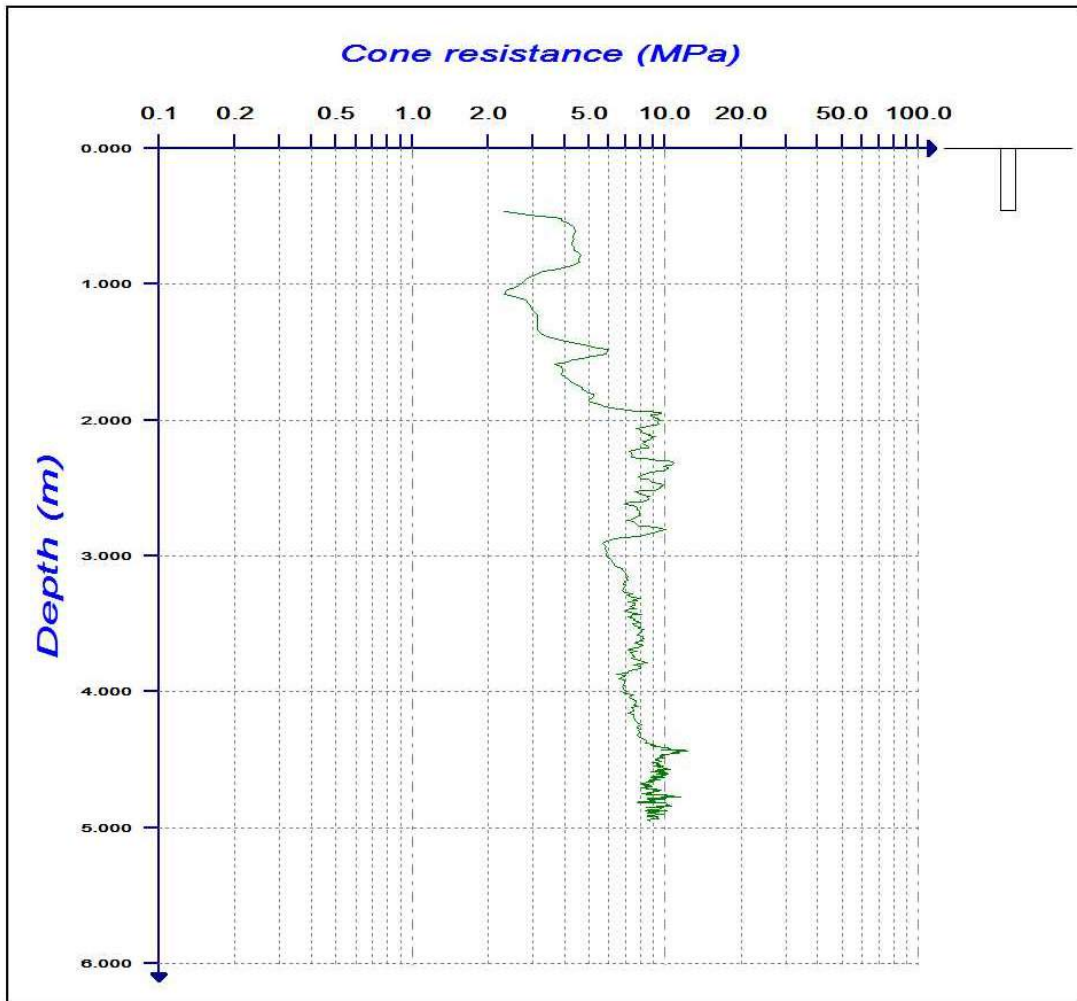
## 2 Site 3 Assasuni 287042008:Test 2



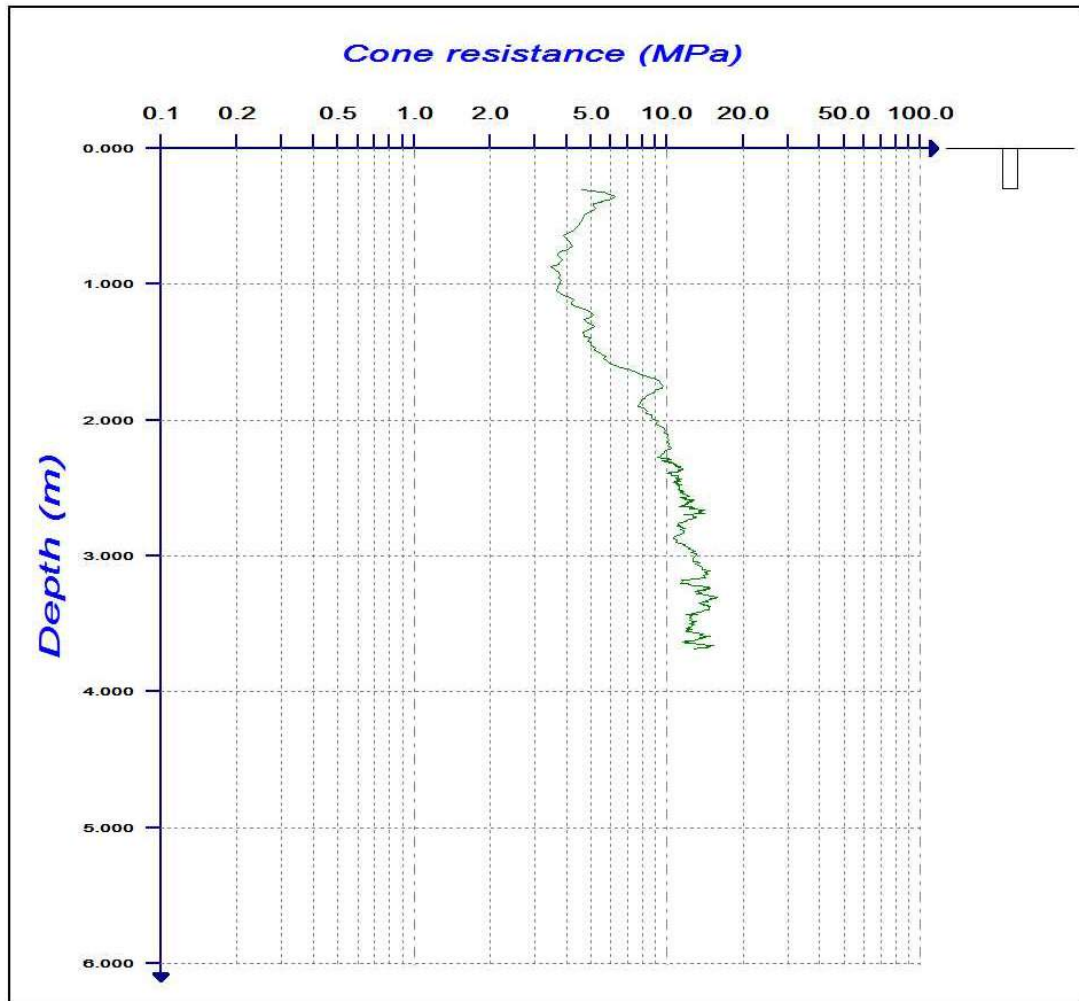
### 3 Site 3 Assasuni 287042008: Test 3



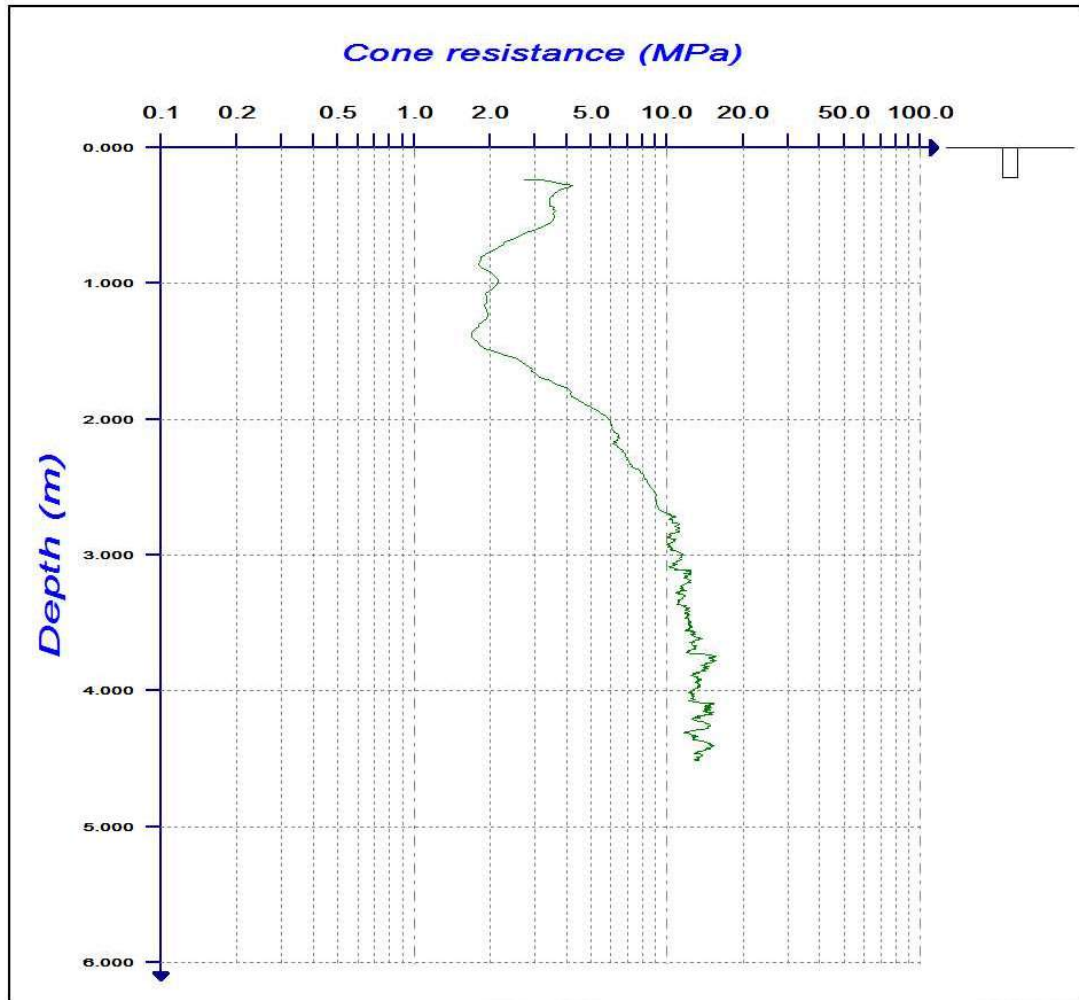
#### 4 Site 10 Dumuria – Site A 247302001: Test 1



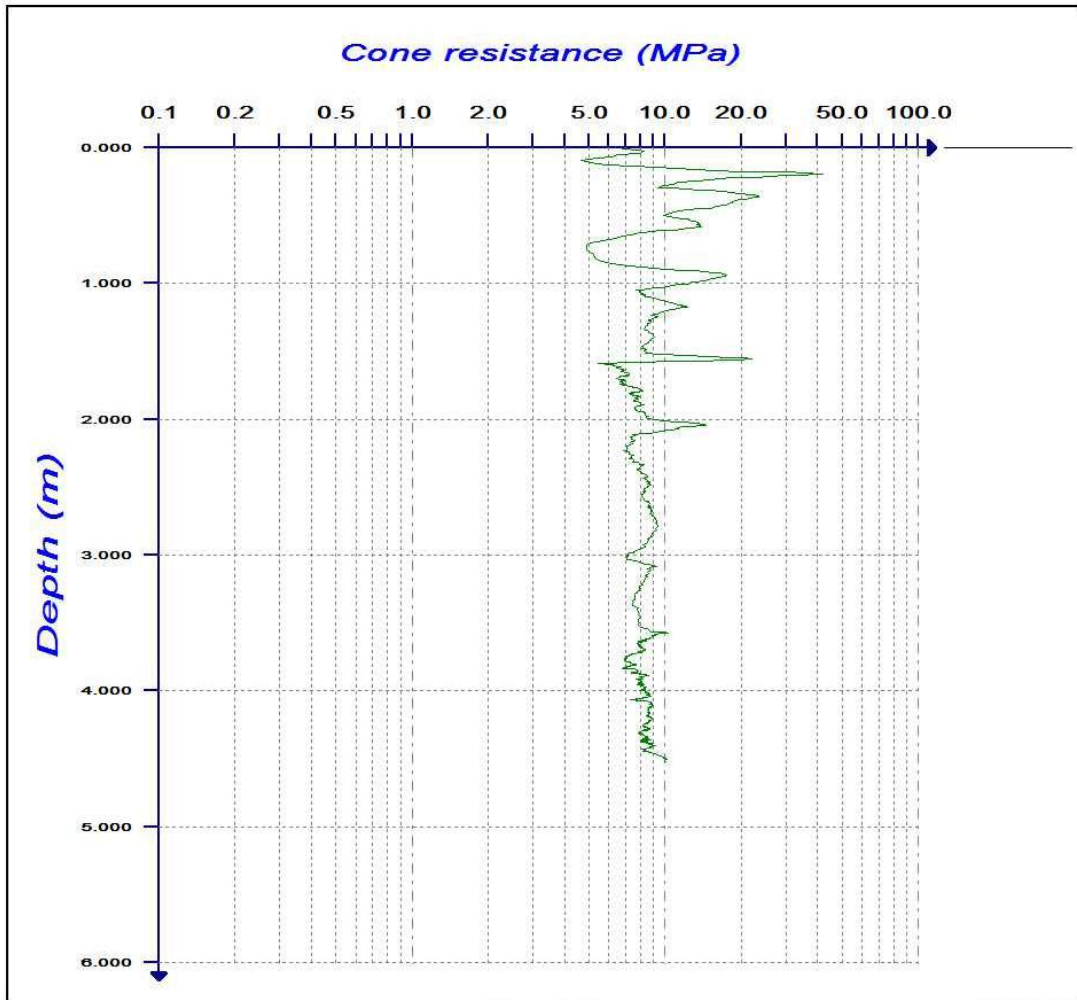
### 5 Site 10 Dumuria – Site A 247302001: Test 2



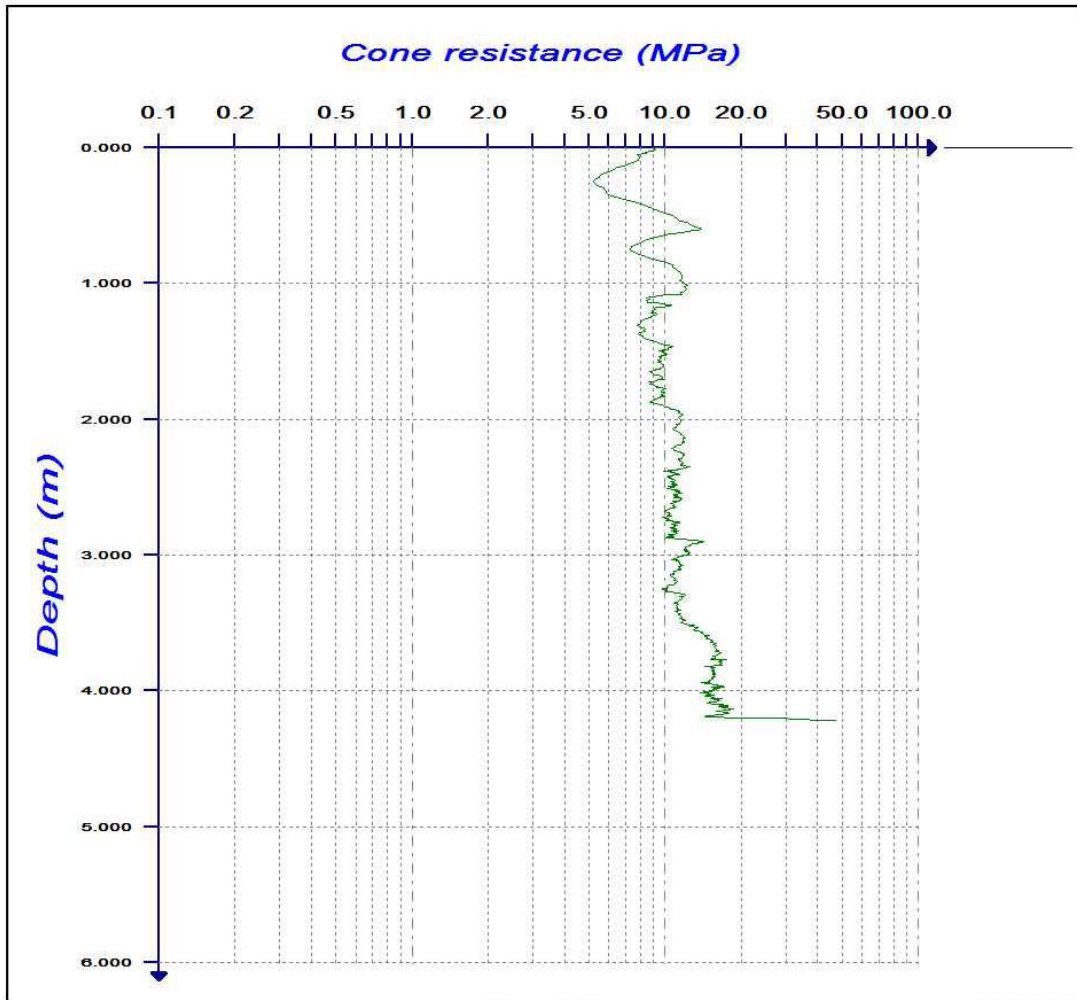
### 6 Site 10 Dumuria – Site A 247302001: Test 3



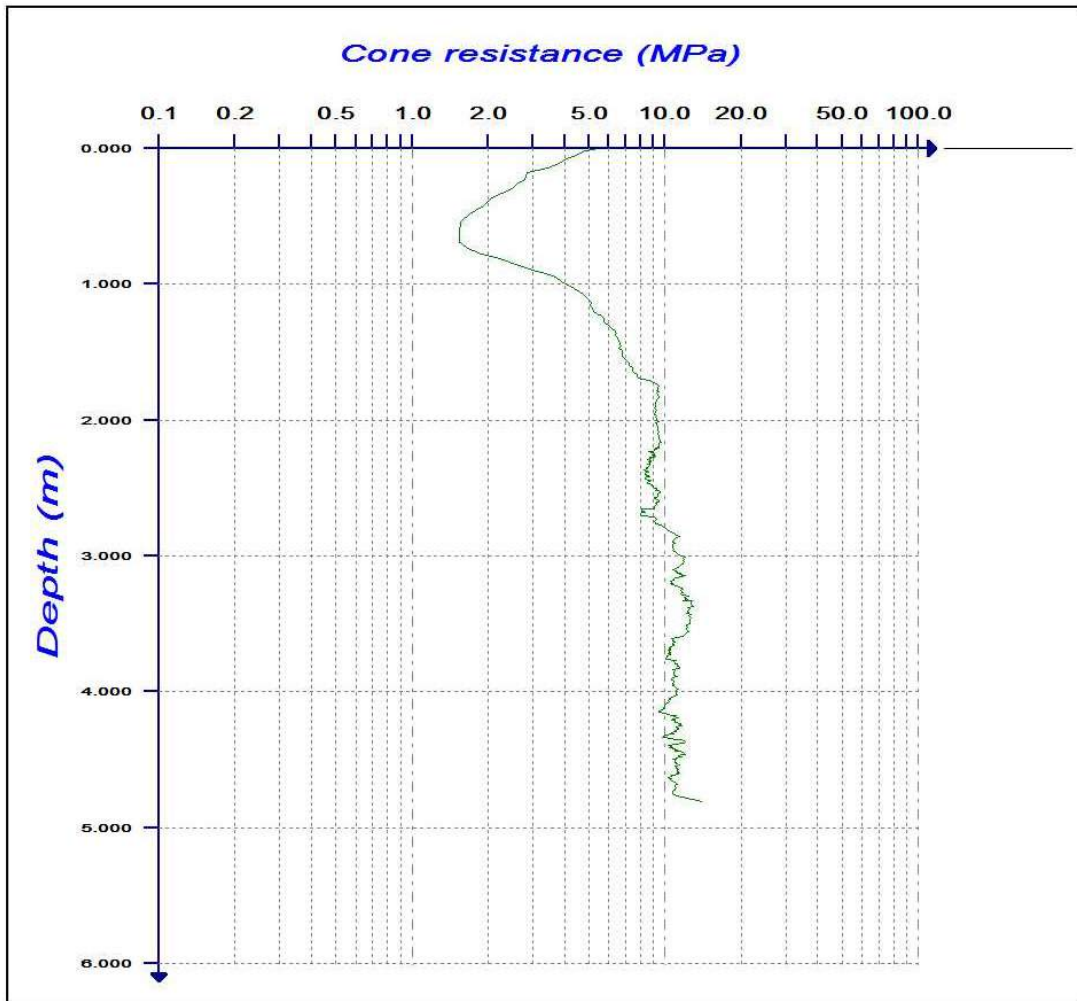
## 7 Site 11 Dumuria – Site B 247303003: Test 1



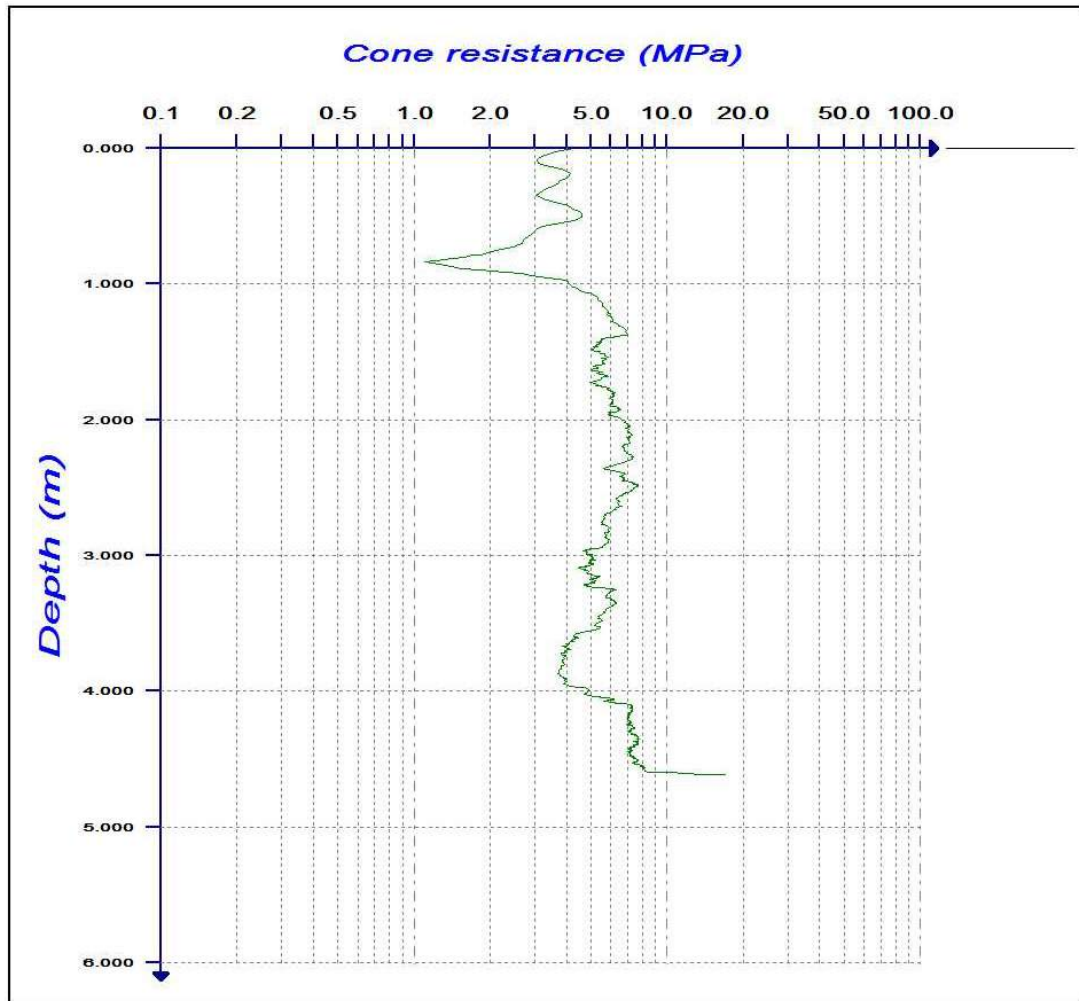
### 8 Site 11 Dumuria – Site B 247303003:Test 2



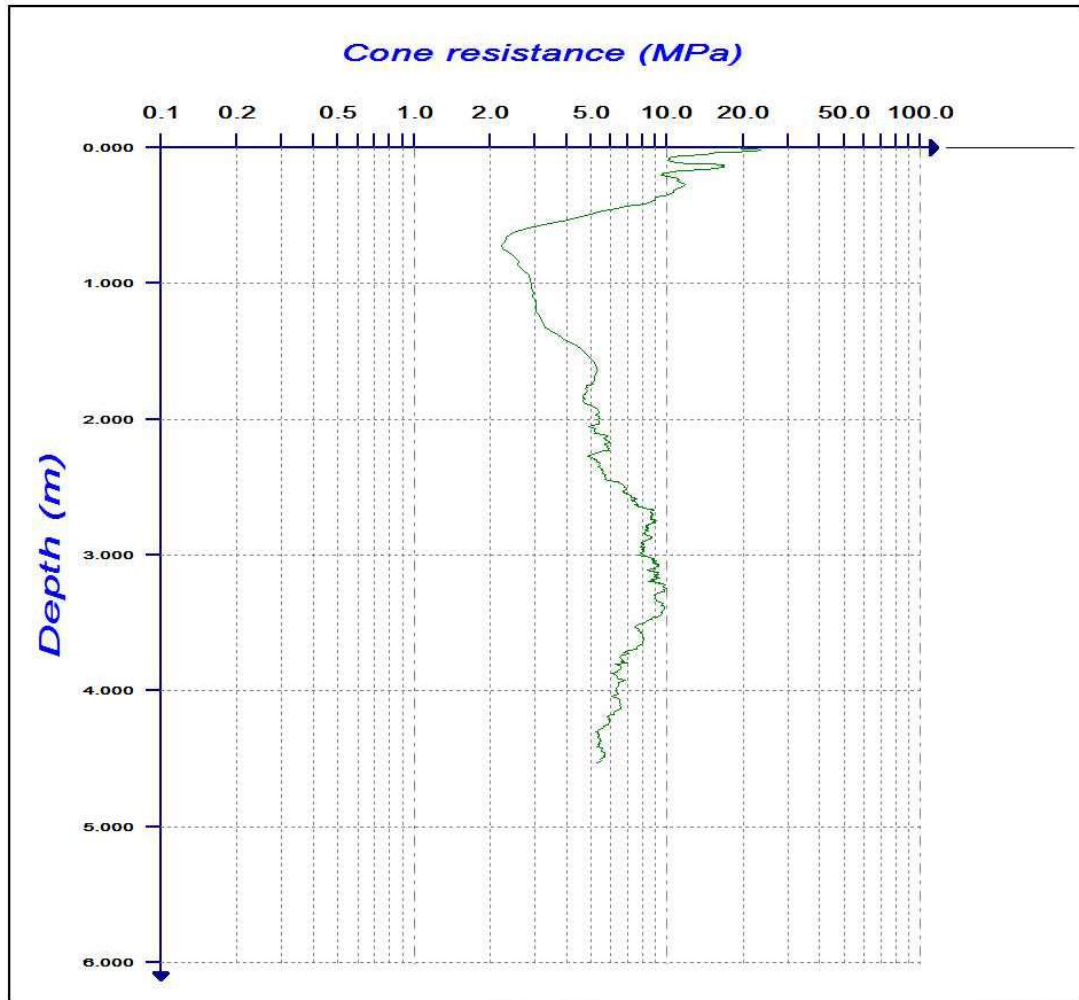
### 9 Site 11 Dumuria – Site B 247303003:Test 3



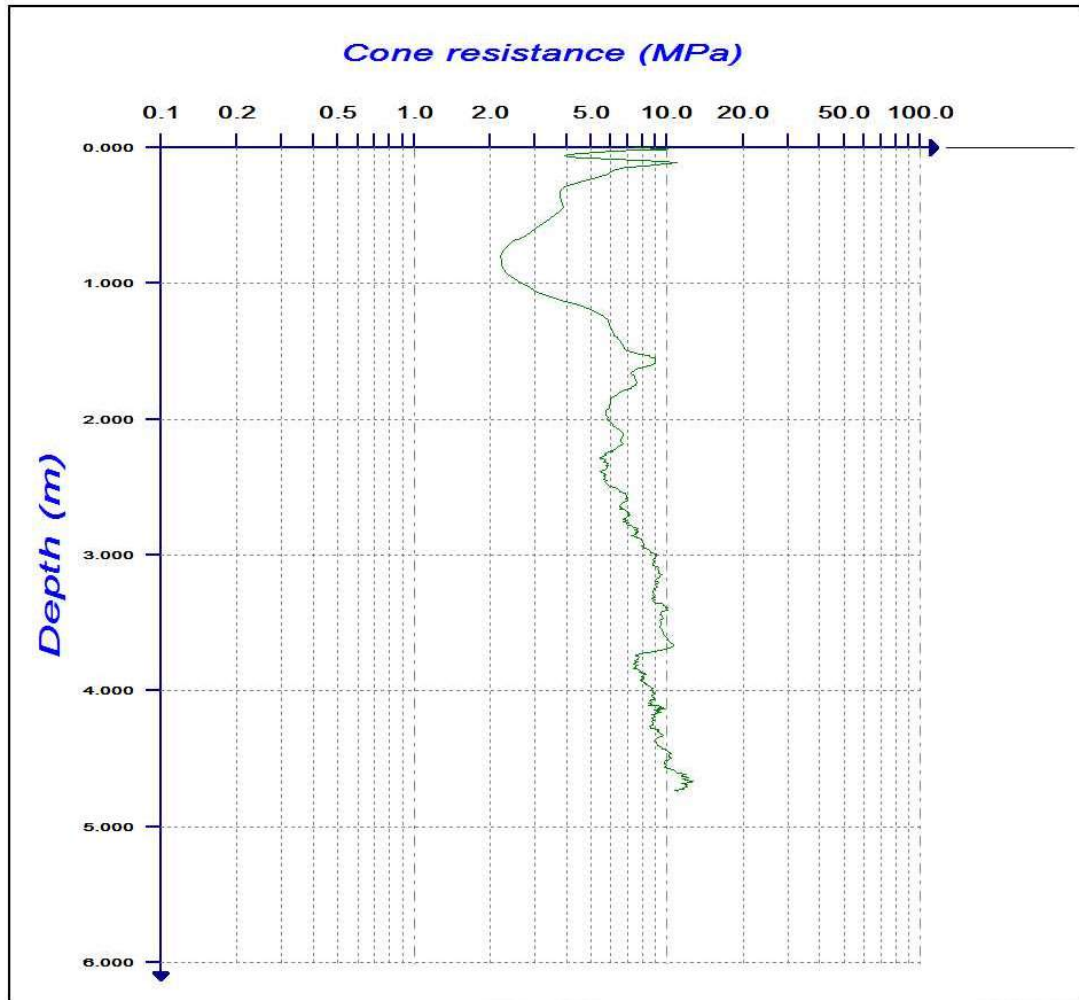
### 10 Site 12 Rupsa 47752009:– Test 1



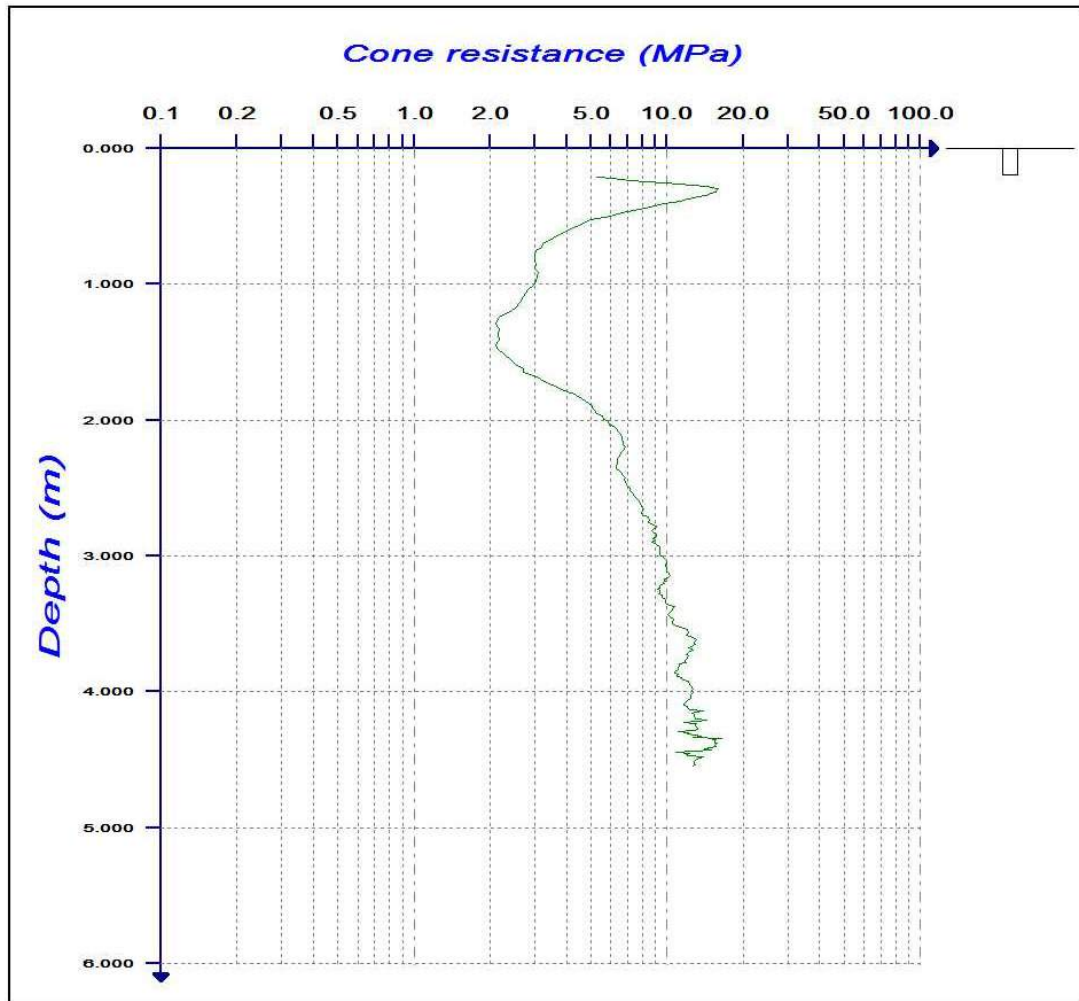
### 11 Site 12 Rupsa 247752009:Test 2



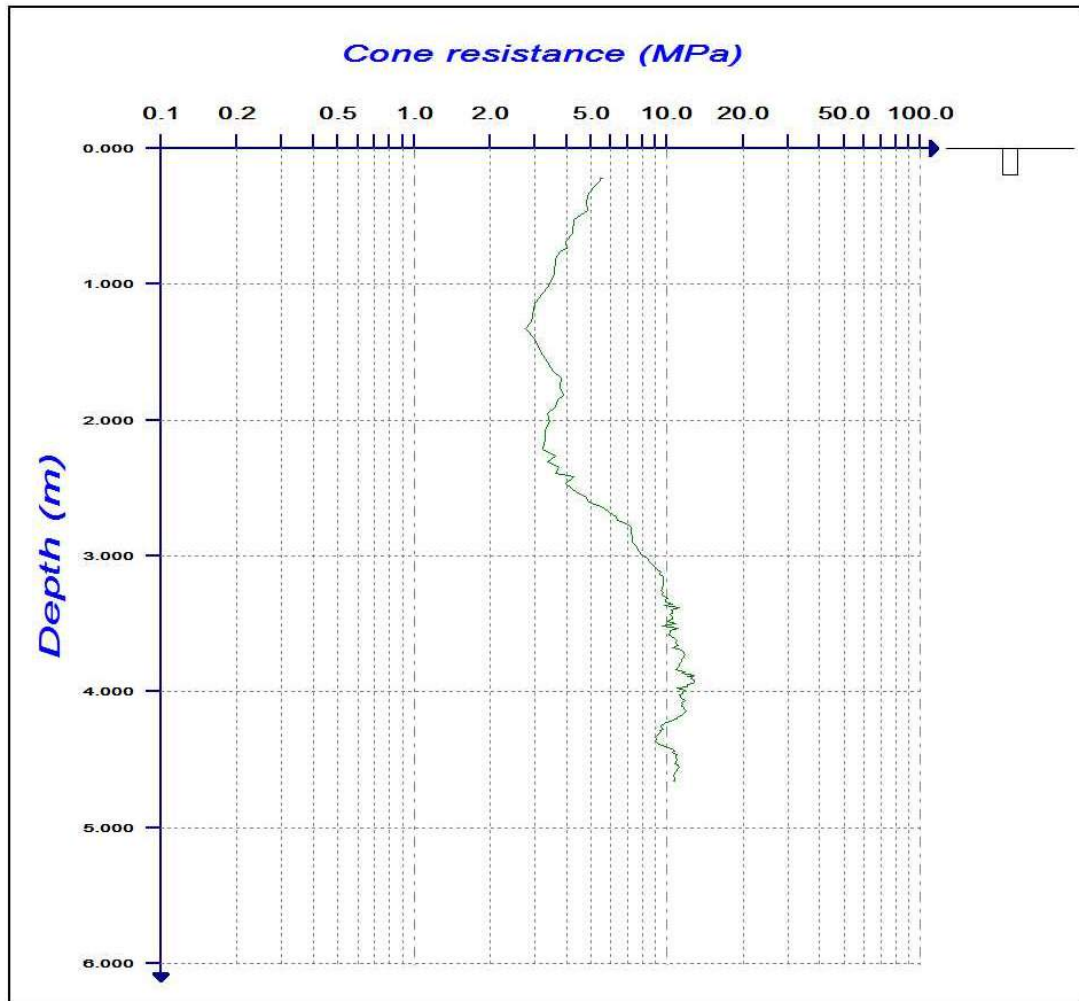
### 12 Site 12 Rupsa 247752009: Test 3



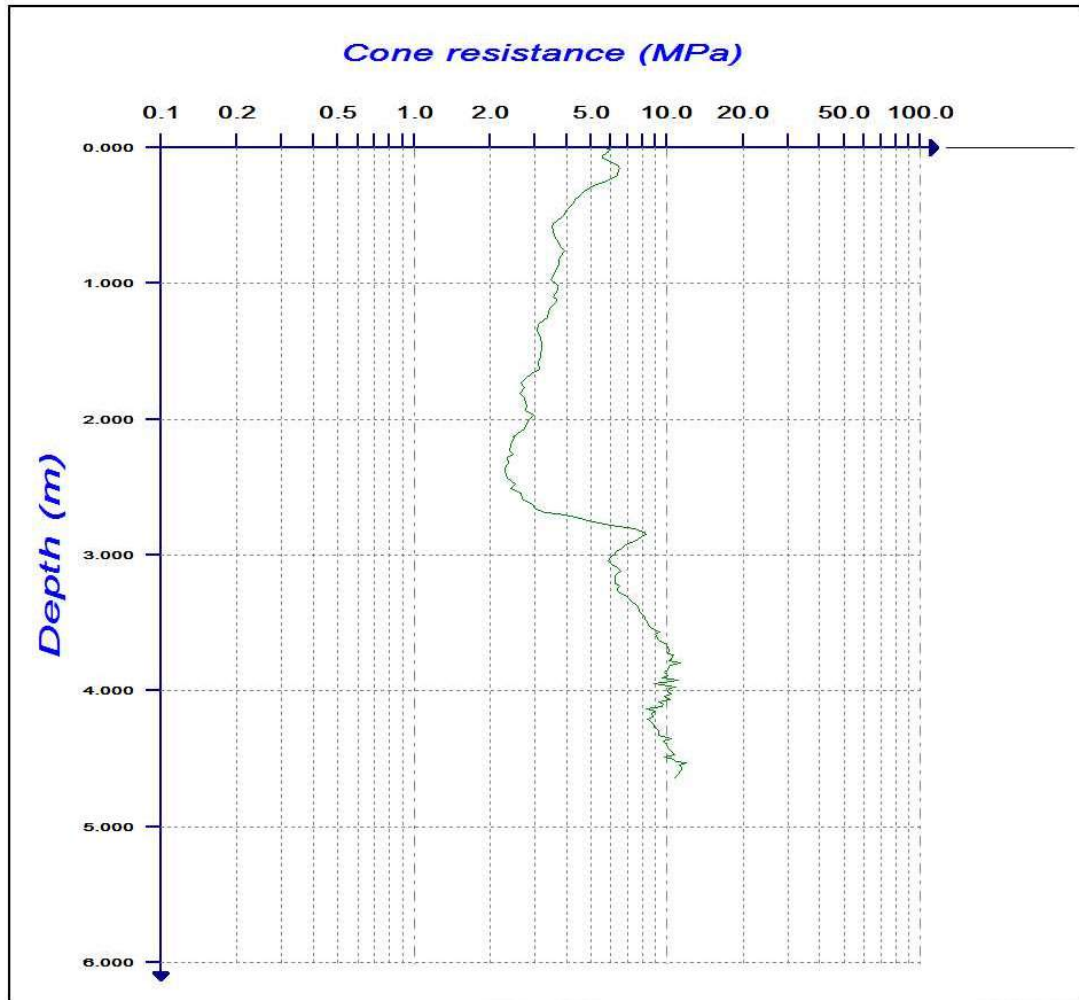
### 13 Site 15 Terokhada – Site A 247942010: – Test 1



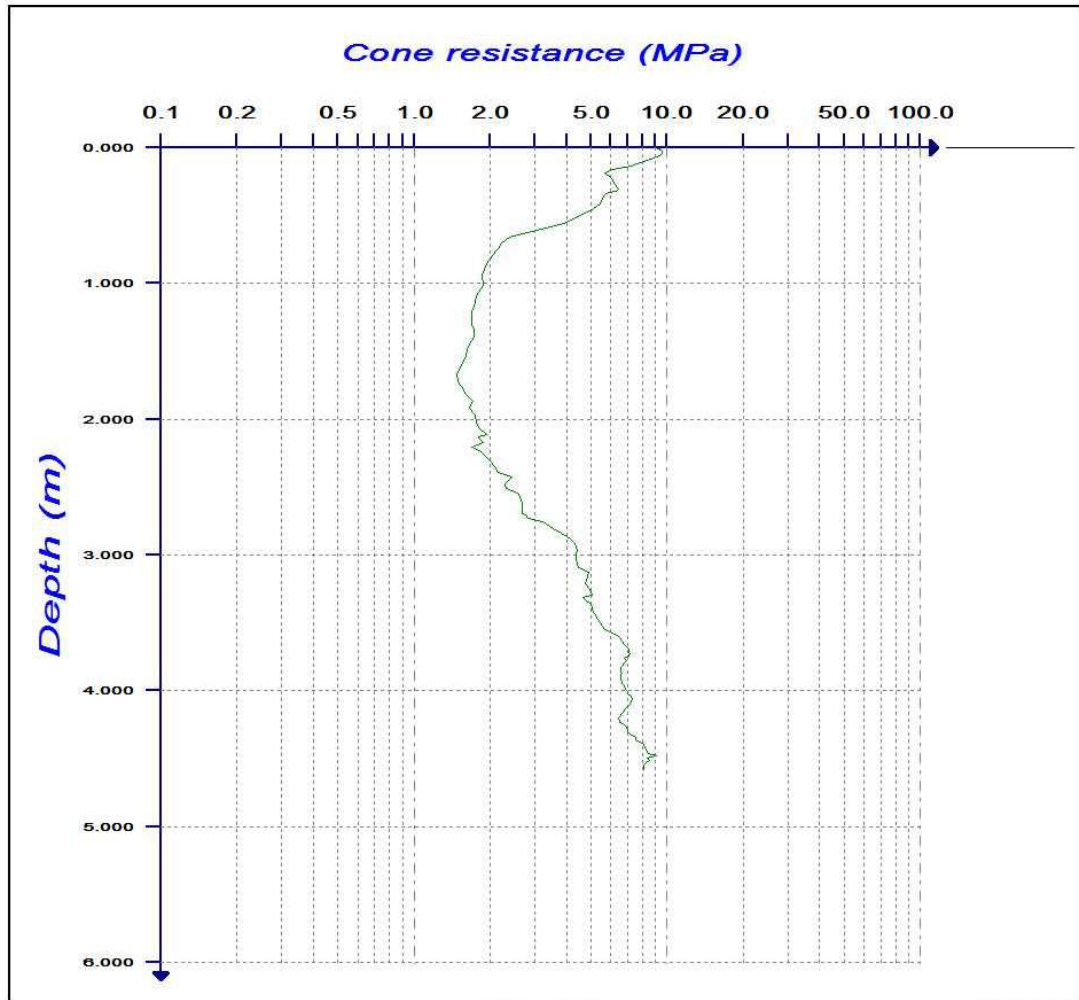
### 14 Site 15 Terokhada – Site A 247942010: Test 2



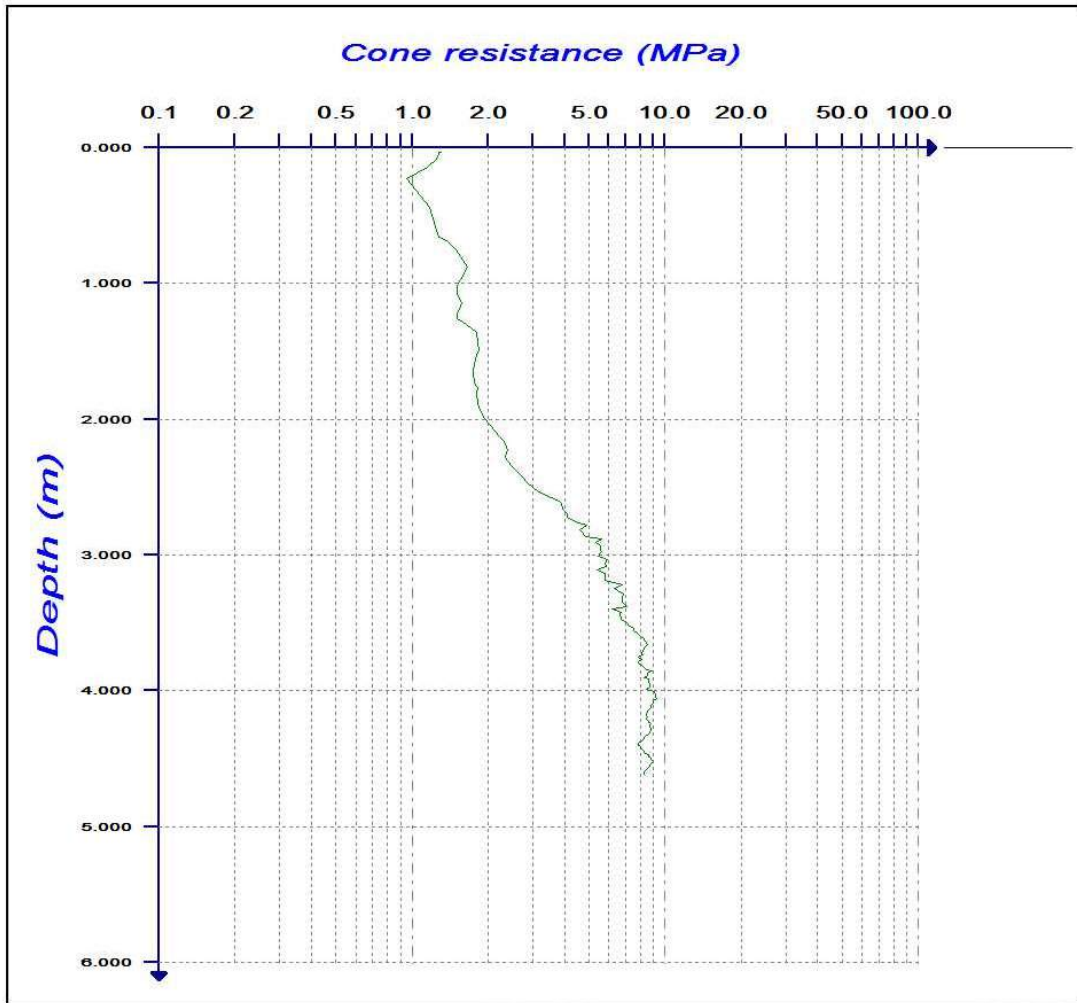
### 15 Site 13 Terokhada – Site B 247942003: Test 1



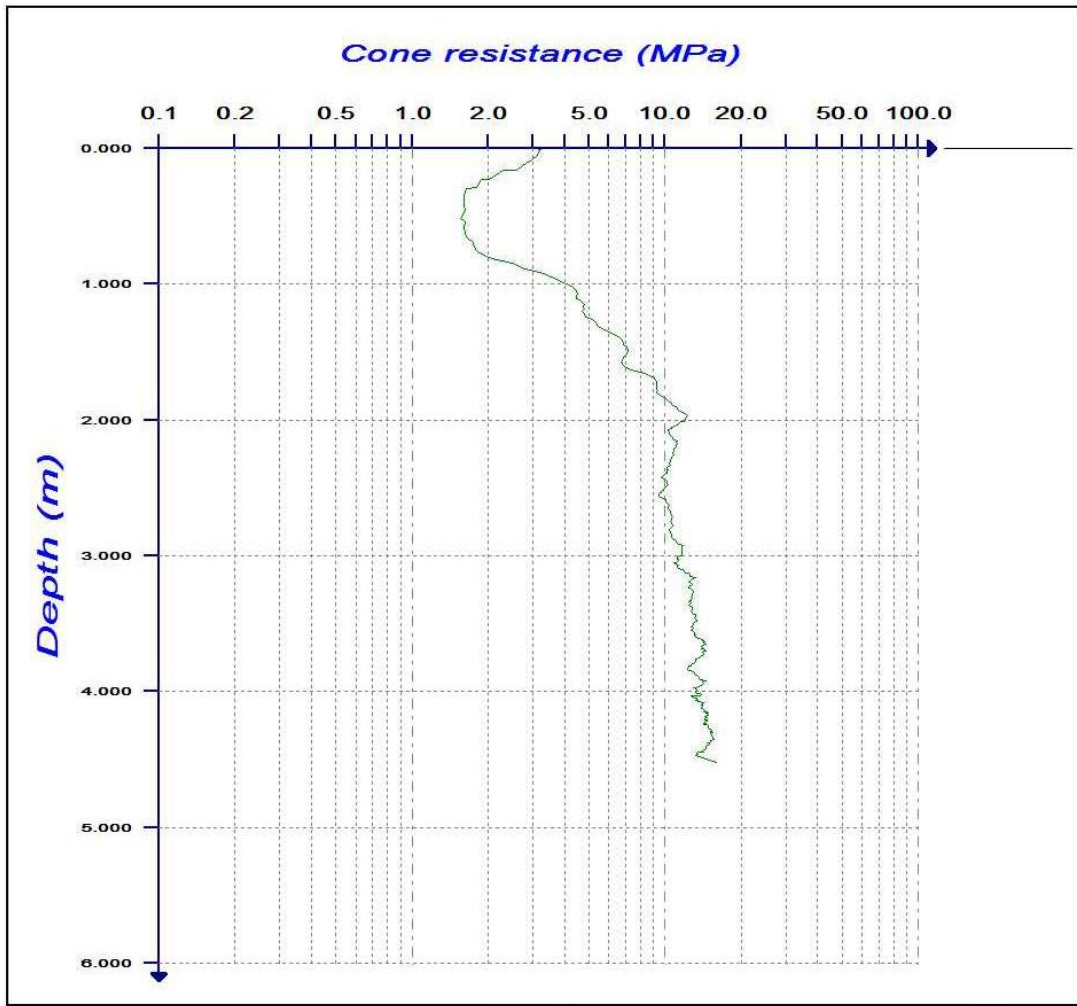
### 16 Site 13 Terokhada – Site B 247942003:Test 2



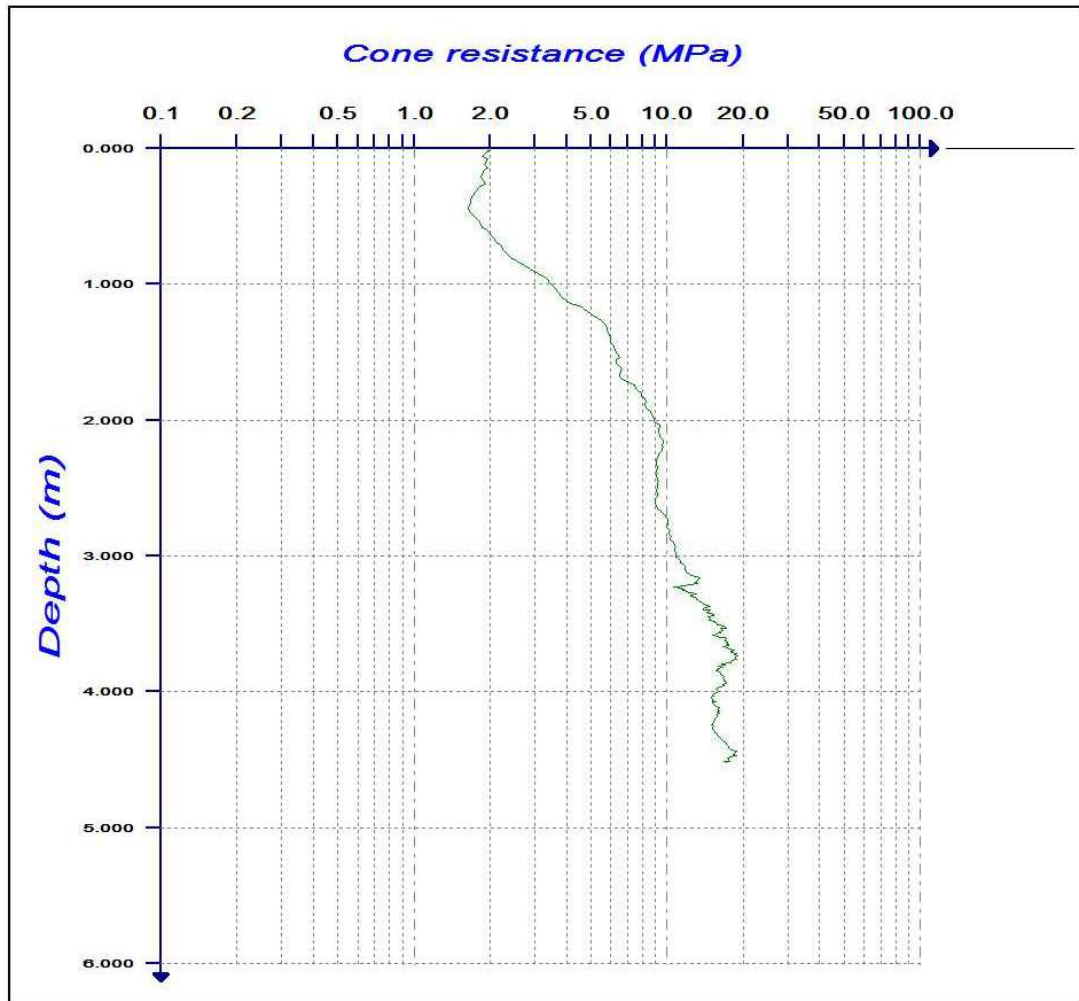
17 Site 13 Terokhada – Site B 247942003: Test 3



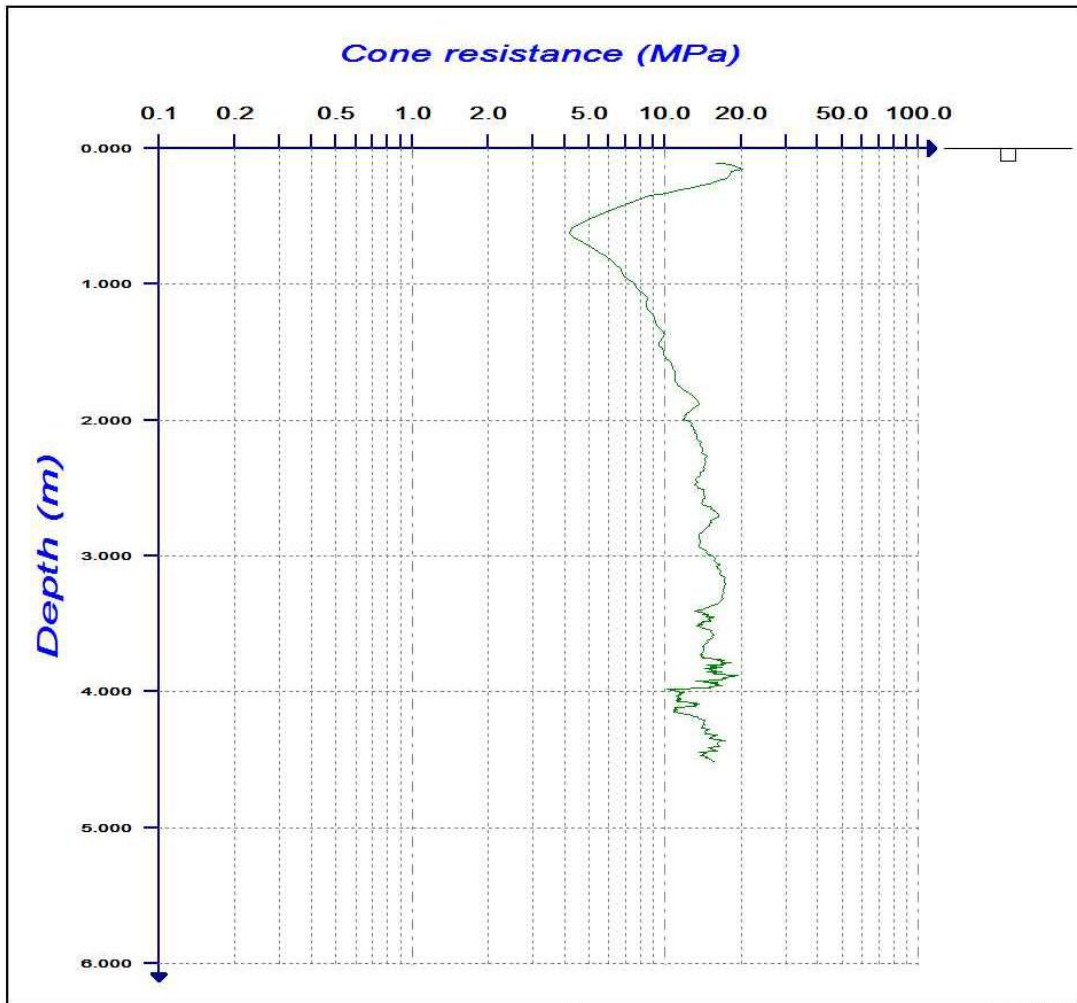
### 18 Site 21 Mongla 201582003: Test 1



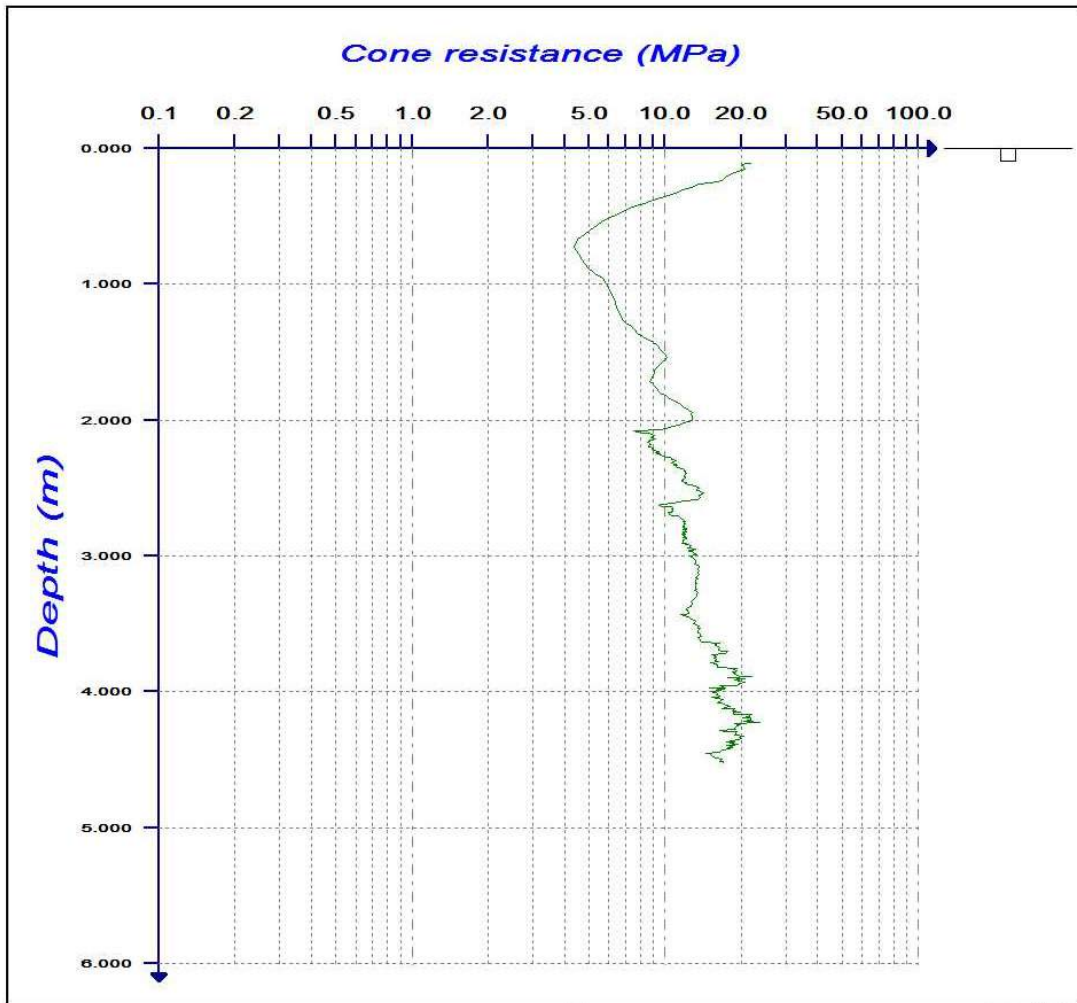
### 19 Site 21 Mongla 201582003: Test 2



## 20 Site 21 Mongla 201582003– Test 3



## 21 Site 21 Mongla 201582003 – Test 4



**Appendix B:        Sample descriptions – draft**

Trial Pit location and samples	Trial Pit No. & Testing
<p><b>Site 3: Assasuni</b>                      Road 287042008                      Date: 29.01.2017                      Time: 10.00am                      1. 1.6 from top                      Grey, Medium plastic, Silty Clay                      2. 2.0 from embankment bottom                      Grey, Medium plastic, Silty Clay                      3. From Surface                      Sand and aggregate</p>	<p><b>Trial Pit 1</b>                      LL/PL &amp; Grain Size Analysis</p>
<p><b>Site 10: Dumuria A</b>                      Road 247302001                      Date: 30.01.2017                      Time: 10.00am                      1. Silty Clay, Grey                      2. Silty Clay, Grey                      3. Silty Clay, Grey</p>	<p><b>Trial pit 1</b>                      LL/PL &amp; Grain Size Analysis</p>
<p><b>Site 10: Dumuria A</b>                      Road 247302001                      Date: 30.01.2017                      Time: 11.00am                      1. Silty Clay, Grey                      2. Silty Clay, Grey                      3. Low plastic Clay, Grey                      4. Silty Clay, Grey</p>	<p><b>Trial pit 2</b>                      LL/PL &amp; Grain Size Analysis</p>
<p><b>Site 10: Dumuria A</b>                      Road 247302001                      Date: 30.01.2017                      Time: 12.00pm                      1. Silty Clay, Grey                      2. Silty Clay, light Grey</p>	<p><b>Trial pit 3</b>                      LL/PL &amp; Grain Size Analysis</p>
<p><b>Site 11: Dumuria B</b>                      Road 247303003                      Date: 30.01.2017                      Time: 1.00pm                      1. From 1.2cm below road surface                      Grey, Medium Plastic Clay                      2. 1 m From toe embankment                      Grey, Medium Plastic Clay                      3. from 20 cm below from road surface.                      Dark grey, Medium Plastic Clay                      4. 0 from embankment surface                      Dark Grey, Medium Plastic Clay</p>	<p><b>Trial Pit 1</b>                      LL/PL &amp; Grain Size Analysis</p>

Trial Pit location and samples	Trial Pit No. & Testing
<p><b>Site 11: Dumuria B</b>                      Road 247303003                      Date: 30.01.2017                      Time: 2.00pm                      1. Medium clay, grey                      2. Medium plastic clay, grey                      3. Clay, dark grey</p>	<p><b>Trial Pit 2</b>                      LL/PL &amp; Grain Size Analysis</p>
<p><b>Site 11: Dumuria B</b>                      Road 247303003                      Date: 30.01.2017                      Time: 2.00pm                      1. Medium plastic clay, grey                      2. Medium clay, grey                      3. Plastic clay, black grey</p>	<p><b>Trial Pit 3</b>                      LL/PL &amp; Grain Size Analysis</p>
<p><b>Site 15: Terokhada A</b>                      Road 247942010                      Date: 31.01.2017                      Time: 2.00pm                      1. from 30 cm below, silty clay grey                      2. from 30 cm B.R.L                      silty clay (wet), grey                      3. from 30 cm below, silty clay grey</p>	<p><b>Trial Pit 1</b>                      LL/PL &amp; Grain Size Analysis</p>
<p><b>Site 15: Terokhada A</b>                      Road 247942010                      Date: 31.01.2017                      Time: 3.00pm                      1. from 20 cm below, silty clay grey                      2. from 20 cm below, silty clay grey                      3. from 20 cm below, clay grey</p>	<p><b>Trial Pit 2</b>                      LL/PL &amp; Grain Size Analysis</p>
<p><b>Site 13: Terokhada B</b>                      Road 247942003                      Date: 31.01.2017                      Time: 3.00pm                      1. From 20 cm B.R.L                      Light grey                      2. Silty clay, light grey                      3. From 20 cm B.R.L                      Silty clay, light grey                      4. Sample from 20 cm B.R.L                      Silty clay, light grey                      5. Fine Sand with silt                      Light grey</p>	<p><b>Trial Pit 1</b>                      LL/PL &amp; Grain Size Analysis</p>

Trial Pit location and samples	Trial Pit No. & Testing
<p><b>Site 13: Terokhada B</b>                      Road 247942003                      Date: 31.01.2017                      Time: 4.00pm                      1. from 20 cm below, fine sand with clay, light grey                      2. from 20 cm below, fine sand with clay, light grey</p>	<p><b>Trial Pit 2</b>                      Grain Size Analysis</p>
<p><b>Site 13: Terokhada B</b>                      Road 247942003                      Date: 31.01.2017                      Time: 4.30pm                      1. silty Clay, Light Grey                      2. silty Clay, Light Grey                      3. from Surface (Silty clay, light grey)</p>	<p><b>Trial Pit 3</b></p>
<p><b>Site 12: Rupsa</b>                      Road 247752009                      Date: 31.01.2017                      Time: 10.00am                      1.Silty clay, blackish grey                      2.Silty clay, dark grey                      3. (Road level)                      Silty clay, dark grey</p>	<p><b>Trial Pit 1</b>                      LL/PL &amp; Grain Size Analysis</p>
<p><b>Site 12: Rupsa</b>                      Road 247752009                      Date: 31.01.2017                      Time: 10.30am                      1. from embankment mid, clay with silt, grey                      2. From embankment mid, clay with silt , grey                      3. From embankment mid, clay with silt ,grey</p>	<p><b>Trial Pit 2</b>                      LL/PL &amp; Grain Size Analysis</p>
<p><b>Site 12: Rupsa</b>                      Road 247752009                      Date: 31.01.2017                      Time: 11.00am                      1.Silty Clay                      2.Silty clay                      3.Silty clay with garbage</p>	<p><b>Trial Pit 3</b>                      LL/PL &amp; Grain Size Analysis</p>
<p><b>Site 21: Mongla A</b>                      Road 201582003                      Date: 01.02.2017                      Time: 11.00am                      1.From 30 cm B.R.L ,clay                      2. From 30 cm B.R.L , Silty clay                      3. From 30 cm B.R.L ,clay</p>	<p><b>Trial Pit 1</b>                      LL/PL &amp; Grain Size Analysis</p>

Trial Pit location and samples	Trial Pit No. & Testing
<b>Site 21: Mongla B</b> Road 201582003 Date: 01.02.2017 Time: 11.30am 1.From 30 cm B.R.L , Fine sand with clay 2. From 30 cm B.R.L , Fine sand with clay.	<b>Trial Pit 1</b> Grain Size Analysis
<b>Site 21: Mongla B</b> Road 201582003 Date: 01.02.2017 Time: 1.00pm 1.From 30 cm B.R.L , Silty clay, Grey 2. From embankment 30 cm B.R.L, Silty clay.	<b>Trial Pit 2</b> LL/PL & Grain Size Analysis

**Appendix C:      Laboratory Test Results**



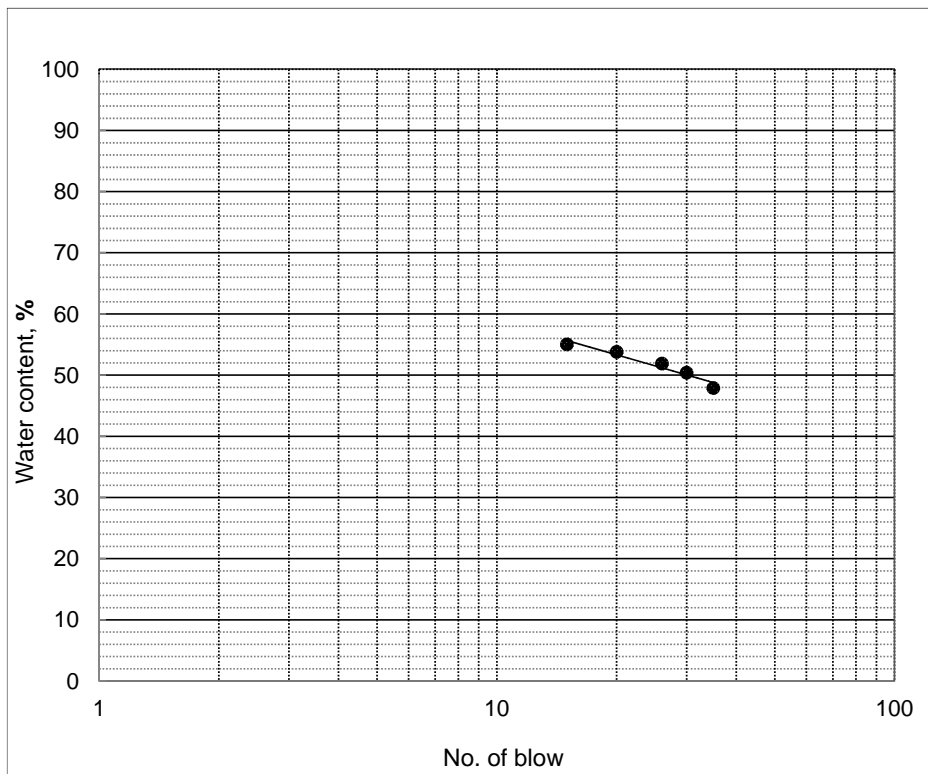
**ATTERBERG LIMIT TEST**

Project:	Ground Improvement for Khulna Soft Clay Soil Project.		
Client:	ReCAP	Bore Hole:	
Location:	Ashasuni	Depth (m):	2.0 m from embankment bottom
Sample Type:	Disturbed	Date:	17-Feb

**Test Results**

No. of Blow	35	30	26	20	15
Wt. of bowl	20.38	15.81	25.83	23.49	15.92
Wt. of bowl+wet soil	26.65	23.30	33.03	30.58	23.16
Wt. of bowl+dry soil	24.62	20.79	30.57	28.10	20.59
Water content	47.88	50.40	51.90	53.80	55.03

Wt. of bowl	15.98	15.86	23.32
Wt. of bowl+wet soil	20.83	21.26	28.81
Wt. of bowl+dry soil	19.80	20.09	27.57
Water content	26.96	27.66	29.18



Liquid Limit, LL=	<b>52.21</b>	%
Plastic Limit, PL=	<b>27.93</b>	%
Plasticity Index, PI=	<b>24.28</b>	



**PARTICLE SIZE ANALYSIS OF SOILS BY SIEVE & HYDROMETER**

Project:	Ground Improvement for Khulna Soft Clay Soil Project.		
Client:	ReCAP	Bore Hole:	
Location:	Ashasuni	Depth 2.0 m from embankment bottom	
Sample Type:	Disturbed	Date:	18-Feb

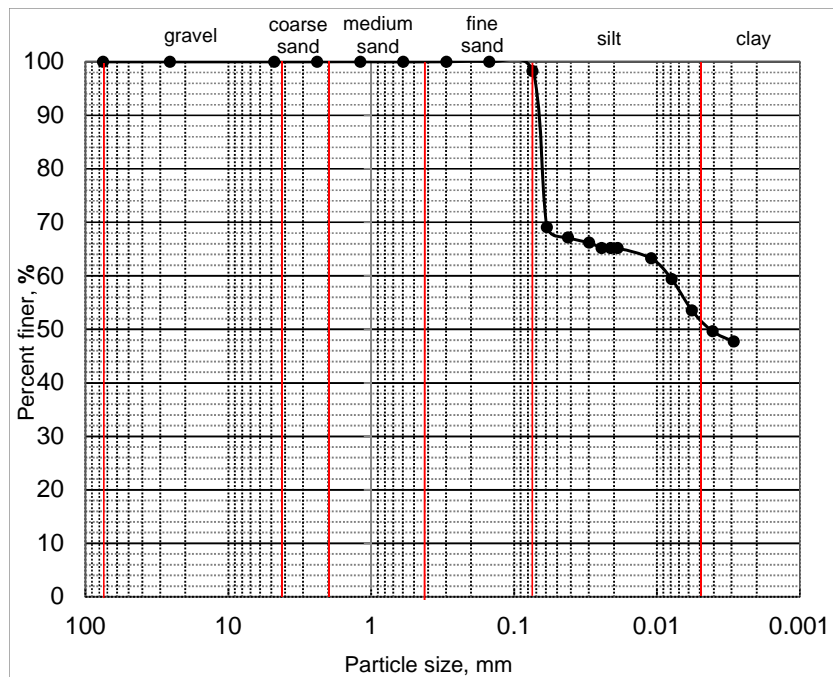
**Test Results**

**Size fractions**

Gravel : 75.00 mm to 4.75 mm =	0.00 %
Coarse sand : 4.75 mm to 2.00 mm (Passing #4 and retained on #10) =	0.00 %
Medium sand : 2.00 mm to 0.425 mm (Passing #10 and retained on #40) =	0.00 %
Fine sand : 0.425 mm to 0.075 mm (Passing #40 and retained on #200) =	1.75 %
Silt size : 0.075 to 0.005 mm =	46.38 %
Clay size : smaller than 0.005 =	51.86 %
Colloid : smaller than 0.001 =	0.00 %
	100.0

Visual classification: Clay  
 USCS classification: Fat Clay

D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	D95 (mm)	Sand (%)	Fines (%)	Cc	Cu	LL (%)	PI (%)	USCS
0.002	0.002	0.004	0.008	0.072	1.75	98.25	0.39	5.05	52.21	24.28	CH



Elapsed time (min)	Hydrometer reading
0.5	35
1	34
2	33.5
3	33
4	33
5	33
15	32
30	30
60	27
120	25
240	24
1440	0



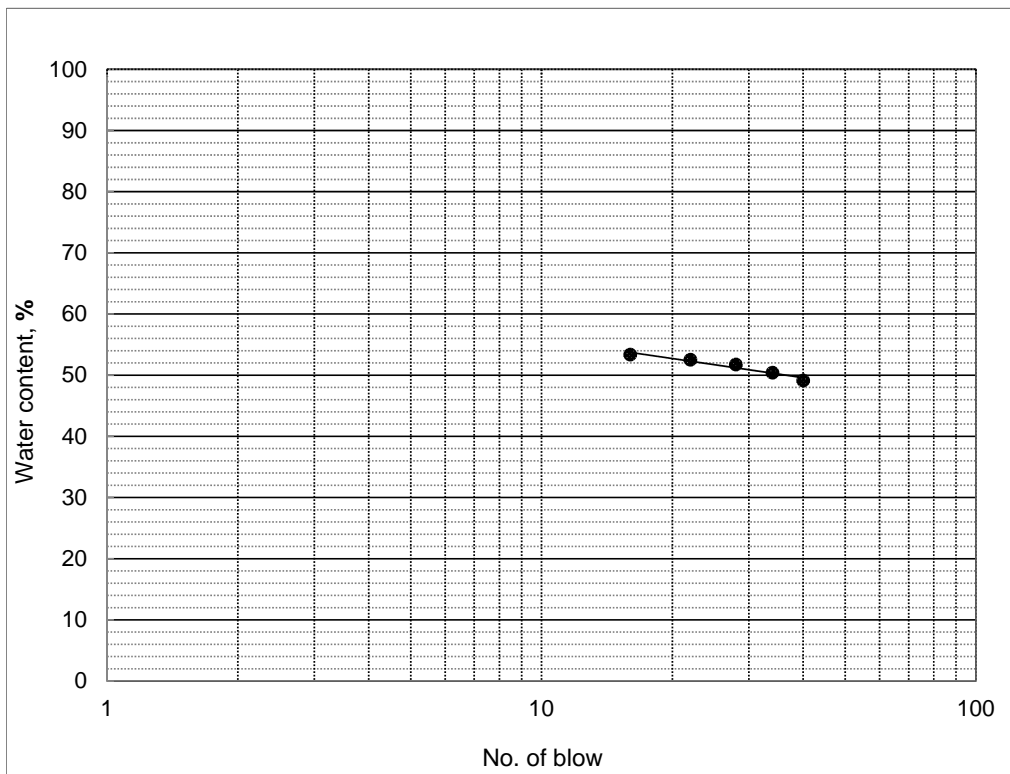
**ATTERBERG LIMIT TEST**

Project:	Ground Improvement for Khulna Soft Clay Soil Project.		
Client:	ReCAP	Bore Hole:	
Location:	Dumuria B	Depth (m):	1.0m from toe embankment
Sample Type:	Disturbed	Date:	17-Feb

**Test Results**

No. of Blow	40	34	28	22	16
Wt. of bowl	18.94	19.11	18.83	19.30	19.72
Wt. of bowl+wet soil	26.56	28.45	27.66	29.29	29.32
Wt. of bowl+dry soil	24.05	25.32	24.65	25.85	25.98
Water content	49.12	50.40	51.72	52.52	53.35

Wt. of bowl	25.83	23.49	15.92
Wt. of bowl+wet soil	30.20	27.25	20.21
Wt. of bowl+dry soil	29.35	26.48	19.35
Water content	24.15	25.75	25.07



Liquid Limit, LL=	<b>52.12</b>	%
Plastic Limit, PL=	<b>24.99</b>	%
Plasticity Index, PI=	<b>27.13</b>	



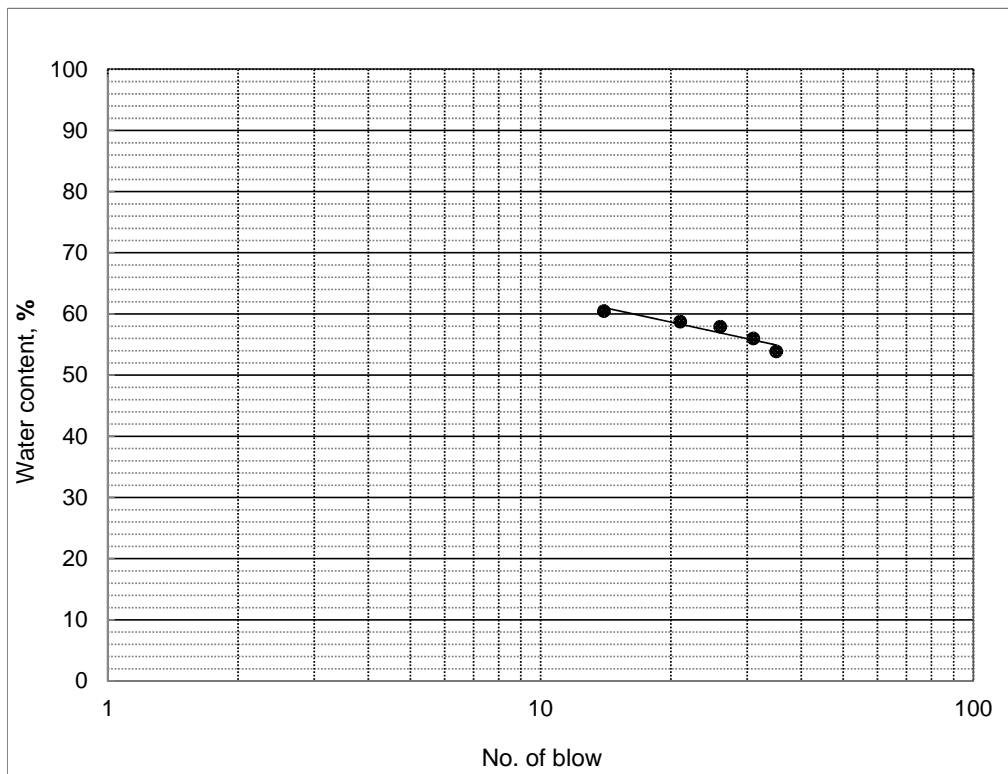
**ATTERBERG LIMIT TEST**

Project:	Ground Improvement for Khulna Soft Clay Soil Project.		
Client:	ReCAP	Bore Hole:	
Location:	Dumuria B	Depth (m):	Bottom of embankment
Sample Type:	Disturbed	Date:	17-Feb

**Test Results**

No. of Blow	35	31	26	21	14
Wt. of bowl	19.35	19.06	29.67	18.00	19.38
Wt. of bowl+wet soil	28.49	26.36	37.36	25.27	28.27
Wt. of bowl+dry soil	25.29	23.74	34.54	22.58	24.92
Water content	53.87	55.98	57.91	58.73	60.47

Wt. of bowl	15.75	19.15	17.61
Wt. of bowl+wet soil	19.42	22.06	20.59
Wt. of bowl+dry soil	18.66	21.48	19.99
Water content	26.12	24.89	25.21



Liquid Limit, LL=	<b>58.07</b>	%
Plastic Limit, PL=	<b>25.41</b>	%
Plasticity Index, PI=	<b>32.66</b>	



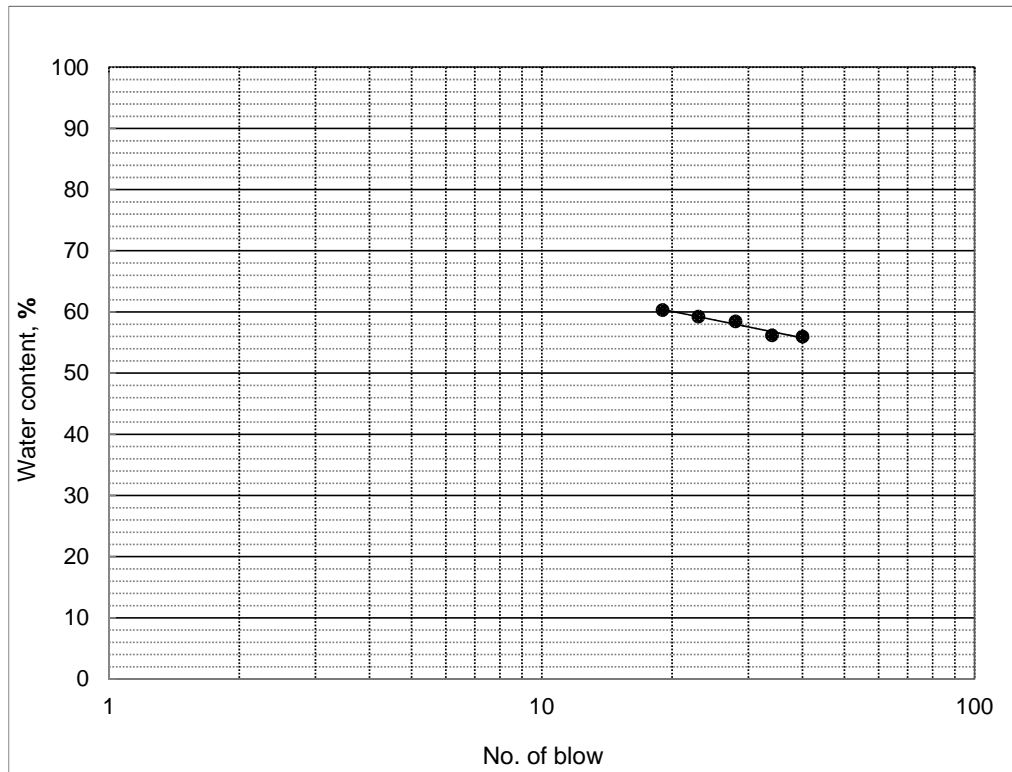
### ATTERBERG LIMIT TEST

Project:	Ground Improvement for Khulna Soft Clay Soil Project.		
Client:	ReCAP	Bore Hole:	
Location:	Dumuria B	Depth (m):	Bottom of embankment
Sample Type:	Disturbed	Date:	17-Feb

#### Test Results

No. of Blow	40	34	28	23	19
Wt. of bowl	23.50	17.91	19.22	18.95	17.85
Wt. of bowl+wet soil	32.25	25.11	27.19	27.31	27.26
Wt. of bowl+dry soil	29.11	22.52	24.25	24.20	23.72
Water content	55.97	56.18	58.45	59.24	60.31

Wt. of bowl	23.39	23.71	15.81
Wt. of bowl+wet soil	27.58	26.90	19.32
Wt. of bowl+dry soil	26.70	26.29	18.63
Water content	26.59	23.64	24.47



Liquid Limit, LL=	<b>58.92</b>	%
Plastic Limit, PL=	<b>24.90</b>	%
Plasticity Index, PI=	<b>34.02</b>	



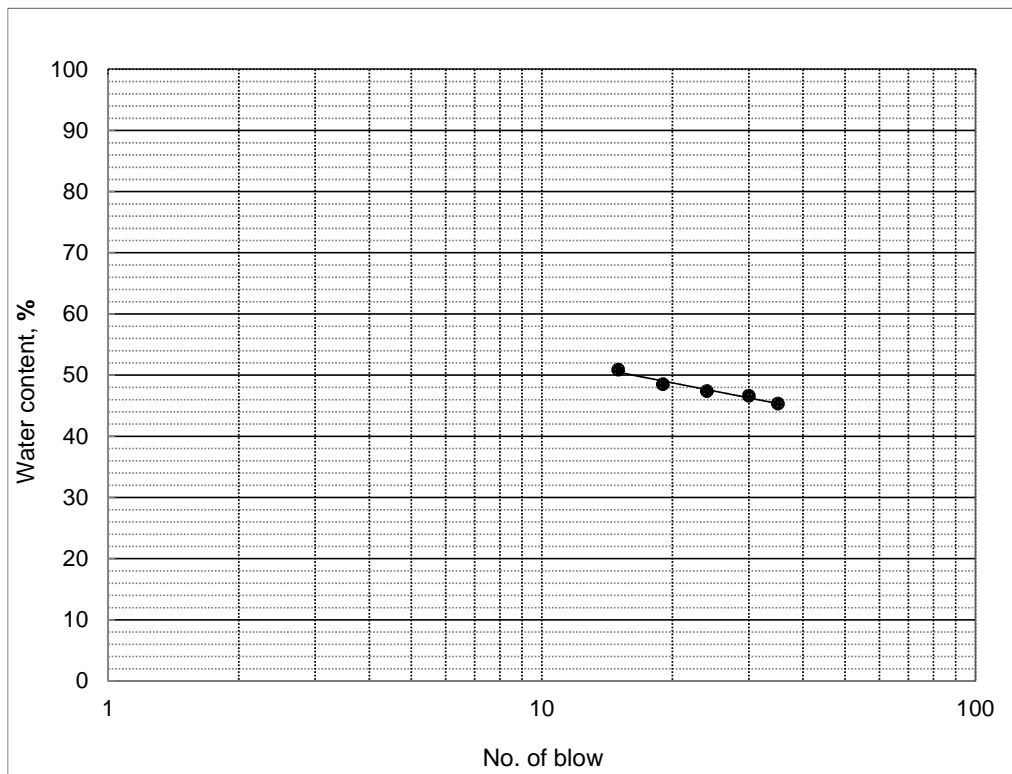
**ATTERBERG LIMIT TEST**

Project:	Ground Improvement for Khulna Soft Clay Soil Project.		
Client:	ReCAP	Bore Hole:	
Location:	Dumuria A 2001	Depth (m):	Bottom of embankment
Sample Type:	Disturbed	Date:	17-Feb

**Test Results**

No. of Blow	35	30	24	19	15
Wt. of bowl	23.39	23.71	23.50	18.92	15.58
Wt. of bowl+wet soil	33.84	34.84	33.70	30.86	24.80
Wt. of bowl+dry soil	30.58	31.30	30.42	26.96	21.69
Water content	45.34	46.64	47.40	48.51	50.90

Wt. of bowl	23.64	15.99	23.53
Wt. of bowl+wet soil	28.47	21.87	29.47
Wt. of bowl+dry soil	27.62	20.86	28.42
Water content	21.36	20.74	21.47



Liquid Limit, LL=	<b>47.27</b>	%
Plastic Limit, PL=	<b>21.19</b>	%
Plasticity Index, PI=	<b>26.08</b>	



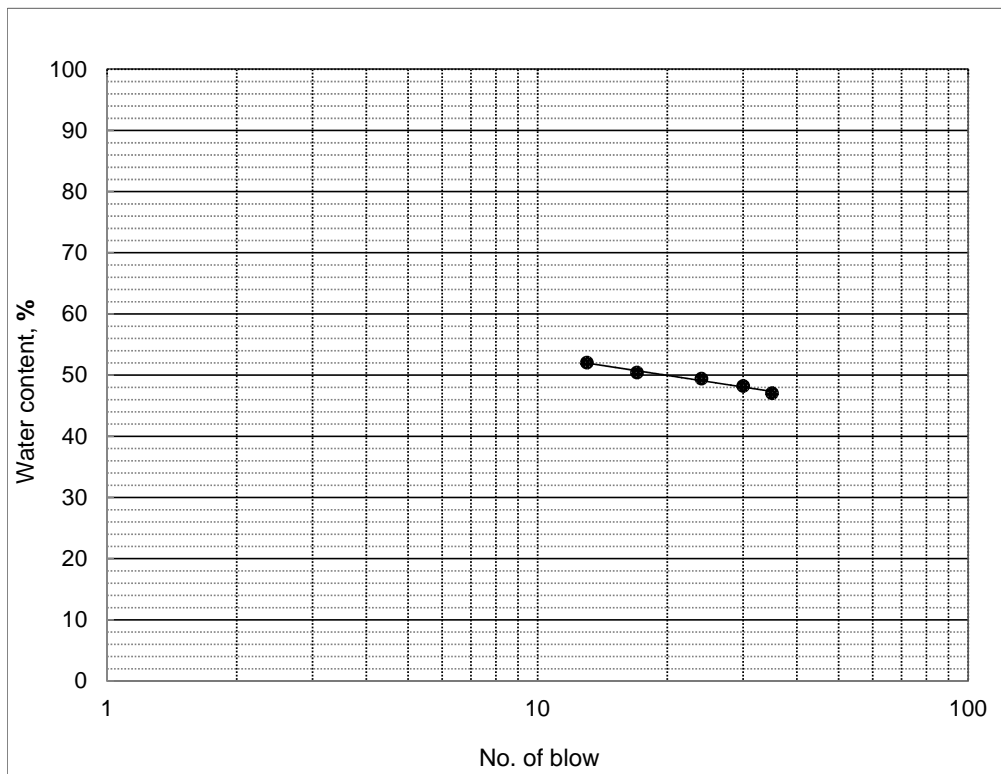
**ATTERBERG LIMIT TEST**

Project:	Ground Improvement for Khulna Soft Clay Soil Project.		
Client:	ReCAP	Bore Hole:	
Location:	Dumuria A 2001	Depth (m):	Bottom of embankment
Sample Type:	Disturbed	Date:	17-Feb

**Test Results**

No. of Blow	35	30	24	17	13
Wt. of bowl	15.67	23.26	18.93	19.59	19.21
Wt. of bowl+wet soil	27.14	34.57	32.17	32.09	30.05
Wt. of bowl+dry soil	23.47	30.89	27.79	27.90	26.34
Water content	47.05	48.23	49.44	50.42	52.03

Wt. of bowl	24.20	19.58	15.77
Wt. of bowl+wet soil	29.70	25.07	20.93
Wt. of bowl+dry soil	28.73	24.13	20.05
Water content	21.41	20.66	20.56



Liquid Limit, LL=	<b>49.23</b>	%
Plastice Limit, PL=	<b>20.88</b>	%
Plasticity Index, PI=	<b>28.36</b>	



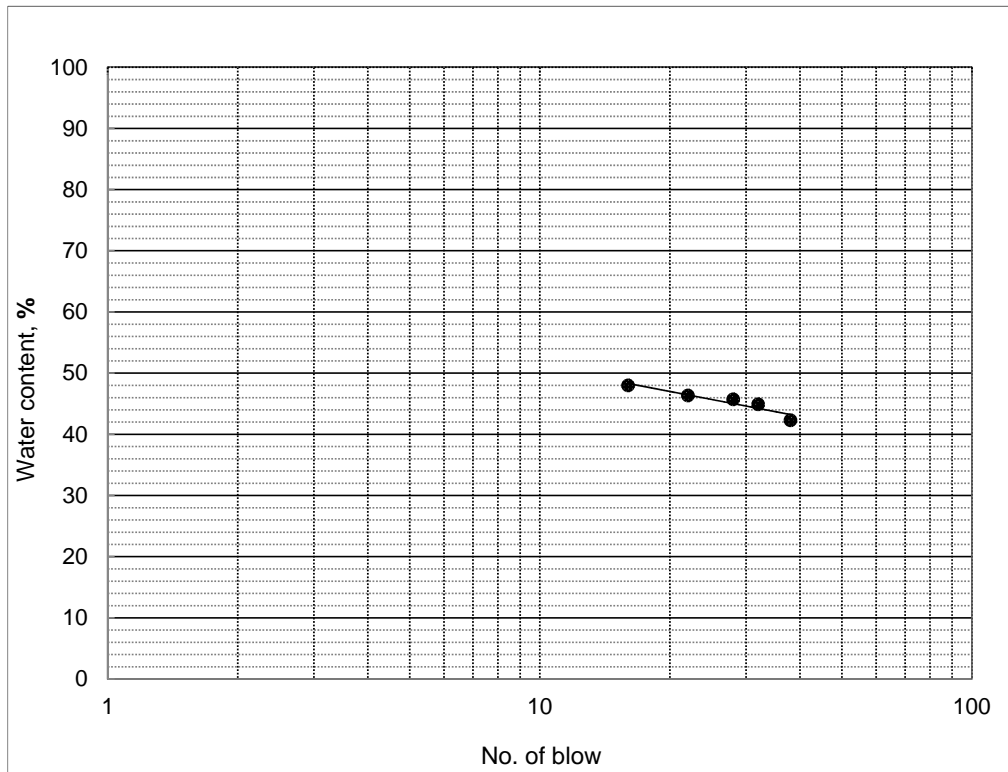
**ATTERBERG LIMIT TEST**

Project:	Ground Improvement for Khulna Soft Clay Soil Project.		
Client:	ReCAP	Bore Hole:	
Location:	Dumuria A 2001	Depth (m):	Bottom of embankment
Sample Type:	Disturbed	Date:	17-Feb

**Test Results**

No. of Blow	38	32	28	22	16
Wt. of bowl	21.60	19.13	17.96	23.87	24.05
Wt. of bowl+wet soil	31.46	29.81	30.55	37.45	35.89
Wt. of bowl+dry soil	28.53	26.50	26.60	33.15	32.05
Water content	42.28	44.91	45.72	46.34	48.00

Wt. of bowl	18.87	18.91	16.22
Wt. of bowl+wet soil	26.07	23.90	21.35
Wt. of bowl+dry soil	24.87	23.07	20.47
Water content	20.00	19.95	20.71



Liquid Limit, LL=	<b>46.03</b>	%
Plastice Limit, PL=	<b>20.22</b>	%
Plasticity Index, PI=	<b>25.81</b>	



**PARTICLE SIZE ANALYSIS OF SOILS BY SIEVE & HYDROMETER**

Project:	Ground Improvement for Khulna Soft Clay Soil Project.		
Client:	ReCAP	Bore Hole:	
Location:	Dumuria B	Depth (m):	1.0m from toe embankment
Sample Type:	Disturbed	Date:	18-Feb

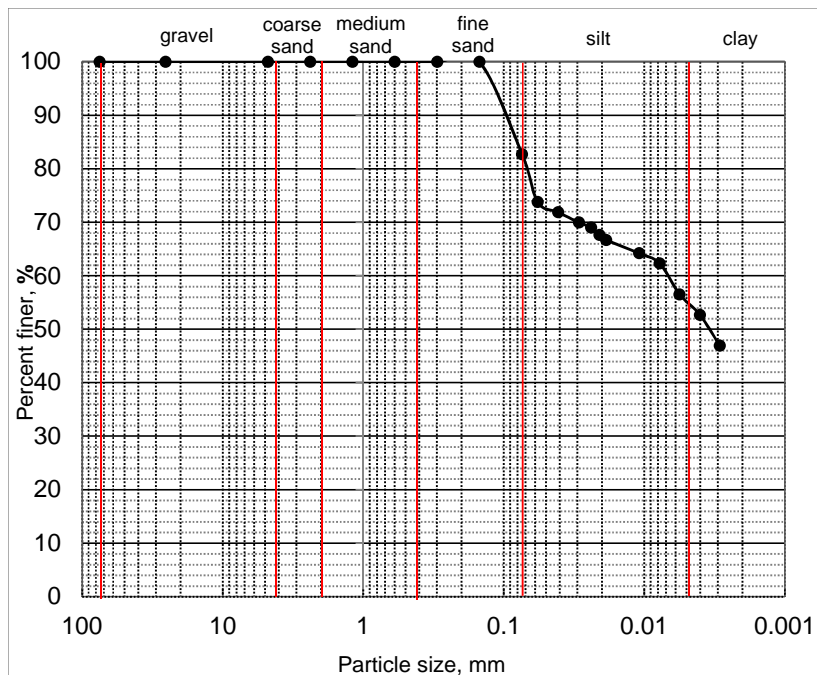
**Test Results**

**Size fractions**

Gravel : 75.00 mm to 4.75 mm =	0.00 %
Coarse sand : 4.75 mm to 2.00 mm (Passing #4 and retained on #10) =	0.00 %
Medium sand : 2.00 mm to 0.425 mm (Passing #10 and retained on #40) =	0.00 %
Fine sand : 0.425 mm to 0.075 mm (Passing #40 and retained on #200) =	17.28 %
Silt size : 0.075 to 0.005 mm =	27.66 %
Clay size : smaller than 0.005 =	55.06 %
Colloid : smaller than 0.001 =	0.00 %
	100.0

Visual classification: Clay  
 USCS classification: Fat Clay with Sand

D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	D95 (mm)	Sand (%)	Fines (%)	Cc	Cu	LL (%)	PI (%)	USCS
0.002	0.002	0.003	0.007	0.127	17.28	82.72	0.47	4.15	52.12	27.13	CH



Elapsed time (min)	Hydrometer reading
0.5	38
1	37
2	36
3	35.5
4	34.8
5	34.3
15	33
30	32
60	29
120	27
240	24
1440	0



**PARTICLE SIZE ANALYSIS OF SOILS BY SIEVE & HYDROMETER**

Project:	Ground Improvement for Khulna Soft Clay Soil Project.		
Client:	ReCAP	Bore Hole:	
Location:	Dumuria B	Depth (m Bottom of embankment	
Sample Type:	Disturbed	Date:	18-Feb

**Test Results**

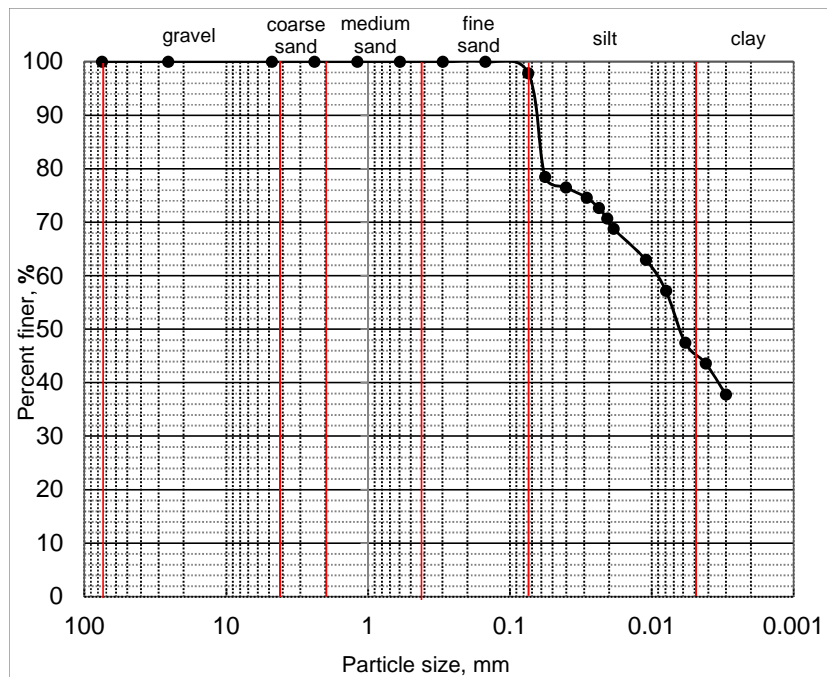
**Size fractions**

Gravel : 75.00 mm to 4.75 mm =	0.00 %
Coarse sand : 4.75 mm to 2.00 mm (Passing #4 and retained on #10) =	0.00 %
Medium sand : 2.00 mm to 0.425 mm (Passing #10 and retained on #40) =	0.00 %
Fine sand : 0.425 mm to 0.075 mm (Passing #40 and retained on #200) =	2.13 %
Silt size : 0.075 to 0.005 mm =	52.31 %
Clay size : smaller than 0.005 mm =	45.56 %
Colloid : smaller than 0.001 mm =	0.00 %

100.0

Visual classification: Clay  
 USCS classification: Fat Clay

D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	D95 (mm)	Sand (%)	Fines (%)	Cc	Cu	LL (%)	PI (%)	USCS
0.002	0.003	0.006	0.009	0.071	2.13	97.87	0.42	5.35	58.07	32.66	CH



Elapsed time (min)	Hydrometer reading
0.5	40
1	39
2	38
3	37
4	36
5	35
15	32
30	29
60	24
120	22
240	19
1440	0



**PARTICLE SIZE ANALYSIS OF SOILS BY SIEVE & HYDROMETER**

Project:	Ground Improvement for Khulna Soft Clay Soil Project.		
Client:	ReCAP	Bore Hole:	
Location:	Dumuria B	Depth (m)	Bottom of embankment
Sample Type:	Disturbed	Date:	18-Feb

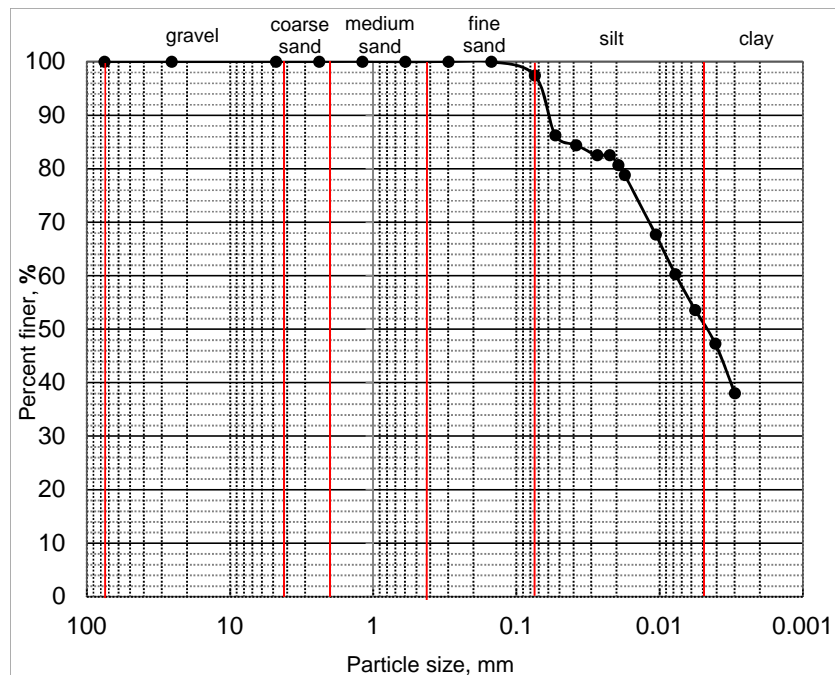
**Test Results**

**Size fractions**

Gravel : 75.00 mm to 4.75 mm =	0.00 %
Coarse sand : 4.75 mm to 2.00 mm (Passing #4 and retained on #10) =	0.00 %
Medium sand : 2.00 mm to 0.425 mm (Passing #10 and retained on #40) =	0.00 %
Fine sand : 0.425 mm to 0.075 mm (Passing #40 and retained on #200) =	2.60 %
Silt size : 0.075 to 0.005 mm =	46.36 %
Clay size : smaller than 0.005 mm =	51.04 %
Colloid : smaller than 0.001 mm =	0.00 %
	100.0

Visual classification: Clay  
 USCS classification: Fat Clay

D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	D95 (mm)	Sand (%)	Fines (%)	Cc	Cu	LL (%)	PI (%)	USCS
0.002	0.003	0.005	0.008	0.070	2.60	97.40	0.51	4.36	58.92	34.02	CH



Elapsed time (min)	Hydrometer reading
0.5	46
1	45
2	44
3	44
4	43
5	42
15	36
30	32
60	28.4
120	25
240	20
1440	0



**PARTICLE SIZE ANALYSIS OF SOILS BY SIEVE & HYDROMETER**

Project:	Ground Improvement for Khulna Soft Clay Soil Project.		
Client:	ReCAP	Bore Hole:	
Location:	Dumuria A 2001	Depth (m) Bottom of embankment	
Sample Type:	Disturbed	Date:	18-Feb

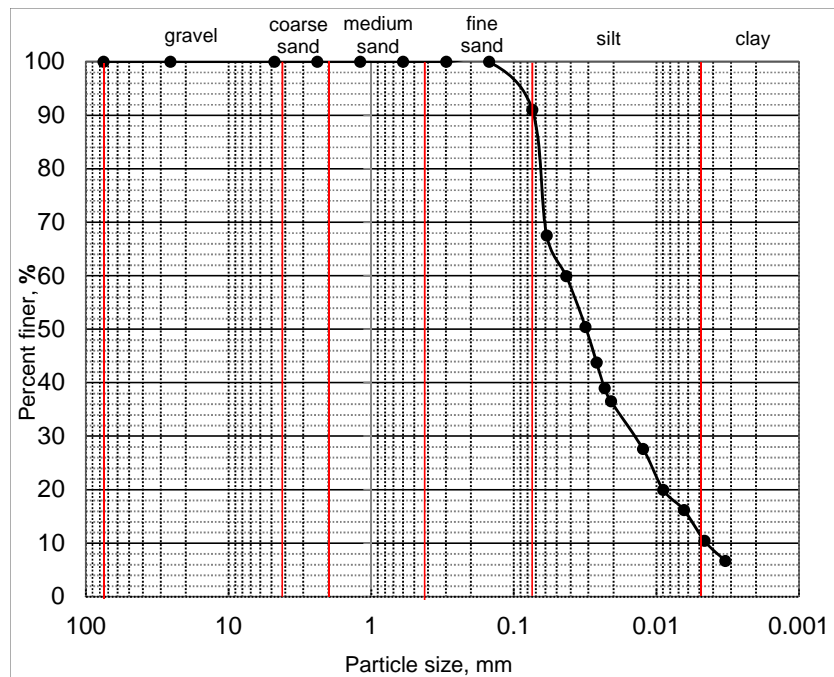
**Test Results**

**Size fractions**

Gravel : 75.00 mm to 4.75 mm =	0.00 %
Coarse sand : 4.75 mm to 2.00 mm (Passing #4 and retained on #10) =	0.00 %
Medium sand : 2.00 mm to 0.425 mm (Passing #10 and retained on #40) =	0.00 %
Fine sand : 0.425 mm to 0.075 mm (Passing #40 and retained on #200) =	8.95 %
Silt size : 0.075 to 0.005 mm =	79.30 %
Clay size : smaller than 0.005 mm =	11.74 %
Colloid : smaller than 0.001 mm =	0.00 %
	100.0

Visual classification: Clay  
 USCS classification: Lean Clay

D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	D95 (mm)	Sand (%)	Fines (%)	Cc	Cu	LL (%)	PI (%)	USCS
0.004	0.015	0.031	0.043	0.107	8.95	91.05	1.12	9.69	47.27	26.08	CL



Elapsed time (min)	Hydrometer reading
0.5	35
1	31
2	26
3	22.5
4	20
5	18.7
15	14
30	10
60	8
120	5
240	3
1440	0



**PARTICLE SIZE ANALYSIS OF SOILS BY SIEVE & HYDROMETER**

Project:	Ground Improvement for Khulna Soft Clay Soil Project.		
Client:	ReCAP	Bore Hole:	
Location:	Dumuria A 2001	Depth (m):	Bottom of embankment
Sample Type:	Disturbed	Date:	18-Feb

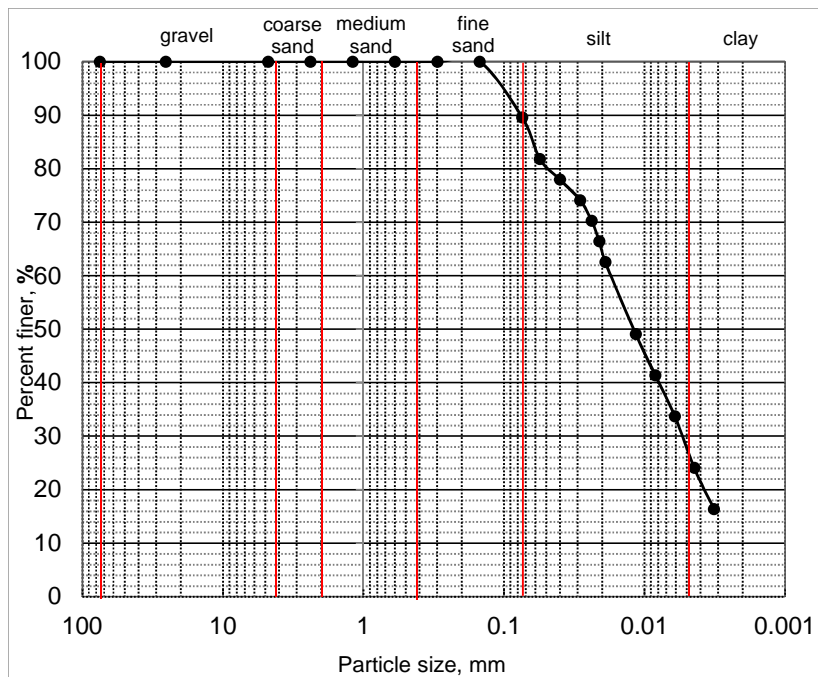
**Test Results**

**Size fractions**

Gravel : 75.00 mm to 4.75 mm =	0.00 %
Coarse sand : 4.75 mm to 2.00 mm (Passing #4 and retained on #10) =	0.00 %
Medium sand : 2.00 mm to 0.425 mm (Passing #10 and retained on #40) =	0.00 %
Fine sand : 0.425 mm to 0.075 mm (Passing #40 and retained on #200) =	10.41 %
Silt size : 0.075 to 0.005 mm =	62.14 %
Clay size : smaller than 0.005 =	27.45 %
Colloid : smaller than 0.001 =	0.00 %
	100.0

Visual classification: Clay  
 USCS classification: Lean Clay

D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	D95 (mm)	Sand (%)	Fines (%)	Cc	Cu	LL (%)	PI (%)	USCS
0.002	0.005	0.012	0.018	0.113	10.41	89.59	0.69	7.21	49.23	28.35	CL



Elapsed time (min)	Hydrometer reading
0.5	42
1	40
2	38
3	36
4	34
5	32
15	25
30	21
60	17
120	12
240	8
1440	0



**PARTICLE SIZE ANALYSIS OF SOILS BY SIEVE & HYDROMETER**

Project:	Ground Improvement for Khulna Soft Clay Soil Project.		
Client:	ReCAP	Bore Hole:	
Location:	Dumuria A	Depth (m):	Bottom of embankment
Sample Type:	Disturbed	Date:	18-Feb

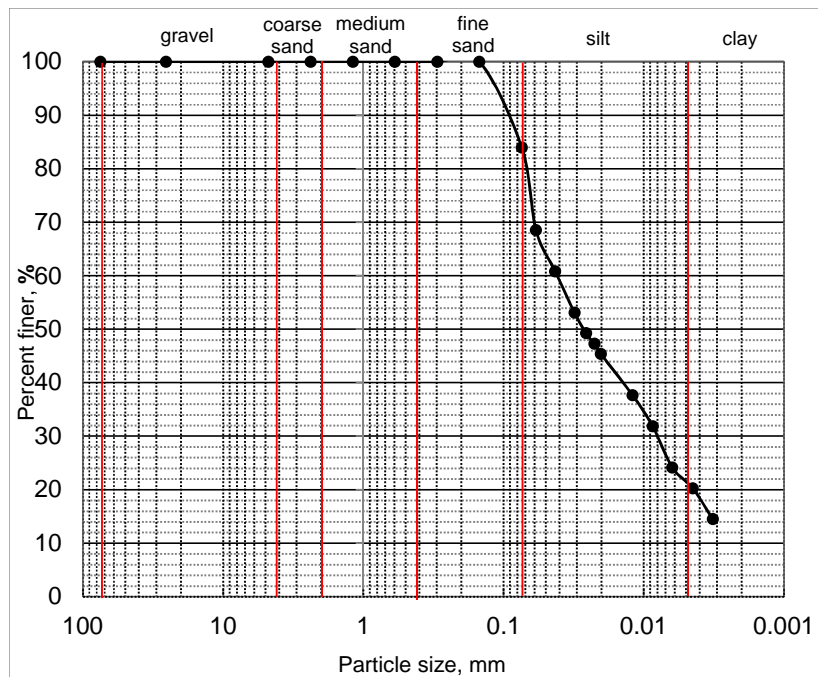
**Test Results**

**Size fractions**

Gravel : 75.00 mm to 4.75 mm =	0.00 %
Coarse sand : 4.75 mm to 2.00 mm (Passing #4 and retained on #10) =	0.00 %
Medium sand : 2.00 mm to 0.425 mm (Passing #10 and retained on #40) =	0.00 %
Fine sand : 0.425 mm to 0.075 mm (Passing #40 and retained on #200) =	16.05 %
Silt size : 0.075 to 0.005 mm =	62.52 %
Clay size : smaller than 0.005 mm =	21.42 %
Colloid : smaller than 0.001 mm =	0.00 %
	100.0

Visual classification: Clay  
 USCS classification: Lean Clay with Sand

D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	D95 (mm)	Sand (%)	Fines (%)	Cc	Cu	LL (%)	PI (%)	USCS
0.003	0.008	0.027	0.042	0.126	16.05	83.95	0.60	15.98	46.03	25.81	CL



Elapsed time (min)	Hydrometer reading
0.5	35
1	31
2	27
3	25
4	24
5	23
15	19
30	16
60	12
120	10
240	7
1440	0

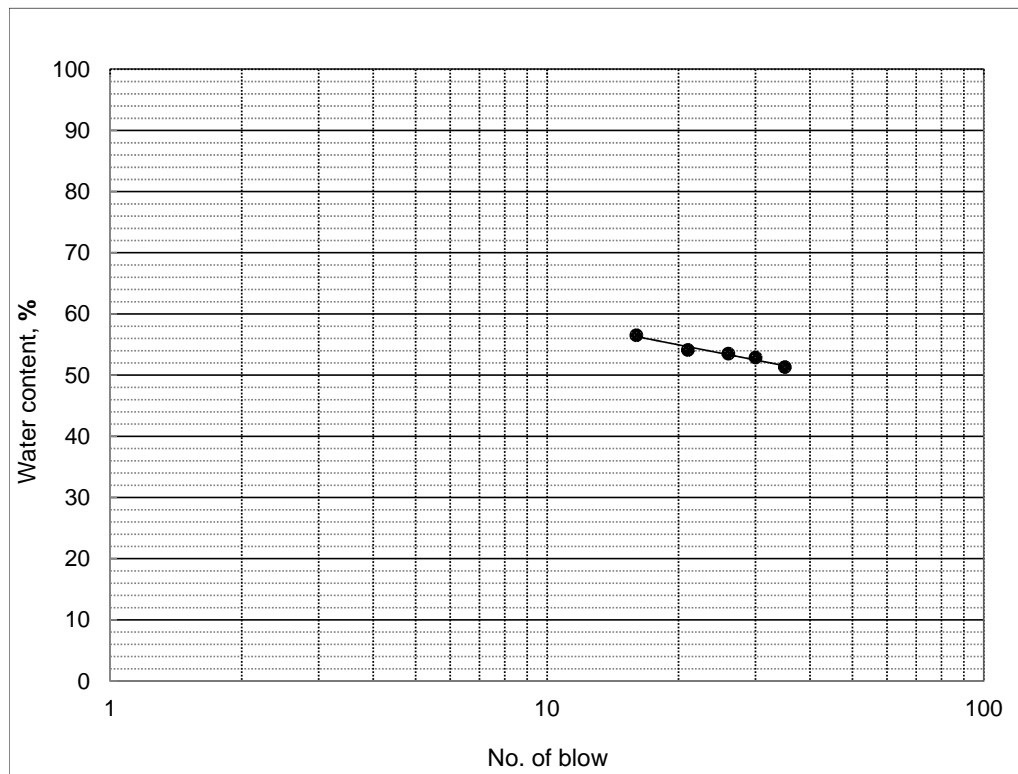
### ATTERBERG LIMIT TEST

Project:	Ground Improvement for Khulna Soft Clay Soil Project.		
Client:	ReCAP	Bore Hole:	
Location:	Mongla A	Depth (m):	0.3m below road level
Sample Type:	Disturbed	Date:	17-Feb

#### Test Results

No. of Blow	35	30	26	21	16
Wt. of bowl	18.91	19.25	19.58	15.92	31.54
Wt. of bowl+wet soil	27.64	28.27	27.90	23.44	39.93
Wt. of bowl+dry soil	24.68	25.15	25.00	20.80	36.90
Water content	51.30	52.88	53.51	54.10	56.53

Wt. of bowl	15.76	17.61	15.83
Wt. of bowl+wet soil	19.51	21.25	19.69
Wt. of bowl+dry soil	18.86	20.65	18.99
Water content	20.97	19.74	22.15



Liquid Limit, LL=	<b>53.62</b>	%
Plastic Limit, PL=	<b>20.95</b>	%
Plasticity Index, PI=	<b>32.67</b>	



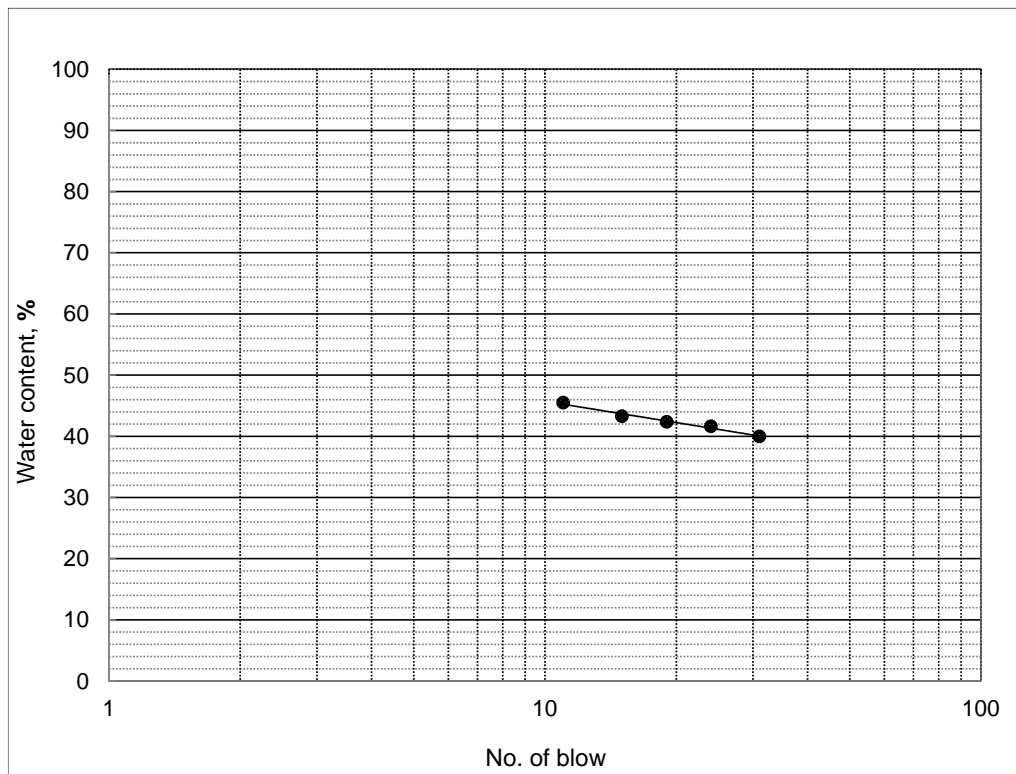
**ATTERBERG LIMIT TEST**

Project:	Ground Improvement for Khulna Soft Clay Soil Project.		
Client:	ReCAP	Bore Hole:	
Location:	Mongla B	Depth (m):	0.3m below road level
Sample Type:	Disturbed	Date:	17-Feb

**Test Results**

No. of Blow	31	24	19	15	11
Wt. of bowl	24.06	19.42	19.02	19.33	15.82
Wt. of bowl+wet soil	33.37	29.25	30.85	32.24	27.78
Wt. of bowl+dry soil	30.71	26.36	27.33	28.34	24.04
Water content	40.00	41.64	42.36	43.29	45.50

Wt. of bowl	23.87	21.60	18.11
Wt. of bowl+wet soil	29.43	28.29	23.64
Wt. of bowl+dry soil	28.31	26.90	22.74
Water content	25.23	26.23	19.44



Liquid Limit, LL=	<b>41.41</b>	%
Plastic Limit, PL=	<b>23.63</b>	%
Plasticity Index, PI=	<b>17.78</b>	



**PARTICLE SIZE ANALYSIS OF SOILS BY SIEVE & HYDROMETER**

Project:	Ground Improvement for Khulna Soft Clay Soil Project.		
Client:	ReCAP	Bore Hole:	
Location:	Mongla A	Depth (m):	0.3m below road level
Sample Type:	Disturbed	Date:	18-Feb

**Test Results**

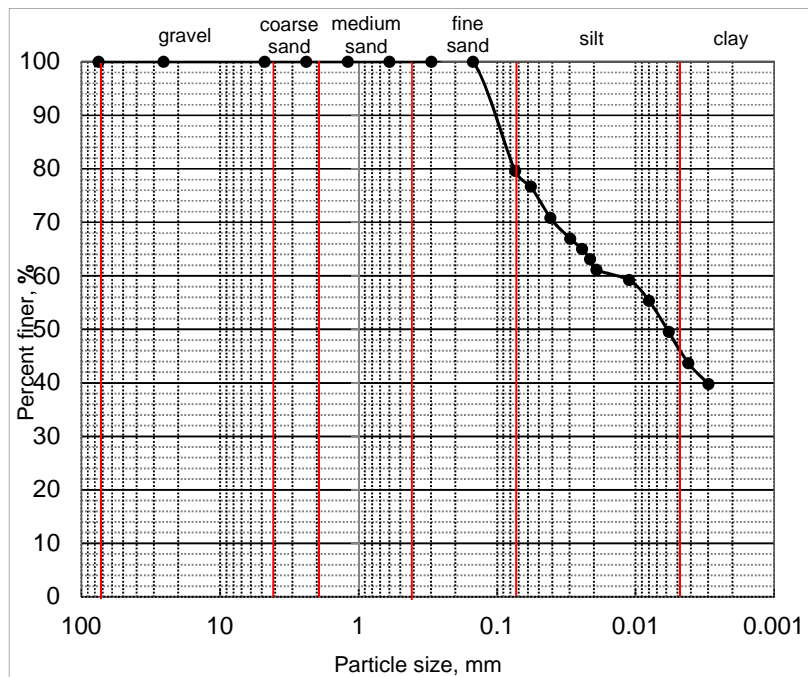
**Size fractions**

Gravel : 75.00 mm to 4.75 mm =	0.00 %
Coarse sand : 4.75 mm to 2.00 mm (Passing #4 and retained on #10) =	0.00 %
Medium sand : 2.00 mm to 0.425 mm (Passing #10 and retained on #40) =	0.00 %
Fine sand : 0.425 mm to 0.075 mm (Passing #40 and retained on #200) =	20.41 %
Silt size : 0.075 to 0.005 mm =	32.88 %
Clay size : smaller than 0.005 mm =	46.71 %
Colloid : smaller than 0.001 mm =	0.00 %

100.0

Visual classification: Clay  
 USCS classification: Fat Clay with Sand

D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	D95 (mm)	Sand (%)	Fines (%)	Cc	Cu	LL (%)	PI (%)	USCS
0.002	0.003	0.006	0.015	0.131	20.41	79.59	0.26	8.36	53.62	32.67	CH



Elapsed time (min)	Hydrometer reading
0.5	39
1	36
2	34
3	33
4	32
5	31
15	30
30	28
60	25
120	22
240	20
1440	0



**PARTICLE SIZE ANALYSIS OF SOILS BY SIEVE & HYDROMETER**

Project:	Ground Improvement for Khulna Soft Clay Soil Project.		
Client:	ReCAP	Bore Hole:	
Location:	Mongla B	Depth (m):	0.3m below road level
Sample Type:	Disturbed	Date:	17-Feb

**Test Results**

**Size fractions**

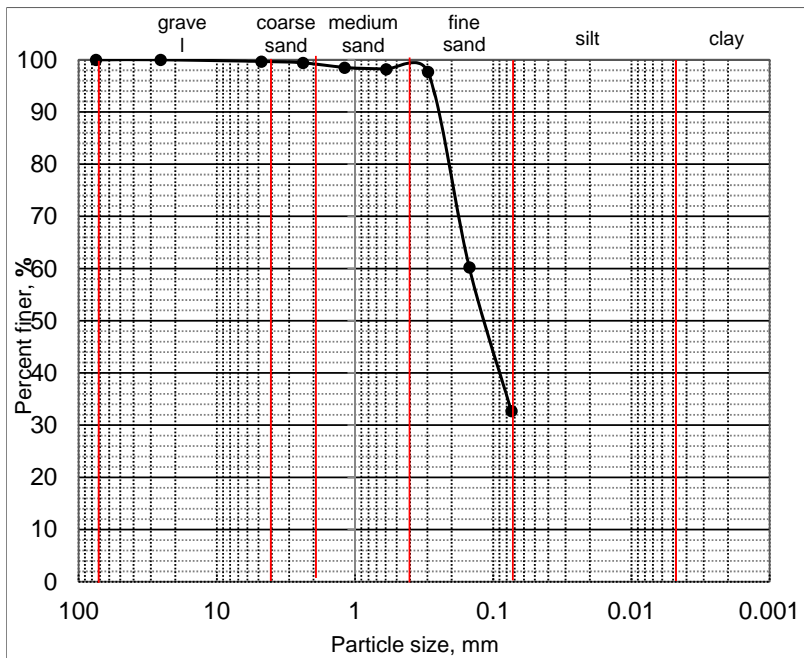
Gravel : 75.00 mm to 4.75 mm =	0.33 %
Coarse sand : 4.75 mm to 2.00 mm (Passing #4 and retained on #10) =	0.54 %
Medium sand : 2.00 mm to 0.425 mm (Passing #10 and retained on #40) =	1.23 %
Fine sand : 0.425 mm to 0.075 mm (Passing #40 and retained on #200) =	65.17 %
Silt size : 0.075 to 0.005 mm =	32.73 %
Clay size : smaller than 0.005 =	0.00 %
Colloid : smaller than 0.001 =	0.00 %

100.0

Visual classification: Fine Sand

USCS classification: Silty Sand

D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	D95 (mm)	Sand (%)	Fines (%)	Cc	Cu	LL (%)	PI (%)	USCS
-	-	0.121	0.148	0.286	66.94	32.73	-	-	-	-	SM



Sieve No.	Wt. of soil (gm)	% of soil retained
4	0.4	0.33
8	0.3	0.25
16	1.1	0.91
30	0.4	0.33
50	0.6	0.49
100	45.4	37.43
200	33.4	27.54
pan	44.80	32.73

100.00



**PARTICLE SIZE ANALYSIS OF SOILS BY SIEVE & HYDROMETER**

Project:	Ground Improvement for Khulna Soft Clay Soil Project.		
Client:	ReCAP	Bore Hole:	
Location:	Mongla B	Depth (m):	0.3m below road level
Sample Type:	Disturbed	Date:	18-Feb

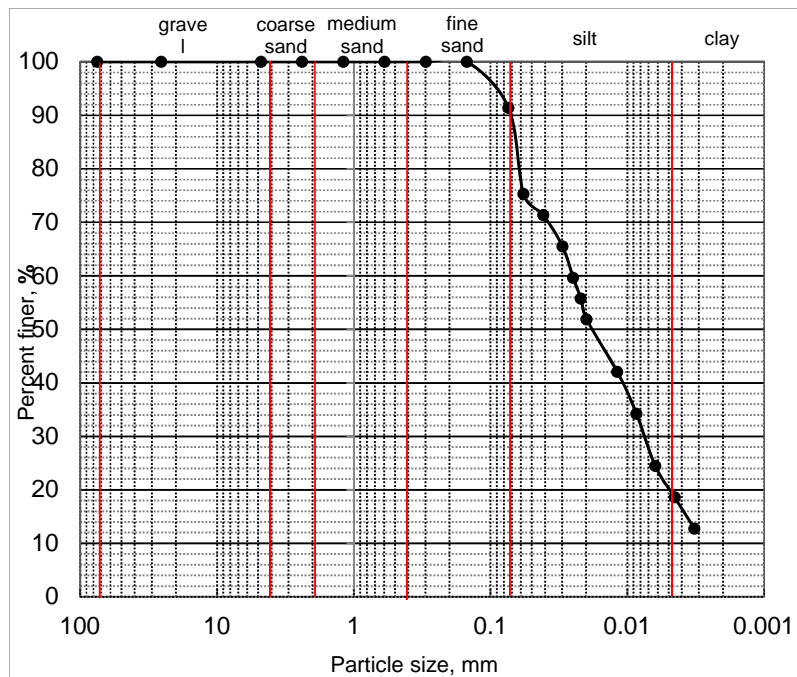
**Test Results**

**Size fractions**

Gravel : 75.00 mm to 4.75 mm =	0.00 %
Coarse sand : 4.75 mm to 2.00 mm (Passing #4 and retained on #10) =	0.00 %
Medium sand : 2.00 mm to 0.425 mm (Passing #10 and retained on #40) =	0.00 %
Fine sand : 0.425 mm to 0.075 mm (Passing #40 and retained on #200) =	8.62 %
Silt size : 0.075 to 0.005 mm =	71.12 %
Clay size : smaller than 0.005 mm =	20.26 %
Colloid : smaller than 0.001 mm =	0.00 %
	100.0

Visual classification: Clay  
 USCS classification: Lean Clay

D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	D95 (mm)	Sand (%)	Fines (%)	Cc	Cu	LL (%)	PI (%)	USCS
0.003	0.008	0.018	0.025	0.105	8.62	91.38	0.81	9.00	41.41	17.78	CL



Elapsed time (min)	Hydrometer reading
0.5	38
1	36
2	33
3	30
4	28
5	26
15	21
30	17
60	12
120	9
240	6
1440	0



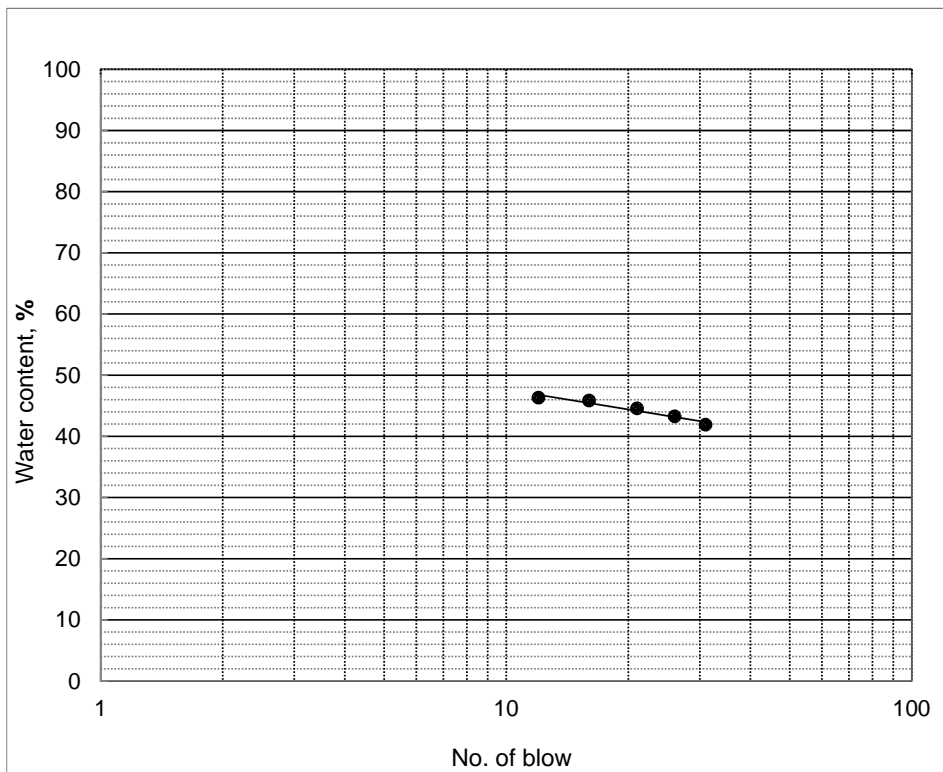
**ATTERBERG LIMIT TEST**

Project:	Ground Improvement for Khulna Soft Clay Soil Project.		
Client:	ReCAP	Bore Hole:	
Location:	Rupsa	Depth (m):	Bottom of Embankment
Sample Type:	Disturbed	Date:	17-Feb

**Test Results**

No. of Blow	31	26	21	16	12
Wt. of bowl	24.21	15.77	19.41	18.84	16.09
Wt. of bowl+wet soil	32.00	22.26	27.78	28.35	22.25
Wt. of bowl+dry soil	29.70	20.30	25.20	25.36	20.30
Water content	41.89	43.27	44.56	45.86	46.32

Wt. of bowl	18.83	19.16	17.99
Wt. of bowl+wet soil	23.55	23.47	22.32
Wt. of bowl+dry soil	22.67	22.65	21.52
Water content	22.92	23.50	22.66



Liquid Limit, LL=	<b>43.53</b>	%
Plastic Limit, PL	<b>23.03</b>	%
Plasticity Index, F	<b>20.50</b>	



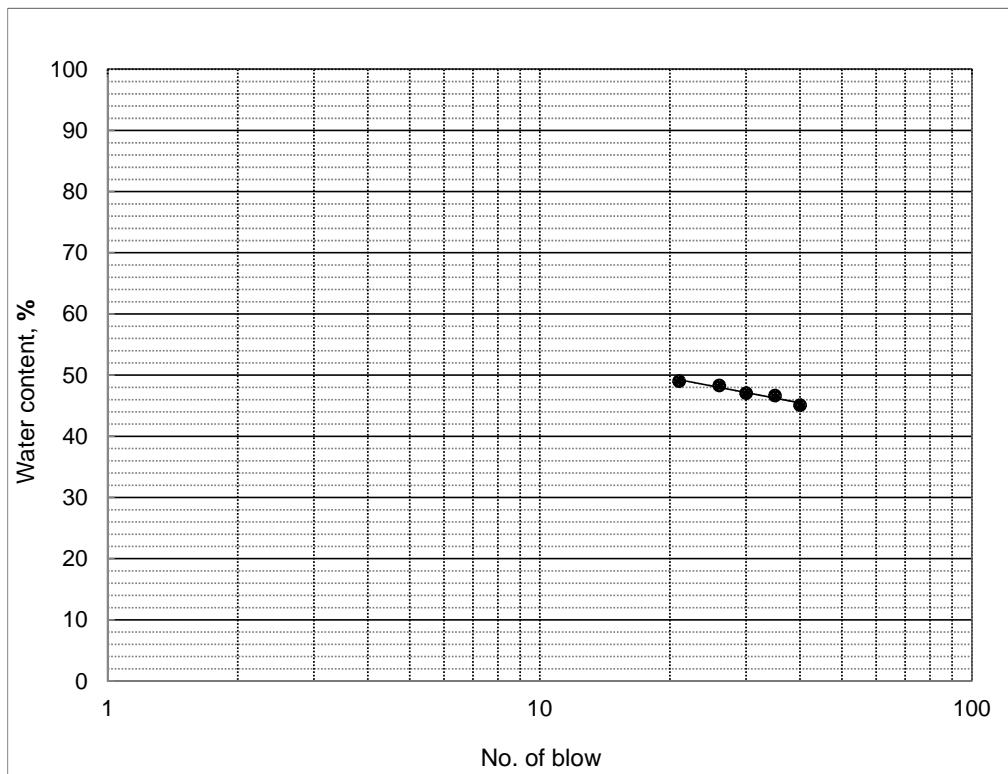
**ATTERBERG LIMIT TEST**

Project:	Ground Improvement for Khulna Soft Clay Soil Project.		
Client:	ReCAP	Bore Hole:	
Location:	Rupsa	Depth (m):	Middle of Embankment
Sample Type:	Disturbed	Date:	17-Feb

**Test Results**

No. of Blow	40	35	30	26	21
Wt. of bowl	23.13	15.83	16.02	15.98	22.04
Wt. of bowl+wet soil	33.04	24.19	23.71	22.49	28.12
Wt. of bowl+dry soil	29.96	21.53	21.25	20.37	26.12
Water content	45.10	46.67	47.04	48.29	49.02

Wt. of bowl	18.60	23.43	15.94
Wt. of bowl+wet soil	20.26	26.39	18.12
Wt. of bowl+dry soil	19.98	25.89	17.75
Water content	20.29	20.33	20.44



Liquid Limit, LL=	<b>48.44</b>	%
Plastic Limit, PL=	<b>20.35</b>	%
Plasticity Index, PI=	<b>28.08</b>	



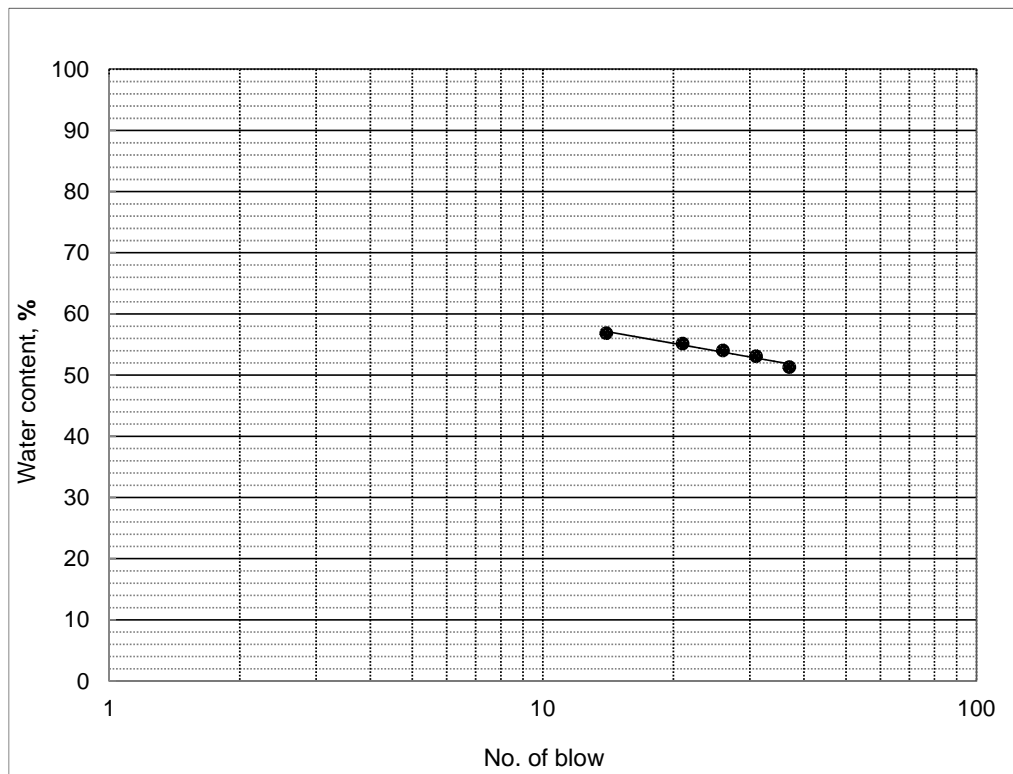
### ATTERBERG LIMIT TEST

Project:	Ground Improvement for Khulna Soft Clay Soil Project.		
Client:	ReCAP	Bore Hole:	
Location:	Rupsa	Depth (m):	Bottom of Embankment
Sample Type:	Disturbed	Date:	17-Feb

#### Test Results

No. of Blow	37	31	26	21	14
Wt. of bowl	18.93	27.59	15.74	18.89	23.63
Wt. of bowl+wet soil	25.24	34.80	22.61	26.12	31.19
Wt. of bowl+dry soil	23.10	32.30	20.20	23.55	28.45
Water content	51.32	53.08	54.04	55.15	56.85

Wt. of bowl	15.57	23.49	19.32
Wt. of bowl+wet soil	17.94	26.53	21.84
Wt. of bowl+dry soil	17.45	25.92	21.33
Water content	26.06	25.10	25.37



Liquid Limit, LL=	<b>54.26</b>	%
Plastic Limit, PL=	<b>25.51</b>	%
Plasticity Index, PI=	<b>28.75</b>	



**PARTICLE SIZE ANALYSIS OF SOILS BY SIEVE & HYDROMETER**

Project:	Ground Improvement for Khulna Soft Clay Soil Project.		
Client:	ReCAP	Bore Hole:	
Location:	Rupsa	Depth (m):	Bottom of Embankment
Sample Type:	Disturbed	Date:	18-Feb

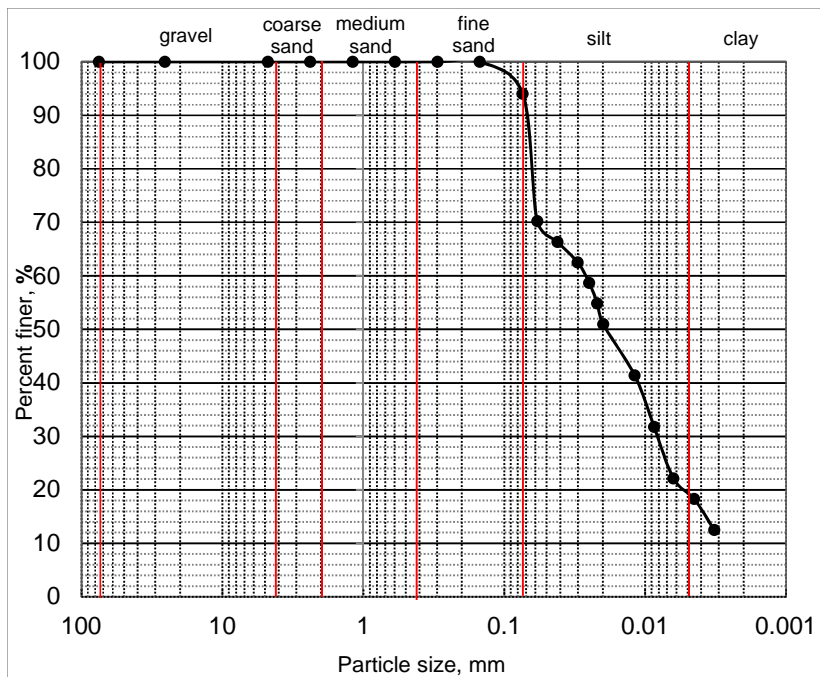
**Test Results**

**Size fractions**

Gravel : 75.00 mm to 4.75 mm =	0.00 %
Coarse sand : 4.75 mm to 2.00 mm (Passing #4 and retained on #10) =	0.00 %
Medium sand : 2.00 mm to 0.425 mm (Passing #10 and retained on #40) =	0.00 %
Fine sand : 0.425 mm to 0.075 mm (Passing #40 and retained on #200) =	5.97 %
Silt size : 0.075 to 0.005 mm =	74.68 %
Clay size : smaller than 0.005 =	19.35 %
Colloid : smaller than 0.001 =	0.00 %
	100.0

Visual classification: Clay  
 USCS classification: Lean Clay

D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	D95 (mm)	Sand (%)	Fines (%)	Cc	Cu	LL (%)	PI (%)	USCS
0.003	0.008	0.019	0.027	0.086	5.97	94.03	0.89	9.45	43.53	20.50	CL



Elapsed time (min)	Hydrometer reading
0.5	36
1	34
2	32
3	30
4	28
5	26
15	21
30	16
60	11
120	9
240	6
1440	0



**PARTICLE SIZE ANALYSIS OF SOILS BY SIEVE & HYDROMETER**

Project:	Ground Improvement for Khulna Soft Clay Soil Project.		
Client:	ReCAP	Bore Hole:	
Location:	Rupsa	Depth:	Middle of embankment
Sample Type:	Disturbed	Date:	18-Feb

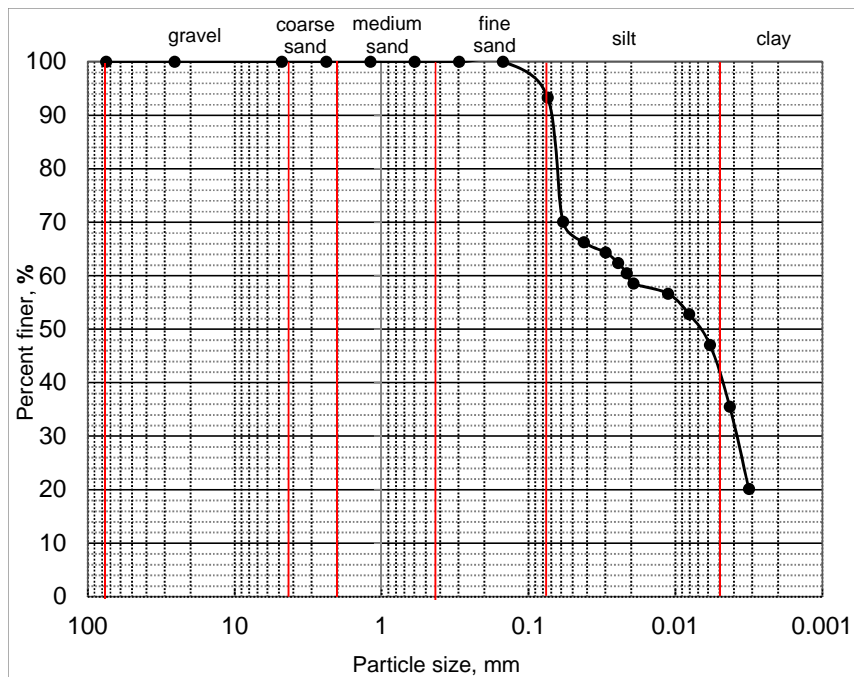
**Test Results**

**Size fractions**

Gravel : 75.00 mm to 4.75 mm =	0.00 %
Coarse sand : 4.75 mm to 2.00 mm (Passing #4 and retained on #10) =	0.00 %
Medium sand : 2.00 mm to 0.425 mm (Passing #10 and retained on #40) =	0.00 %
Fine sand : 0.425 mm to 0.075 mm (Passing #40 and retained on #200) =	6.73 %
Silt size : 0.075 to 0.005 mm =	52.25 %
Clay size : smaller than 0.005 =	41.02 %
Colloid : smaller than 0.001 =	0.00 %
	100.0

Visual classification: Clay  
 USCS classification: Lean Clay

D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	D95 (mm)	Sand (%)	Fines (%)	Cc	Cu	LL (%)	PI (%)	USCS
0.002	0.004	0.007	0.021	0.093	6.73	93.27	0.32	9.45	48.44	28.09	CL



Elapsed time (min)	Hydrometer reading
0.5	36
1	34
2	33
3	32
4	31
5	30
15	29
30	27
60	24
120	18
240	10
1440	0



**PARTICLE SIZE ANALYSIS OF SOILS BY SIEVE & HYDROMETER**

Project:	Ground Improvement for Khulna Soft Clay Soil Project.		
Client:	ReCAP	Bore Hole:	
Location:	Rupsa	Depth (m):	Bottom of Embankment
Sample Type:	Disturbed	Date:	18-Feb

**Test Results**

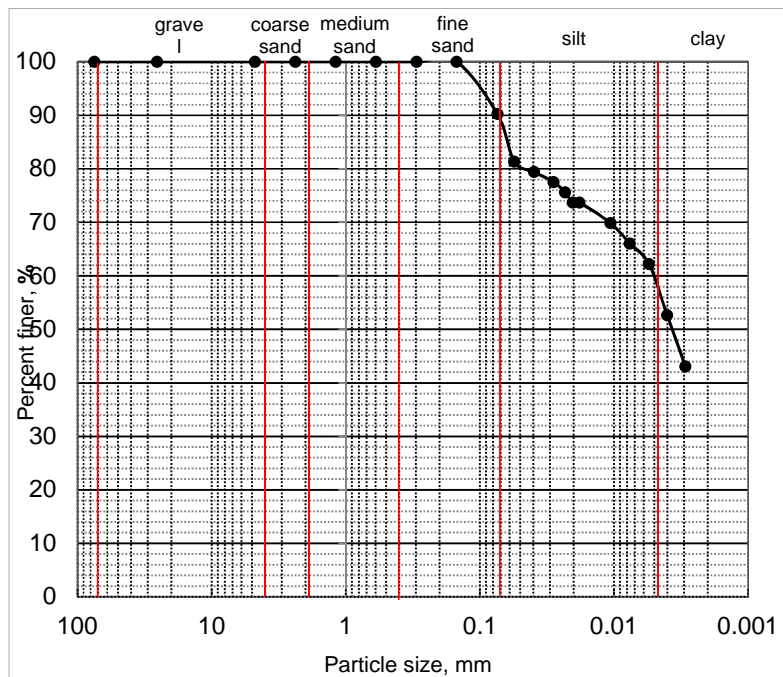
**Size fractions**

Gravel : 75.00 mm to 4.75 mm =	0.00 %
Coarse sand : 4.75 mm to 2.00 mm (Passing #4 and retained on #10) =	0.00 %
Medium sand : 2.00 mm to 0.425 mm (Passing #10 and retained on #40) =	0.00 %
Fine sand : 0.425 mm to 0.075 mm (Passing #40 and retained on #200)	9.78 %
Silt size : 0.075 to 0.005 mm =	31.18 %
Clay size : smaller than 0.005 =	59.04 %
Colloid : smaller than 0.001 =	0.00 %

100.0

Visual classification: Clay  
 USCS classification: Fat Clay

D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	D95 (mm)	Sand (%)	Fines (%)	Cc	Cu	LL (%)	PI (%)	USCS
0.002	0.002	0.004	0.005	0.111	9.78	90.22	0.69	3.03	54.26	28.75	CH



Elapsed time (min)	Hydrometer reading
0.5	42
1	41
2	40
3	39
4	38
5	38
15	36
30	34
60	32
120	27
240	22
1440	0



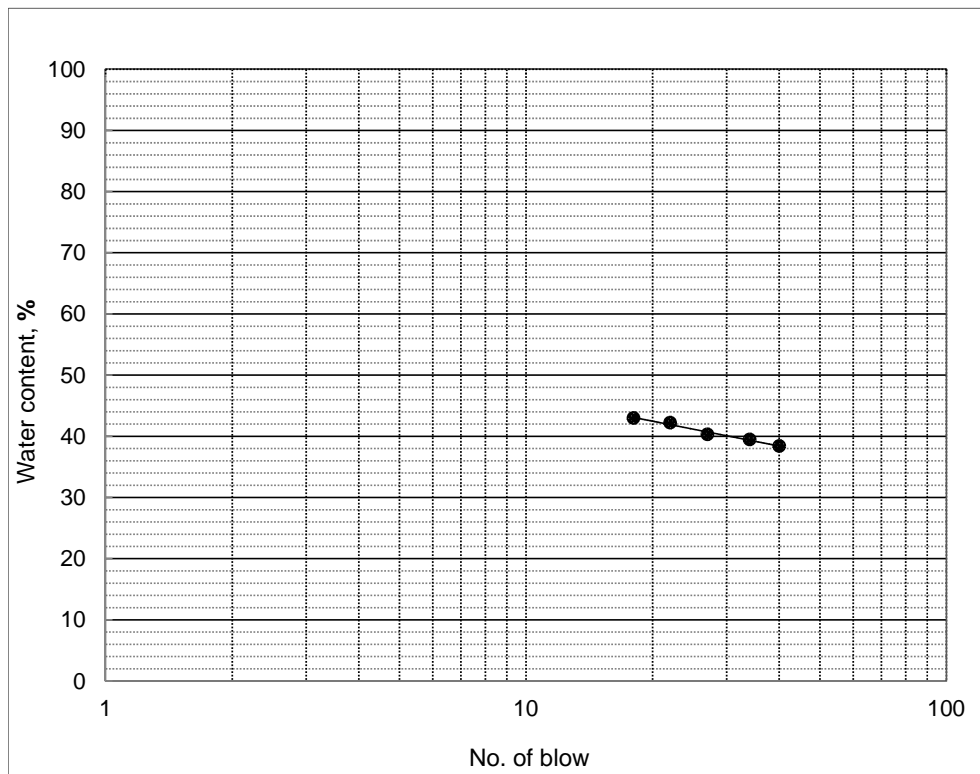
**ATTERBERG LIMIT TEST**

Project:	Ground Improvement for Khulna Soft Clay Soil Project.		
Client:	ReCAP	Bore Hole:	
Location:	Terokada A	Depth (m)	0.3m from road level
Sample Type:	Disturbed	Date:	17-Feb

**Test Results**

No. of Blow	40	34	27	22	18
Wt. of bowl	25.34	19.25	19.10	23.83	16.00
Wt. of bowl+wet soil	33.52	30.20	29.40	35.01	28.87
Wt. of bowl+dry soil	31.25	27.10	26.44	31.69	25.00
Water content	38.41	39.49	40.33	42.24	43.00

Wt. of bowl	19.02	24.06	19.43
Wt. of bowl+wet soil	25.61	30.42	25.18
Wt. of bowl+dry soil	24.42	29.33	24.16
Water content	22.04	20.68	21.56



Liquid Limit, LL=	<b>41.09</b>	%
Plastic Limit, PL=	<b>21.43</b>	%
Plasticity Index, PI=	<b>19.66</b>	



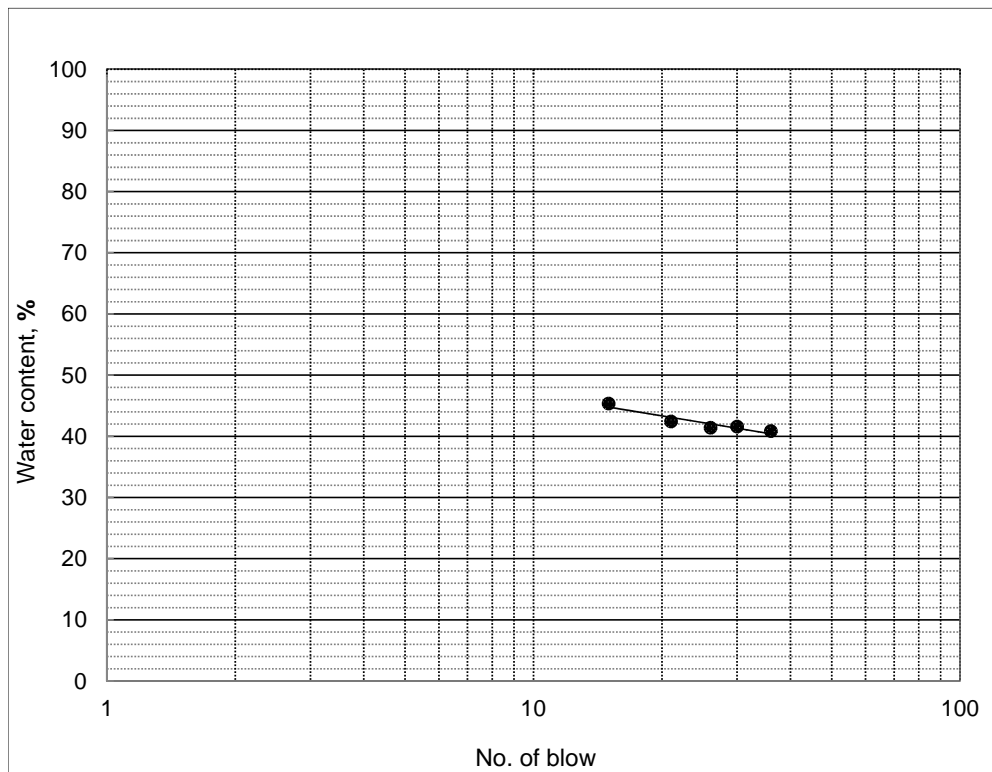
**ATTERBERG LIMIT TEST**

Project:	Ground Improvement for Khulna Soft Clay Soil Project.		
Client:	ReCAP	Bore Hole:	
Location:	Terokada A	Depth (m):	0.2m from road level
Sample Type:	Disturbed	Date:	17-Feb

**Test Results**

No. of Blow	36	30	26	21	15
Wt. of bowl	19.21	15.87	18.60	15.59	23.44
Wt. of bowl+wet soil	27.90	24.62	26.90	24.15	33.15
Wt. of bowl+dry soil	25.38	22.05	24.47	21.60	30.12
Water content	40.84	41.59	41.40	42.43	45.36

Wt. of bowl	23.14	25.41	16.21
Wt. of bowl+wet soil	28.52	30.41	21.00
Wt. of bowl+dry soil	27.58	29.50	20.21
Water content	21.17	22.25	19.75



Liquid Limit, LL=	<b>41.60</b>	%
Plastic Limit, PL=	<b>21.06</b>	%
Plasticity Index, PI=	<b>20.55</b>	



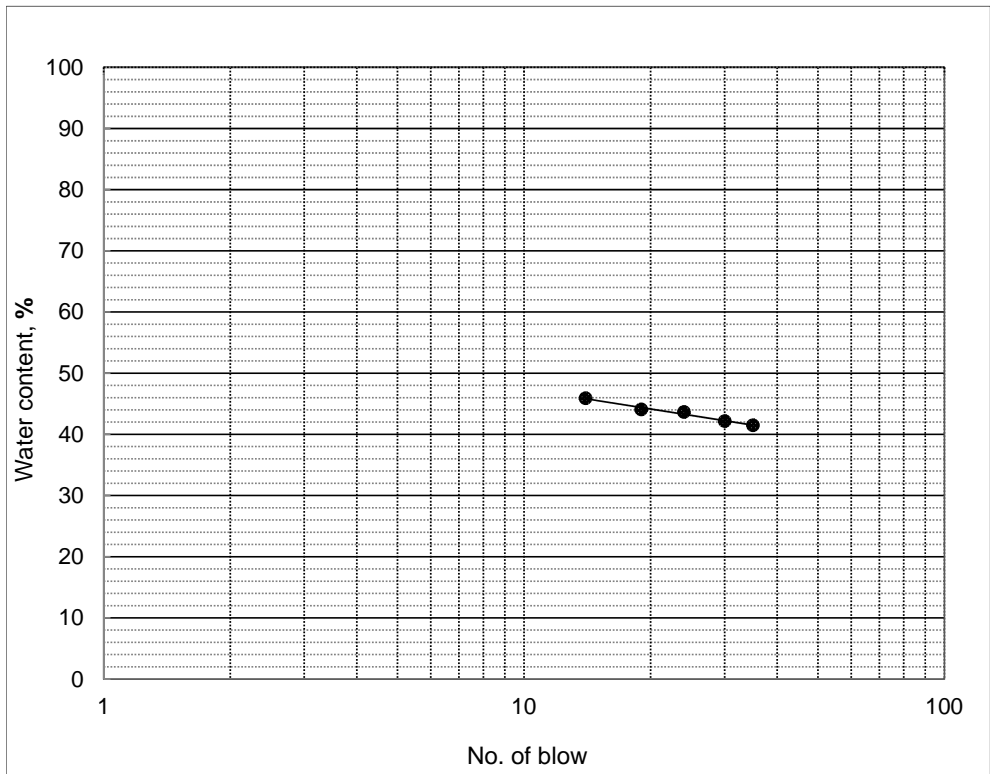
**ATTERBERG LIMIT TEST**

Project:	Ground Improvement for Khulna Soft Clay Soil Project.		
Client:	ReCAP	Bore Hole:	
Location:	Terokada B	Depth (m)	0.2m from road level
Sample Type:	Disturbed	Date:	17-Feb

**Test Results**

No. of Blow	35	30	24	19	14
Wt. of bowl	19.22	18.98	19.18	19.32	19.08
Wt. of bowl+wet soil	28.26	26.13	28.56	27.46	27.44
Wt. of bowl+dry soil	25.61	24.01	25.71	24.97	24.81
Water content	41.47	42.15	43.64	44.07	45.90

Wt. of bowl	19.40	15.91	31.53
Wt. of bowl+wet soil	22.99	19.87	34.22
Wt. of bowl+dry soil	22.22	19.04	33.66
Water content	27.30	26.52	26.29



Liquid Limit, LL=	<b>43.40</b>	%
Plastic Limit, PL=	<b>26.70</b>	%
Plasticity Index, PI=	<b>16.69</b>	



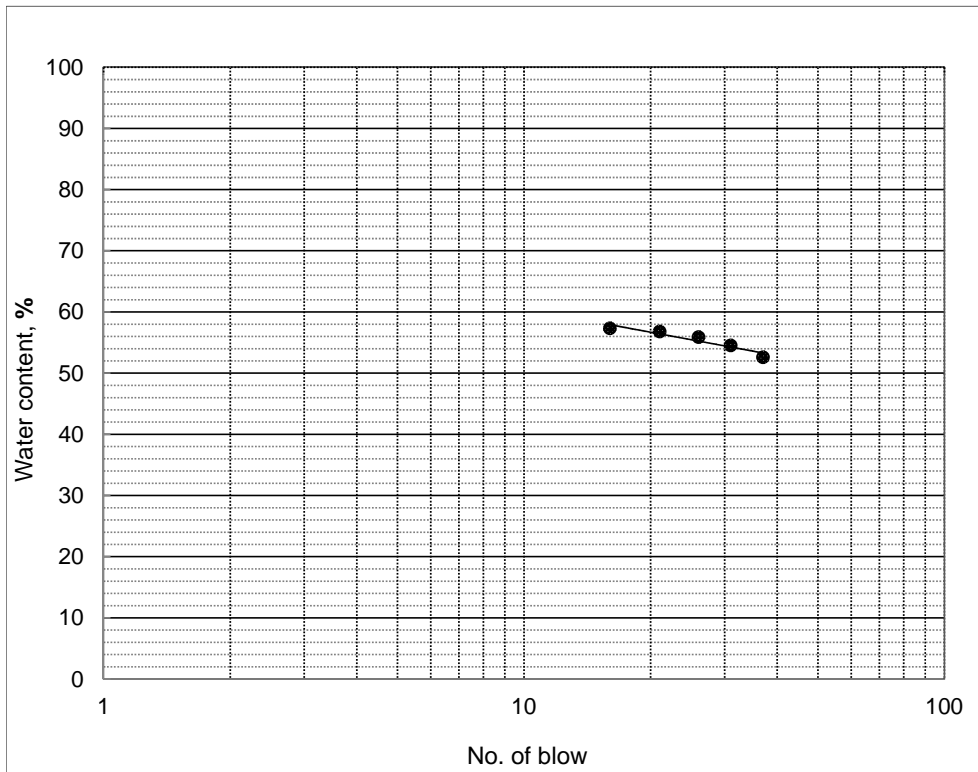
**ATTERBERG LIMIT TEST**

Project:	Ground Improvement for Khulna Soft Clay Soil Project.		
Client:	ReCAP	Bore Hole:	
Location:	Terokada B	Depth (m) bottom of embankment	
Sample Type:	Disturbed	Date:	17-Feb

**Test Results**

No. of Blow	37	31	26	21	16
Wt. of bowl	15.87	24.06	24.30	19.12	19.50
Wt. of bowl+wet soil	26.17	33.44	35.57	30.88	30.01
Wt. of bowl+dry soil	22.62	30.13	31.53	26.62	26.18
Water content	52.59	54.53	55.88	56.80	57.34

Wt. of bowl	15.81	20.38	15.58
Wt. of bowl+wet soil	19.96	25.26	19.03
Wt. of bowl+dry soil	19.15	24.30	18.35
Water content	24.25	24.49	24.55



Liquid Limit, LL=	<b>56.06</b>	%
Plastic Limit, PL=	<b>24.43</b>	%
Plasticity Index, PI=	<b>31.63</b>	



**PARTICLE SIZE ANALYSIS OF SOILS BY SIEVE & HYDROMETER**

Project:	Ground Improvement for Khulna Soft Clay Soil Project.		
Client:	ReCAP	Bore Hole:	
Location:	Terokada A	Depth (m)	0.3m from road level
Sample Type:	Disturbed	Date:	18-Feb

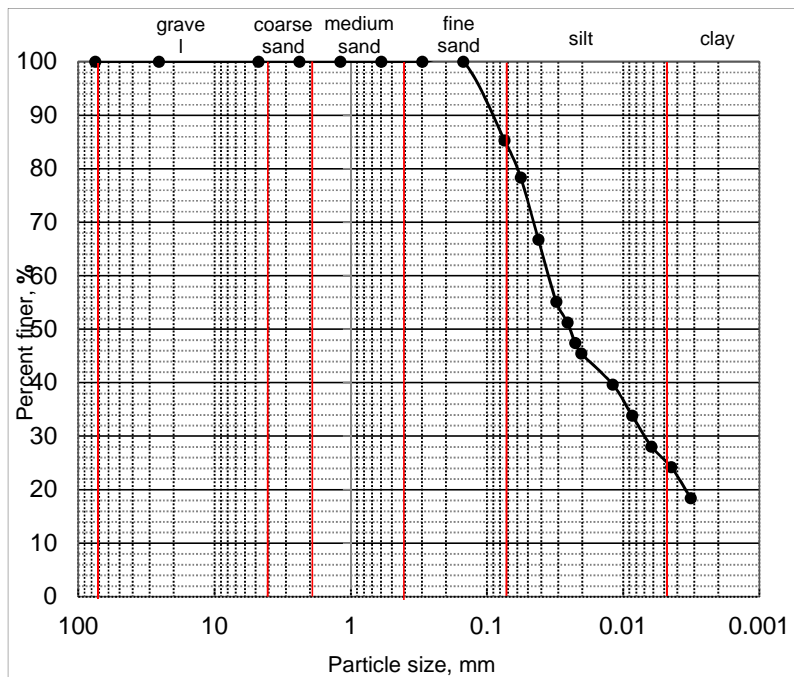
**Test Results**

**Size fractions**

Gravel : 75.00 mm to 4.75 mm =	0.00 %
Coarse sand : 4.75 mm to 2.00 mm (Passing #4 and retained on #10) =	0.00 %
Medium sand : 2.00 mm to 0.425 mm (Passing #10 and retained on #40) =	0.00 %
Fine sand : 0.425 mm to 0.075 mm (Passing #40 and retained on #200) =	14.73 %
Silt size : 0.075 to 0.005 mm =	59.82 %
Clay size : smaller than 0.005 mm =	25.45 %
Colloid : smaller than 0.001 mm =	0.00 %
	100.0

Visual classification: Clay  
 USCS classification: Lean Clay

D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	D95 (mm)	Sand (%)	Fines (%)	Cc	Cu	LL (%)	PI (%)	USCS
0.002	0.007	0.025	0.036	0.124	14.73	85.27	0.60	15.40	41.09	19.66	CL



Elapsed time (min)	Hydrometer reading
0.5	40
1	34
2	28
3	26
4	24
5	23
15	20
30	17
60	14
120	12
240	9
1440	0



**PARTICLE SIZE ANALYSIS OF SOILS BY SIEVE & HYDROMETER**

Project:	Ground Improvement for Khulna Soft Clay Soil Project.		
Client:	ReCAP	Bore Hole:	
Location:	Terokada A	Depth (m)	0.2m from road level
Sample Type:	Disturbed	Date:	18-Feb

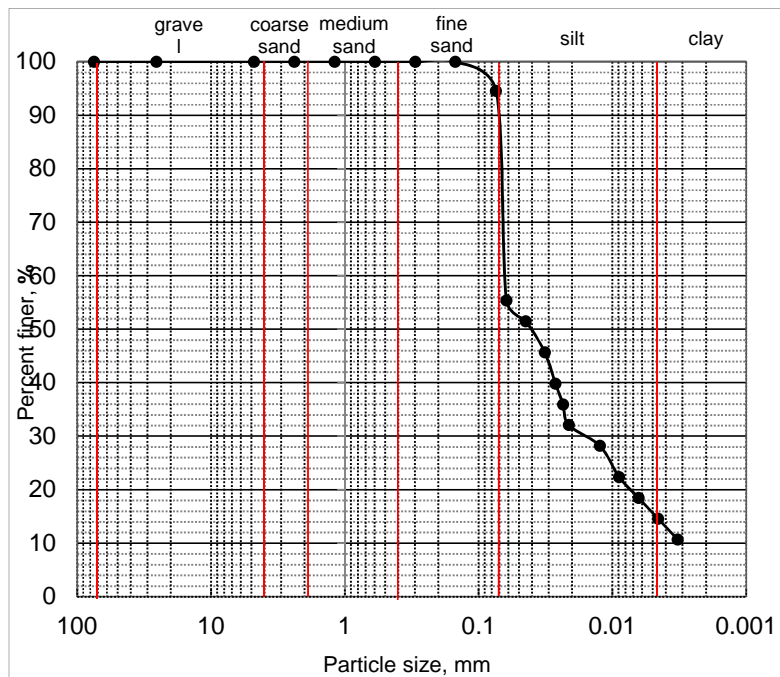
**Test Results**

**Size fractions**

Gravel : 75.00 mm to 4.75 mm =	0.00 %
Coarse sand : 4.75 mm to 2.00 mm (Passing #4 and retained on #10) =	0.00 %
Medium sand : 2.00 mm to 0.425 mm (Passing #10 and retained on #40) =	0.00 %
Fine sand : 0.425 mm to 0.075 mm (Passing #40 and retained on #200)	5.45 %
Silt size : 0.075 to 0.005 mm =	79.00 %
Clay size : smaller than 0.005 mm =	15.55 %
Colloid : smaller than 0.001 mm =	0.00 %
	100.0

Visual classification: Clay  
 USCS classification: Lean Clay

D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	D95 (mm)	Sand (%)	Fines (%)	Cc	Cu	LL (%)	PI (%)	USCS
0.003	0.016	0.041	0.063	0.080	5.45	94.55	1.38	20.31	41.60	20.54	CL



Elapsed time (min)	Hydrometer reading
0.5	28
1	26
2	23
3	20
4	18
5	16
15	14
30	11
60	9
120	7
240	5
1440	0



**PARTICLE SIZE ANALYSIS OF SOILS BY SIEVE & HYDROMETER**

Project:	Ground Improvement for Khulna Soft Clay Soil Project.		
Client:	ReCAP	Bore Hole:	
Location:	Terokada B	Depth (m):	0.2m from road level
Sample Type:	Disturbed	Date:	18-Feb

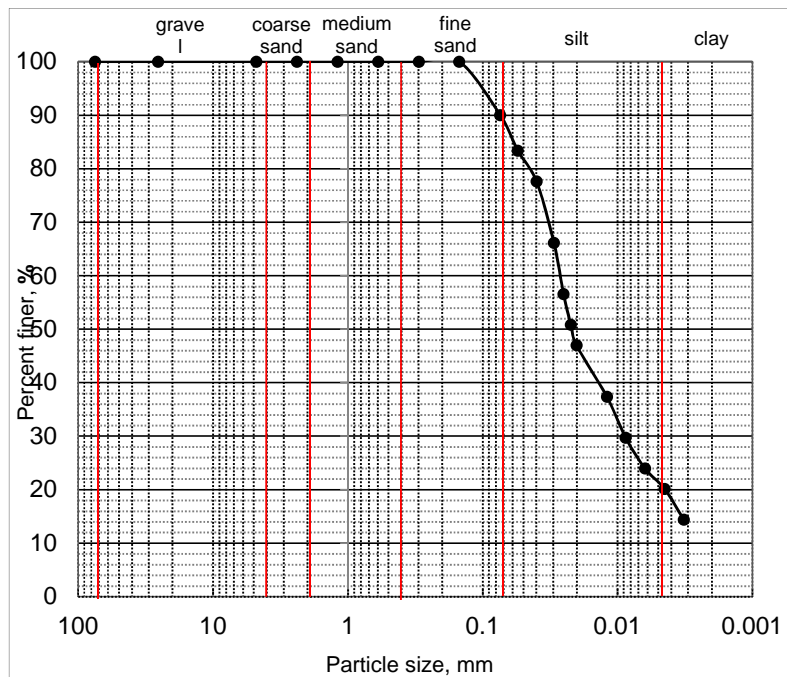
**Test Results**

**Size fractions**

Gravel : 75.00 mm to 4.75 mm =	0.00 %
Coarse sand : 4.75 mm to 2.00 mm (Passing #4 and retained on #10) =	0.00 %
Medium sand : 2.00 mm to 0.425 mm (Passing #10 and retained on #40) =	0.00 %
Fine sand : 0.425 mm to 0.075 mm (Passing #40 and retained on #200) =	9.99 %
Silt size : 0.075 to 0.005 mm =	68.75 %
Clay size : smaller than 0.005 =	21.27 %
Colloid : smaller than 0.001 =	0.00 %
	100.0

Visual classification: Clay  
 USCS classification: Lean Clay

D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	D95 (mm)	Sand (%)	Fines (%)	Cc	Cu	LL (%)	PI (%)	USCS
0.003	0.009	0.022	0.027	0.111	9.99	90.01	1.11	10.23	43.4	16.70	CL



Elapsed time (min)	Hydrometer reading
0.5	43
1	40
2	34
3	29
4	26
5	24
15	19
30	15
60	12
120	10
240	7
1440	0



**PARTICLE SIZE ANALYSIS OF SOILS BY SIEVE & HYDROMETER**

Project:	Ground Improvement for Khulna Soft Clay Soil Project.		
Client:	ReCAP	Bore Hole:	
Location:	Terokada B	Depth (m):	0.2m from road level
Sample Type:	Disturbed	Date:	17-Feb

**Test Results**

**Size fractions**

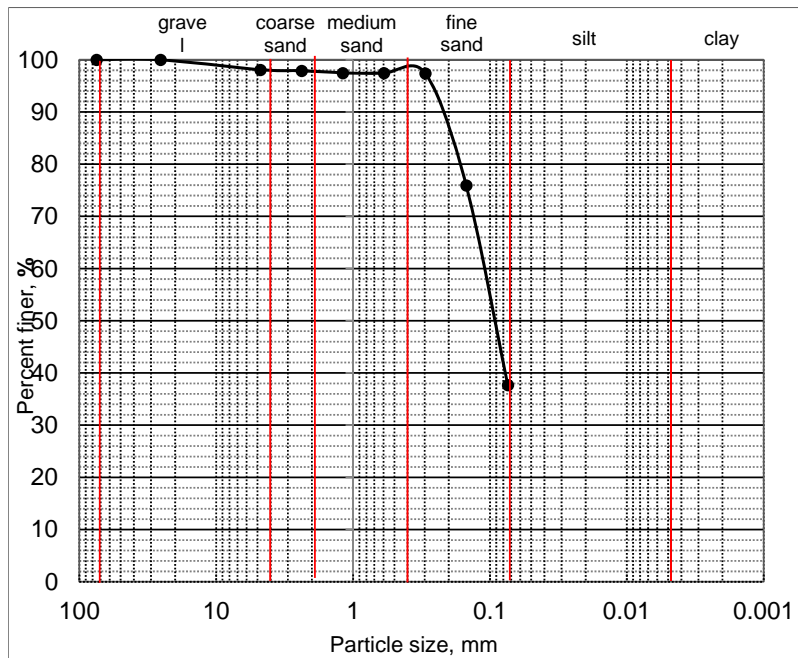
Gravel : 75.00 mm to 4.75 mm =	1.92 %
Coarse sand : 4.75 mm to 2.00 mm (Passing #4 and retained on #10) =	0.31 %
Medium sand : 2.00 mm to 0.425 mm (Passing #10 and retained on #40) =	0.33 %
Fine sand : 0.425 mm to 0.075 mm (Passing #40 and retained on #200) =	59.75 %
Silt size : 0.075 to 0.005 mm =	37.68 %
Clay size : smaller than 0.005 mm =	0.00 %
Colloid : smaller than 0.001 mm =	0.00 %

100.0

Visual classification: Fine Sand

USCS classification: Silty Sand

D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	D95 (mm)	Sand (%)	Fines (%)	Cc	Cu	LL (%)	PI (%)	USCS
-	-	0.098	0.118	0.280	60.40	37.68	-	-	-	-	SM



Sieve No.	Wt. of soil (gm)	% of soil retained
4	2.2	1.92
8	0.2	0.17
16	0.5	0.44
30	0.02	0.02
50	0.04	0.03
100	24.6	21.48
200	43.8	38.25
pan	55.24	37.68

100.00



**PARTICLE SIZE ANALYSIS OF SOILS BY SIEVE & HYDROMETER**

Project:	Ground Improvement for Khulna Soft Clay Soil Project.		
Client:	ReCAP	Bore Hole:	
Location:	Terokada B	Depth (m):	bottom of embankment
Sample Type:	Disturbed	Date:	18-Feb

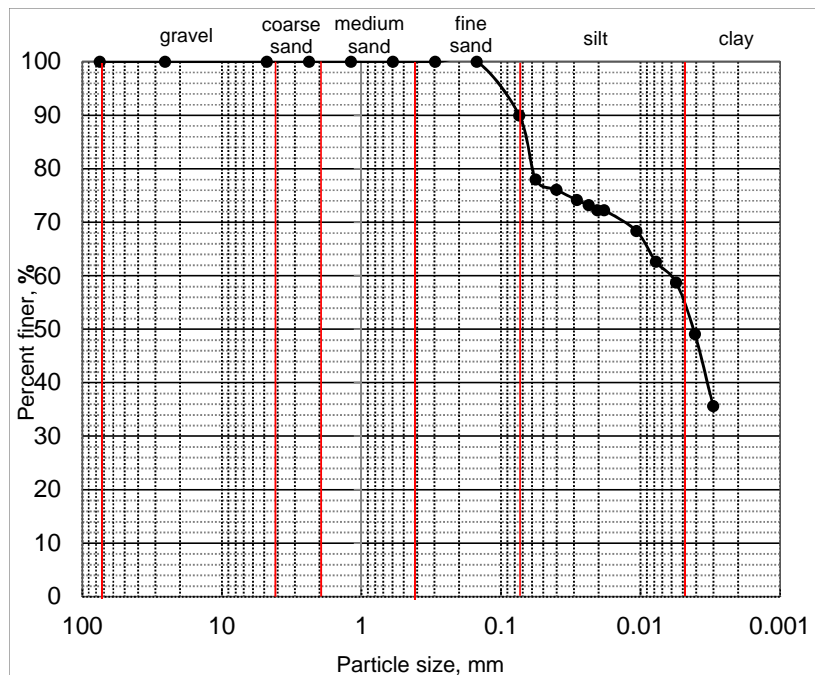
**Test Results**

**Size fractions**

Gravel : 75.00 mm to 4.75 mm =	0.00 %
Coarse sand : 4.75 mm to 2.00 mm (Passing #4 and retained on #10) =	0.00 %
Medium sand : 2.00 mm to 0.425 mm (Passing #10 and retained on #40) =	0.00 %
Fine sand : 0.425 mm to 0.075 mm (Passing #40 and retained on #200) =	10.03 %
Silt size : 0.075 to 0.005 mm =	34.89 %
Clay size : smaller than 0.005 =	55.08 %
Colloid : smaller than 0.001 =	0.00 %
	100.0

Visual classification: Clay  
 USCS classification: Fat Clay

D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	D95 (mm)	Sand (%)	Fines (%)	Cc	Cu	LL (%)	PI (%)	USCS
0.002	0.003	0.004	0.006	0.112	10.03	89.97	0.67	3.51	56.06	31.63	CH]



Elapsed time (min)	Hydrometer reading
0.5	40
1	39
2	38
3	37.5
4	37
5	37
15	35
30	32
60	30
120	25
240	18
1440	0



**PARTICLE SIZE ANALYSIS OF SOILS BY SIEVE & HYDROMETER**

Project:	Ground Improvement for Khulna Soft Clay Soil Project.		
Client:	ReCAP	Bore Hole:	
Location:	Terokada B	Depth (m):	bottom of embankment
Sample Type:	Disturbed	Date:	17-Feb

**Test Results**

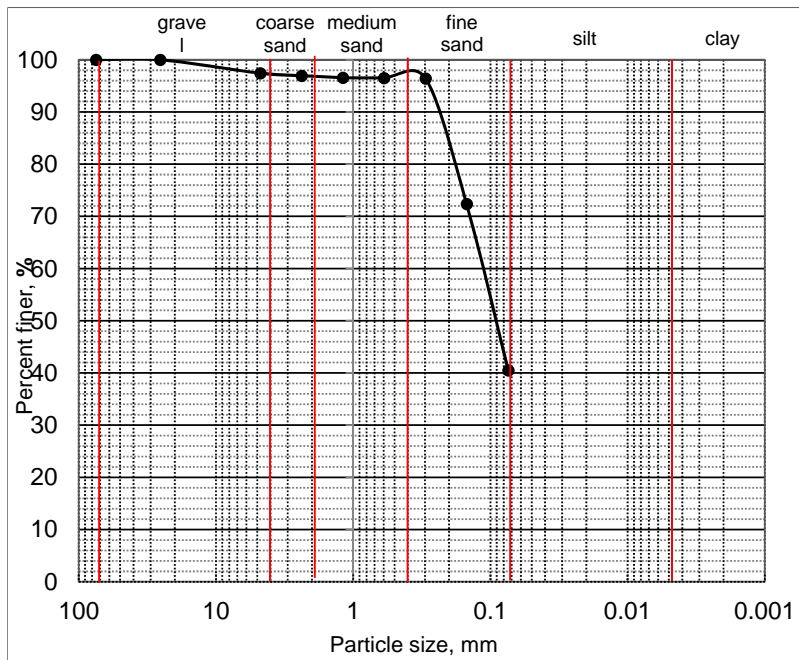
**Size fractions**

Gravel : 75.00 mm to 4.75 mm =	2.58 %
Coarse sand : 4.75 mm to 2.00 mm (Passing #4 and retained on #10) =	0.60 %
Medium sand : 2.00 mm to 0.425 mm (Passing #10 and retained on #40) =	0.37 %
Fine sand : 0.425 mm to 0.075 mm (Passing #40 and retained on #200) =	55.95 %
Silt size : 0.075 to 0.005 mm =	40.51 %
Clay size : smaller than 0.005 =	0.00 %
Colloid : smaller than 0.001 =	0.00 %

100.0

Visual classification: Fine Sand  
 USCS classification: Silty Sand

D10 (mm)	D30 (mm)	D50 (mm)	D60 (mm)	D95 (mm)	Sand (%)	Fines (%)	Cc	Cu	LL (%)	PI (%)	USCS
-	-	0.096	0.120	0.288	56.92	40.51	-	-	-	-	SM



Sieve No.	Wt. of soil (gm)	% of soil retained
4	2.7	2.58
8	0.5	0.48
16	0.4	0.38
30	0.06	0.06
50	0.09	0.09
100	25.2	24.05
200	33.4	31.87
pan	48.95	40.51
		100.00

