BEIRA SANITATION PROJECT
Geo-technical Investigation Report

Project No.	**2008117**
Project Title	**BEIRA SANITATION PROJECT**
Site Location	**Beira, Mozambique**
Client	**C.M.C**
Site Working Period	**July 17, 2008 – July 20, 2008**
Report Date	**July 28, 2008**

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Content

Attached Drawing

Attached Sheet

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1. Introduction

1.1 General

The Proposed Construction is located in Beira City. The Client intends to have 5 boreholes drilled for this geo-technical investigation, and pile foundation will be used for the proposed construction.

1.2 Object of Investigation

The object of the investigation is to ascertain subsoil conditions by drilling at specified depth, conducting in-situ tests, so as to obtain appropriate geotechnical design parameters, allowable bearing capacity, and recommendations for type & depth of foundations to be adopted after analysis of the results and testing of collected samples.

1.3 Method of Investigation

1.3.1 Drilling & Sampling

5 boreholes were allocated by CMC and drilled at 40m depth required by CMC with one XY-1A rig. The locations of boreholes were shown on the site plan (See attachment 1). The method of rotary drilling with bentonite protection was adopted for the boreholes. The diameter of drilling is 127mm for the top-filled soil and 110mm for the rest of borehole.

1.3.2 Standard Penetration Test (SPT)

Standard Penetration Test (SPT) was carried out in 5 boreholes which involve driving a standard split spoon sampler tool through a distance of 450 mm at a

specified depth of the borehole using a semi-automatic trip hammer weighing 63.5kg with a falling height of 760mm. The blows required to drive the sampler the first 150mm are considered to be the seating driving, this soil thickness is assumed to be disturbed and the number of blows are taken for indicative purposes only. The number of blows required to drive the sampler for the last 300mm are recorded as SPT “N – Value”.

The general interval of SPT is 2.00 – 3.00m. The disturbed samples were recovered from the spoon sampler for analysis of particle size.

1.4 Summary of the Investigation work Conducted

Table 1

Item	Unit	Qty.
Soil Drilling	m/borehole	200/5
SPT	No.	70

2. Land Form and Geo-technical Condition of Site

2.1 Land form

The site is located in the coastal plain. The original land form was changed by human being’s activities. The level of borehole is from 2.657m to 4.557m, the maximum difference of boreholes’ level is 2.1m. The engineering survey was done by CMC.

2.2 Geo-technical condition

The subsoil of site can be divided as 3 layers, the characteristics of each layer is shown in table 2.

Description of Subsoil Table 2

Layer No.	Classification of Subsoil	Description	Thickness (m) Min. /Max.		Altitude for Top of Layer (m) Min. /Max.	
①	Fill	Grayish black, mainly composed of trash, broken stones and sand, Loose, inhomogeneous.	2.10	4.10	3.15	4.56
②-1	Silty Clay	Dark grey, soft-plastic, partially fluidal -plastic or plastic, low temper, low dry strength, sandwiched with silty sand, inhomogeneous.	9.30	12.40	0.16	1.76
②-2	Silty Clay	Dark grey, plastic, medium temper, medium dry strength, inhomogeneous.	1.00	3.80	-11.25	-9.14
②-3	Medium & coarse sand with silty clay	Grey, slightly dense to medium dense, with 30% silty clay, sand mainly composed of quartz and feldspar.	7.40	9.50	-13.25	-11.24
③-1	Silty Clay	Grayish white with grayish yellow, stiff, high temper, high dry strength, with lot of Kaolin.	4.30	5.00	-21.44	-19.44
③-2	Coarse sand with silty clay	Grayish yellow, dense, with 25% silty clay, sand mainly composed of quartz and feldspar.	Not Penetrated.		-26.04	-24.34

3. Hydrogeological Conditions

The groundwater is buried in subsoil as phreatic or slightly artesian porous type. The groundwater level is influenced by precipitation with seasonal change. During investigation, the groundwater level was encountered at the depth 1.7m in Borehole SPT2.

4. Analysis & Selection of Geotechnical Parameter

The Mean Value & Standard Value of SPT for Subsoil

Table 3

Layer No.	Classification of Subsoil	Actual SPT Blow Nr.		Corrected SPT Blow Nr.	
		Mean Value	Standard Value	Mean Value	Standard Value
①	Fill	6.3	-	6.2	-
②-1	Silty Clay	4.0	3.4	3.5	2.9
②-2	Silty Clay	11.8	-	8.8	-
②-3	Medium & coarse sand with silty clay	14.2	13.4	9.9	9.4
③-1	Silty clay	40.1	38.6	25.7	24.9
③-2	Coarse sand with silty clay	44.3	42.8	26.0	25.3

5. Bearing Capacity of Subsoil

Characteristic Value of Bearing Capacity

Table 4

Layer No.	Classification of Subsoil	Characteristic Value of Bearing Capacity fak（Kpa）
②-1	Silty clay	65
②-2	Silty clay	140
②-3	Medium & coarse sand with silty clay	160
③-1	Silty clay	300
③-2	Coarse sand with silty clay	280

6. Foundation Proposal

1、According to the geo-technical conditions of site and load characteristics of

proposed construction, layer ③-1 is suggested as bearing stratum, and bored & cast-in-situ pile is suggest as foundation.

2、The diameter, length and quantity of piles should be decided according to the load of upper structure. The design parameter of pile foundation are specified below, the bearing capacity of single pile should be decided finally by the load test.

Design Parameter of Pile Foundation Table 5

Layer No.	Classification of Subsoil	Bored & Cast-in-situ Pile		Coefficient of anti-uplift
		q_{pk}	q_{sik}	
		kpa	kpa	λ_i
②-1	Silty clay		30	0.70
②-2	Silty clay		65	0.70
②-3	Medium & coarse sand with silty clay		65	0.50
③-1	Silty clay	1350(25<h≤30)	92	0.70
Remark	1. *q_{pk}(KPa):* Ultimate standard value of tip resistance of pile; 2. *q_{sik}(KPa):* Ultimate standard value of pile lateral friction resistance, the characteristic value is only 50% of ultimate standard value.			

3. Estimation of Bearing Capacity for Single Pile

Estimation of bearing capacity for single pile is based on the following equation:

$$Q_{uk}= Q_{sk} +Q_{pk}=u\sum q_{sik}\cdot l_i+ q_{pk}\cdot A_p$$

Quk : Ultimate Standard Value of Bearing Capacity for Single Pile

U: Perimeter of Pile Shaft;

Li(m): Thickness of Pile Shaft through Layer i

Ap(m2): Area of Pile Section

qsik(KPa): Ultimate standard value of pile lateral friction resistance (see Table 5)

qpk(KPa): Ultimate standard value of tip resistance of pile (see Table 5)

Estimation of Ultimate Bearing Capacity for Single Pile

Table 6

Type of Pile	Diameter（mm）	Bearing Stratum	Depth into bearing stratum（m）	Length of Pile（m）	Estimation of ultimate bearing capacity for single pile (kN）	BH No.	Remark
Bored & cast-in-situ Pile	Φ600	③-1	1.5	25.5	2438.84	SPT1	
				25.0	2445.43	SPT2	
				29.8	2444.48	SPT3	
				30.0	2655.49	SPT4	
				30.2	2673.40	SPT5	
Note：1. Length of pile is calculated from ground level. The lateral resistance of layer ① is not considered; 2. The depth of piles penetrated into bearing stratum is considered as 1.5m; 3. The ultimate bearing capacity of pile should be decided finally according to the load test.							

7. Conclusion and Suggestion

1. Bored & cast-in-situ pile is suggested as foundation, layer③-1 is suggested as bearing stratum.

2. The diameter, length and quantity of piles should be decided according to the load of upper structure. The standard value of ultimate bearing capacity is estimated in table 6. The ultimate bearing capacity of pile should be decided finally according to the load test.