15. 地形地質測量結果報告書（現地再委託）

REPUBLIC OF RWANDA
MINISTRY OF INFRASTRUCTURE

Execution Agency :

Japan International Coorporation Agency

Buyer :

Consultant :

CONSULTING ENGINEERS & ARCHITECTS
YACHIYO ENGINEERING CO., LTD.

Project :

IMPROVEMENT OF SUBSTATIONS AND DISTRIBUTION NETWORK, PHASE 3, IN THE REPUBLIC OF RWANDA

SOIL INVESTIGATIONS

FILE 1 / 2

KIGALI, August 2017

CONTENT

I. METHODOLOGY

These soil studies relate to five areas defined by the project "Improvement of substations and distribution network, phase 3, in theRepublic of Rwanda.

These areas are presented, each, by the enclosed plans :

- New substation construction site at Gasogi where 6 survey points were dug : Sip1 , Sip2, Sip3, Sip4, Sip5, Sip6
- Branch point line 110 kV, on the new substation where 1 survey point were dug : Sip7
- 15 kV Distribution line Gasogi substation - Nyagasambu, where 15 survey points were dug on : Sip1 , Sip2, Sip3, Sip4, Sip5, Sip6, Sip7 , Sip9, Sip10, Sip11, Sip12, Sip13, Sip15, Sip16 & Sip17 ; corresponding to the corner points of the projected electrical line.
- 15 kV Distribution line Gasogi substation - Masaka hospital, where 15 survey points were dug on : Sip1 , Sip3, Sip4, Sip5, Sip6, Sip8, Sip9, Sip10, Sip12, Sip13, Sip15, Sip16, Sip17, Sip18 & Sip19 ; corresponding to the corner points of the projected electrical line.
- Reconstruction of transmission 110 kV line Jabana - Birembo, where 13 survey points were dug on : Sip176 , Sip177, Sip178, Sip180, Sip181, Sip182, Sip184, Sip186, Sip187, Sip189, Sip190, Sip195, Sip196 ; corresponding to the location of the existing pylons on the current electrical line.

The points considered are those which are the most solicited and the most representative, from the geotechnical point of view, for different soils.

So, all soil investigation points have been tested according to the details described below.

1) Field tests and levy of samples

This phase comprises :

- Observations and analysis of soils texture on the walls of the test pits, 4 meters for maximum depth ;
- Levy of undisturbed samples ;
- Levy of samples overhauled ;
- Backfilling of the test pits ;
- Penetration test in natural ground, performed with a static penetrometer 50 kN, up to more than 10 m deep, 3 meters around the soil investigation point.

The bearing capacity = Rp x 0.01; Rp is the resistance to the tip and 0.01 is the coefficient taking into account the presence of clay ; Rt is the total resistance taking into account friction (see penetrometer tests below).

2) Laboratory tests

On the selected samples from test pits, physical,mechanical and chemical tests analysis were performed by the following tests :

- Phisical tests : Natural water content, Specific gravity, Sieve analysis, Liquid limit, Plastic limit.
- Mechanical tests : Modified proctor, Shear test, unconfined compression test.
- Chemical tests : the degree of alkalinity in soil expressed as a pH, the concentration of sulphate (as SO_4^{2}) and chlorites (as Cl^-)

3) Results and recommendations for foundation

Bringing together the results of field tests and laboratory tests, soil represented by each point is identified, in its form and in its quality.

This identification, facilitating the rational use of these soils, allows the expert to give recommendations for better land use, such as materials and support.

All the work of geotechnical studies, as described above, is presented in two volumes :

- volume 1/2 : own report of the expert ;
- volume 2/2 : test report.

For reasons of speed and ease, separate laboratories were used simultaneously :

- Rincent BTP Rwanda Ltd,
- Geotechnical laboratory and laboratory of agronomy, University of Rwanda, Huye campus.

II. STANDARDS REFERENCES

In large part, we use the French standardization (NF) and, in lesser extent, British Standards (BSCS) and American Standards (AASHTO) & ASTM.

Sampling ..... - Standard NF P94-202

Moisture content ..... - Standard NF P94-050

Specific gravity ..... - Standard NF P94-053

Sieve analysis ..... - Standard NF P94-056

Atterberg limits .....- Standard NF P94-051

Modified proctor .....- Standard NF P94-093

Direct shear box .....- Standard NF P94-071-2

Unconfined compression strength .....- Standard AASHTO T134

British Soil Classification System .....- BSCS

Chimical analysis (sulfate & chloride) ..... - Standard : ASTM D 4327

Chimical analysis (pH) ..... - Standard : ASTM D 4972

In-Situ static penetration tests performed using a GeoMIL 50 kN SPT.

III. ILLUSTRATION OF STUDIES ON SOME PHASES

1) Excavation of test pit

2) Levy of sample

3) Penetration tests:

Setting ink needles for the base of the penetrometer

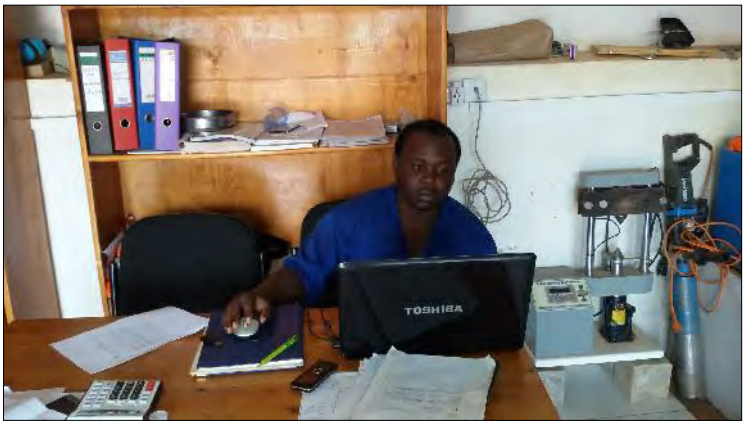
Penetrometer in action : measuring applied forces

4) Laboratory works

a. Liquid limit

b. Sieve analysis

c. Laboratory Technician at work



IV. EXPOSED OBSERVATIONS ON EACH TEST PIT

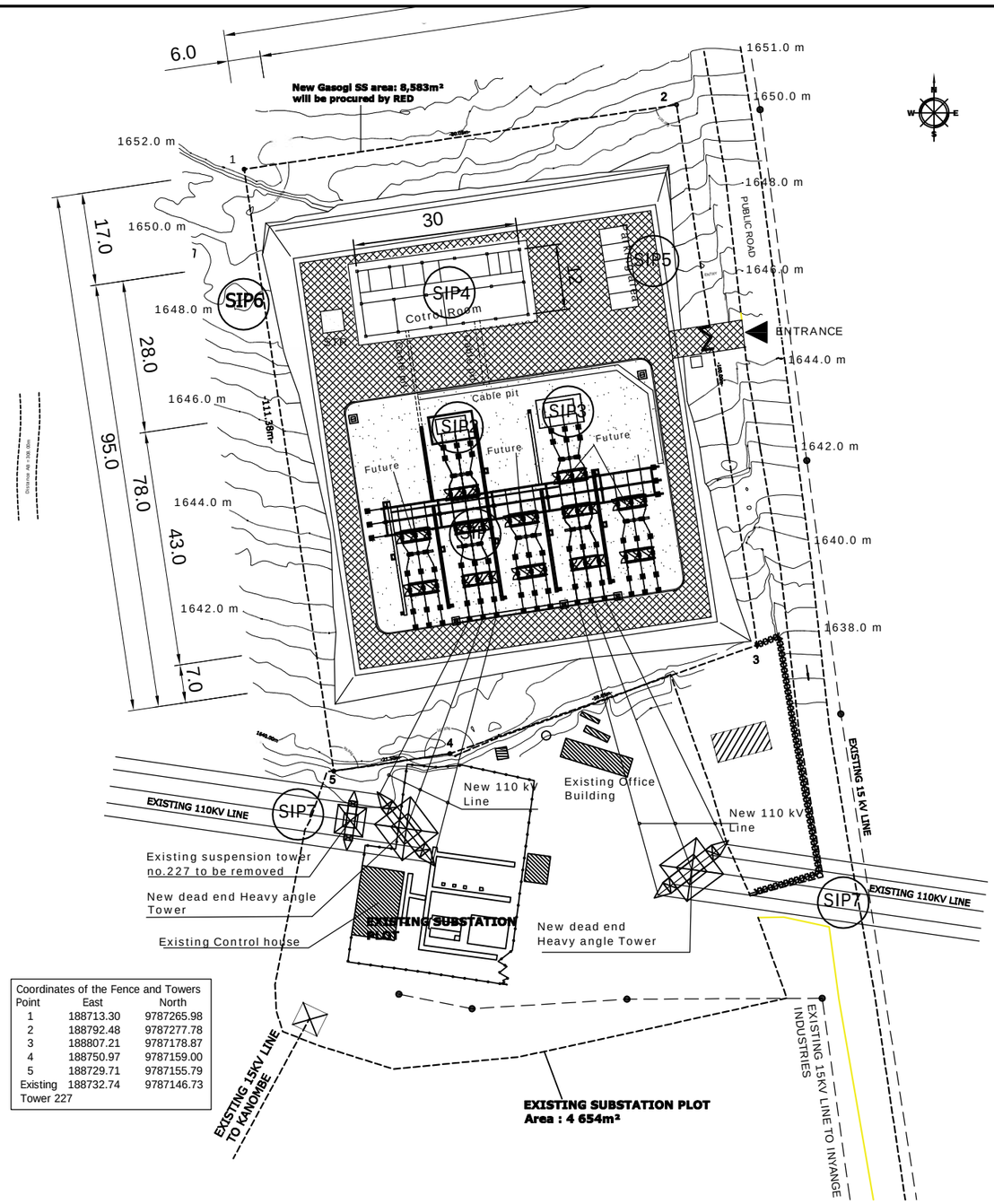
Legend :

- I_P : Plasticity Index - I_c : Consistency Index - $w_{opm\,(\%)}$: Optimum water content

- $\gamma_{d\ opm}$: Optimum dry specific gravity - γ_h : Natural specific gravity - $w_{(N)}$: Natural Moisture content

- Cuu : Cohesion unconsolidated - undrained - ψ_{uu} : Angle of internal friction

A. New substation construction site & Branch point line 110 kV



Coordinates of the Fence and Towers

Point	East	North
1	188713.30	9787265.98
2	188792.48	9787277.78
3	188807.21	9787178.87
4	188750.97	9787159.00
5	188729.71	9787155.79
Existing Tower 227	188732.74	9787146.73

FENCES COORDINATES AND TOWERS

POINT	EAST	NORTH
1	188713.30	9787265.98
2	188792.48	9787277.78
3	188807.21	9787178.87
4	188750.97	9787159.00
5	188729.71	9787155.79
6	188736.95	9787259.40
7	188793.96	9787267.89
8	188801.19	9787217.31
9	188744.48	9787208.82
New tower A	188405.95	9787193.76
New tower B	188713.18	9787215.01
New tower C	188871.40	9787274.67
New tower D	189053.92	9787099.38
Exis. Tower no. 226	188379.36	9787197.46
Exis. Tower no. 227	188732.74	9787146.73
Exis. Tower no. 228	188896.99	9787123.16
Exis. Tower no. 229	189095.09	9787091.72

LEGEND

- Proposed 15 kV line
- Existing 110kV OHL
- Existing 15kV OHL rerouted
- Existing 15kV OHL pole
- SIP — Soil Investigation Point

REV.	DATE	DESCRIPTION	ISSUED	CHECKED
1	March 2015	New Gasogi Substation Layout	REG LTD	REG LTD

REPUBLIC OF RWANDA

RWANDA ENERGY GROUP

Project :

JICA PROJECT PHASE III

Title :

NEW GASOGI SUBSTATION LAYOUT

Name	Fonction	Approva by Client	Date	Signature & stamp

PAPER SIZE	SCALE	DOCUMENT NO.	DATE	DRAWING STATUS
A1	1 / 500		March 2015	FEASIBILITY ☒
				INFO ☐
				FABRICATION ☐
				ERECTION ☐

Drawing n°5/JPPII

Soil investigation point	Extraction depth of the sample	Classification according USCS	Observation	ENGINEERING PROPERTIES		EXCAVATION CONDITION	GEOLOGICAL UNIT SIP 1 Light penetrometer (GeoMIL 50 kN SPT), test without soil coring for sample taking
SIP 1 (new subst. construction site)	2.0 - 3.50 m	Silty gravel poorly graded (GM)	Lateritic zone	- IP : / - Consistency Ic > 1 : very consistent ground - Compaction Backfill : . γ_{d}^{OPM} = 1.95 t / m^3 . W_{OPM} = 14.68 % - Natural soil : . γ_h = 1.68 t / m^3 . $W_{(N)}$ = 14.5 % . γ_s = 2.85 t / m^3	- Permissible bearing pressure (from 2.0 m deep) = 200 kPa - Shear test : . Cuu = 26 kN /m^2 . ψ_{uu} = 23.99° - Chemical analysis : . pH = 7.3 . SO_4^{2} = 31 mg / L . Cl^- = 85 mg / L	Picks and shovels can be used.	

DESCRIPTION OF THE PIT	Depth (below existing ground level) cm	Soil Stratigraphy (observed in the well)	GEOTECHNICAL BEARING CAPACITIES			
			Allowable		ULS *	Ultimate
			(Mpa)	(Kpa)	(Mpa)	(Mpa)
Vegetable soil 0.00 - 0.40 m	0		0	0	0	0
	20		0.25	250	25	45
	40		0.30	300	30	50
Black Silty gravel poorly gradedl 0.40 - 1.40 m	60		0.25	250	25	40
	80		0.63	630	63	80
	100		0.70	700	70	90
	120		0.90	900	90	250
	140		1.00	1000	100	370
Red Silty gravel poorly gradedl 1.40 - 4.00 m	160		1.30	1300	130	420
	180		1.50	1500	150	500
	200					
	220					
	240					
	260					
	280					
	300					
	320					
	340					
	360					
	380					
	400					
	420					
	440					
	460					
	480					
	500					
	520					
	540					
	560					
	580					
	620					
	640					
	660					
	680					
	700					
	720					
	740					
	760					
	780					
	800					
	820					
	840					

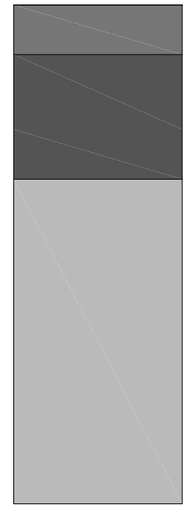
* ULS : Ultimate Limit State

EXCAVATION (test pit)

EXCAVATED SOIL

FOUNDATION TYPE

REFER TO THE DESIGN OF THE STRUCTURE

Soil investigation point	Extraction depth of the sample	Classification according USCS	Observation	ENGINEERING PROPERTIES		EXCAVATION CONDITION	GEOLOGICAL UNIT (Without penetrometer test)
SIP 2 (new subst. construction site)	3.70 - 4.00 m	Silty gravel poorly graded (GM)	Semi rock soil	- IP : / - Consistency Ic > 1 : very consistent ground - Compaction Backfill : . γ_{dOPM} = 1.95 t / m^3 . W_{OPM} = 15.10 % - Natural soil : . γ_h = 1.94 t / m^3 . $W_{(N)}$ = 17.7 % . γ_s = 2.90 t / m^3	- Shear test : . Cuu = 14 kN /m^2 . ψ_{uu} = 26.57° - Chemical analysis : . pH = 6.55 . SO_4^{2} = 11.7 mg / L . Cl^- = 191 mg / L	Picks and shovels can be used.	Texture on the section of the test pit  vegetable soil (30 cm) black Silty gravel poorly graded (2.0 m) light reddish gray Silty gravel poorly graded (± 1.7 m)

EXCAVATION (test pit)

EXCAVATED SOIL

FOUNDATION TYPE

REFER TO THE DESIGN OF THE STRUCTURE

Soil investigation point	Extraction depth of the sample	Classification according USCS	Observation	ENGINEERING PROPERTIES		EXCAVATION CONDITION	GEOLOGICAL UNIT Light penetrometer (GeoMIL 50 kN SPT), test without soil coring for sample taking
SIP 3 (new subst. construction site)	3.50 - 4.00 m	red Clayey gravel poorly graded (GC)	Lateritic zone	- IP : 14.8 % - Consistency Ic = 1.52 > 1 : very consistent ground - Compaction Backfill : . $\gamma_{d^{OPM}}$ = 1.94 t / m^3 . W_{OPM} = 13.80 % - Natural soil : . γ_h = 1.93 t / m^3 . $W_{(N)}$ = 14.6 % . γ_s = 2.80 t / m^3	- Permissible bearing pressure (from 1.60 m deep) = 50 Mpa - Shear test : . Cuu = 14 kN /m^2 . ψ_{uu} = 26.34° - Chemical analysis : . pH = 7.02 . SO_4^{2} = 16.5 mg / L . Cl^- = 177 mg / L	Picks and shovels can be used.	

DESCRIPTION OF THE PIT	Depth (below existing ground level) cm	Soil Stratigraphy (observed in the well)	GEOTECHNICAL BEARING CAPACITIES			
			Allowable (Mpa)	Allowable (Kpa)	ULS * (Mpa)	Ultimate (Mpa)
Vegetable soil 0.00 - 0.40 m	0		0	0	0	0
	20		0.20	200	20	40
	40		0.30	300	30	60
Black Clayey gravel poorly graded 0.40 - 1.90 m	60		0.25	250	25	45
	80		0.20	200	20	40
	100		0.80	800	80	130
	120		1.20	1200	120	350
	140		1.40	1400	140	420
	160		1.50	1500	150	500
	180					
	200					
Red Clayey gravel poorly graded 1.90 - 4.00 m	220					
	240					
	260					
	280					
	300					
	320					
	340					
	360					
	380					
	400					
	420					
	440					
	460					
	480					
	500					
	520					
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	560					
	580					
	620					
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	660					
	680					
	700					
	720					
	740					
	760					
	780					
	800					
	820					
	840					

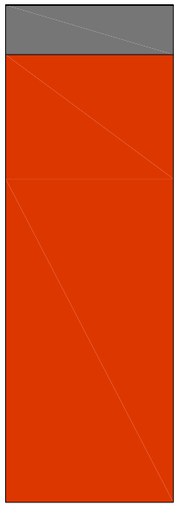
* ULS : Ultimate Limit State

EXCAVATION (test pit)

EXCAVATED SOIL

FOUNDATION TYPE

REFER TO THE DESIGN OF THE STRUCTURE

Soil investigation point	Extraction depth of the sample	Classification according USCS	Observation	ENGINEERING PROPERTIES		EXCAVATION CONDITION	GEOLOGICAL UNIT (Without penetrometer test)
SIP 4 (new subst. construction site)	3.50 - 4.00 m	Clayey gravel poorly graded (GC)	Semi rock soil	- IP : 15.2 % - Consistency Ic = 1.34 > 1 : very consistent ground - Compaction Backfill : . $\gamma_{d^{OPM}}$ = 2.01 t / m^3 . W_{OPM} = 12.80 % - Natural soil : . γ_h = 1.94 t / m^3 . $W_{(N)}$ = 18.0 % . γ_S = 2.80 t / m^3	- Shear test : . Cuu = 10 kN /m^2 . ψ_{uu} = 27.25° - Chemical analysis : . pH = 6.63 . SO_4^{2} = 19 mg / L . Cl^- = 197 mg / L	Picks and shovels can be used.	Texture on the section of the test pit  vegetable soil (20 cm) Red Clayey gravel poorly graded (± 3.8 m)

EXCAVATION (test pit)

EXCAVATED SOIL

13

FOUNDATION TYPE

REFER TO THE DESIGN OF THE STRUCTURE

Soil investigation point	Extraction depth of the sample	Classification according USCS	Observation	ENGINEERING PROPERTIES		EXCAVATION CONDITION	GEOLOGICAL UNIT Light penetrometer (GeoMIL 50 kN SPT), test without soil coring for sample taking
SIP 5 (new subst. construction site)	3.50 - 4.00 m	Clayey of intermediate plasticity (CI)	Semi rock soil	- IP : 18.1 % - Consistency Ic = 1.30 > 1 : very consistent ground - Compaction Backfill : . $\gamma_{d^{OPM}}$ = 1.88 t / m^3 . W_{OPM} = 14.40 % - Natural soil : . γ_h = 1.84 t / m^3 . $W_{(N)}$ = 16 % . γ_s = 2.80 t / m^3	- Shear test : . Cuu = 37 kN /m^2 . ψ_{uu} = 19.80° - Chemical analysis : . pH = 6.67 . SO_4^{2} = 21 mg / L . Cl^- = 193 mg / L	Picks and shovels can be used.	

DESCRIPTION OF THE PIT	Depth (below existing ground level) cm	Soil Stratigraphy (observed in the well)	GEOTECHNICAL BEARING CAPACITIES			
			Allowable		ULS *	Ultimate
			(Mpa)	(Kpa)	(Mpa)	(Mpa)
Vegetable soil 0.00 - 0.30 m	0		0	0	0	0
	20		0.20	200	35	55
	40		0.30	300	40	65
Black Clayey gravel 0.30 - 1.30 m	60		0.25	250	30	55
	80		0.20	200	42	75
	100		0.80	800	80	130
	120		1.20	1200	130	420
	140		1.50	1500	150	500
Clayey of intermediate plasticity 1.30 - 4.00 m	160					
	180					
	200					
	220					
	240					
	260					
	280					
	300					
	320					
	340					
	360					
	380					
	400					
	420					
	440					
	460					
	480					
	500					
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	540					
	560					
	580					
	620					
	640					
	660					
	680					
	700					
	720					
	740					
	760					
	780					
	800					
	820					
	840					

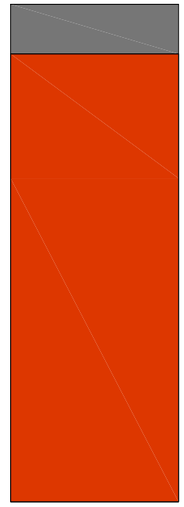
* ULS : Ultimate Limit State

EXCAVATION (test pit)

EXCAVATED SOIL

FOUNDATION TYPE

REFER TO THE DESIGN OF THE STRUCTURE

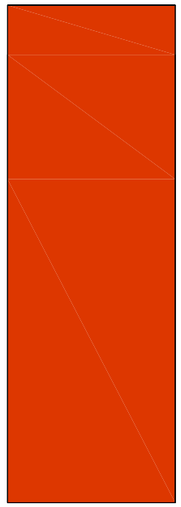
Soil investigation point	Extraction depth of the sample	Classification according USCS	Observation	ENGINEERING PROPERTIES		EXCAVATION CONDITION	GEOLOGICAL UNIT (Without penetrometer test)
SIP 6 (new subst. construction site)	3.50 - 4.00 m	Clayey of intermediate plasticity (CI)	Lateritic zone	- IP : 18.8 % - Consistency Ic = 1.25 > 1 : very consistent ground - Compaction Backfill : . $\gamma_{d^{OPM}}$ = 1.82 t / m^3 . W_{OPM} = 16.98 % - Natural soil : . γ_h = 1.71 t / m^3 . $W_{(N)}$ = 18 % . γ_S = 2.77 t / m^3	- Shear test : . Cuu = 26 kN /m^2 . ψ_{uu} = 20.30° - Chemical analysis : . pH = 5.4 . SO_4^{2} = 11.2 mg / L . Cl^- = 78.8 mg / L	Picks and shovels can be used.	Texture on the section of the test pit  vegetable soil (30 cm) Clayey of intermediate plasticity (± 3.7 m)

EXCAVATION (test pit)

EXCAVATED SOIL

FOUNDATION TYPE

REFER TO THE DESIGN OF THE STRUCTURE

Soil investigation point	Extraction depth of the sample	Classification according USCS	Observation	ENGINEERING PROPERTIES		EXCAVATION CONDITION	GEOLOGICAL UNIT (Without penetrometer test)
SIP 7 (new subst. construction site)	3.50 - 4.00 m	Silty sand poorly graded (SM)	Lateritic zone	- IP : 16 % - Consistency Ic = 1.24 > 1 : very consistent ground - Compaction Backfill : . $\gamma_{d^{OPM}}$ = 1.96 t / m^3 . W_{OPM} = 14.69 % - Natural soil : . γ_h = 1.93 t / m^3 . $W_{(N)}$ = 18.3 % . γ_S = 2.86 t / m^3	- Shear test : . Cuu = 25 kN /m^2 . ψ_{uu} = 23.75° - Chemical analysis : . pH = 6.31 . SO_4^{2} = 37 mg / L . Cl^- = 134 mg / L	Picks and shovels can be used.	Texture on the section of the test pit  Silty sand poorly graded (± 4.0 m)

EXCAVATION (test pit)

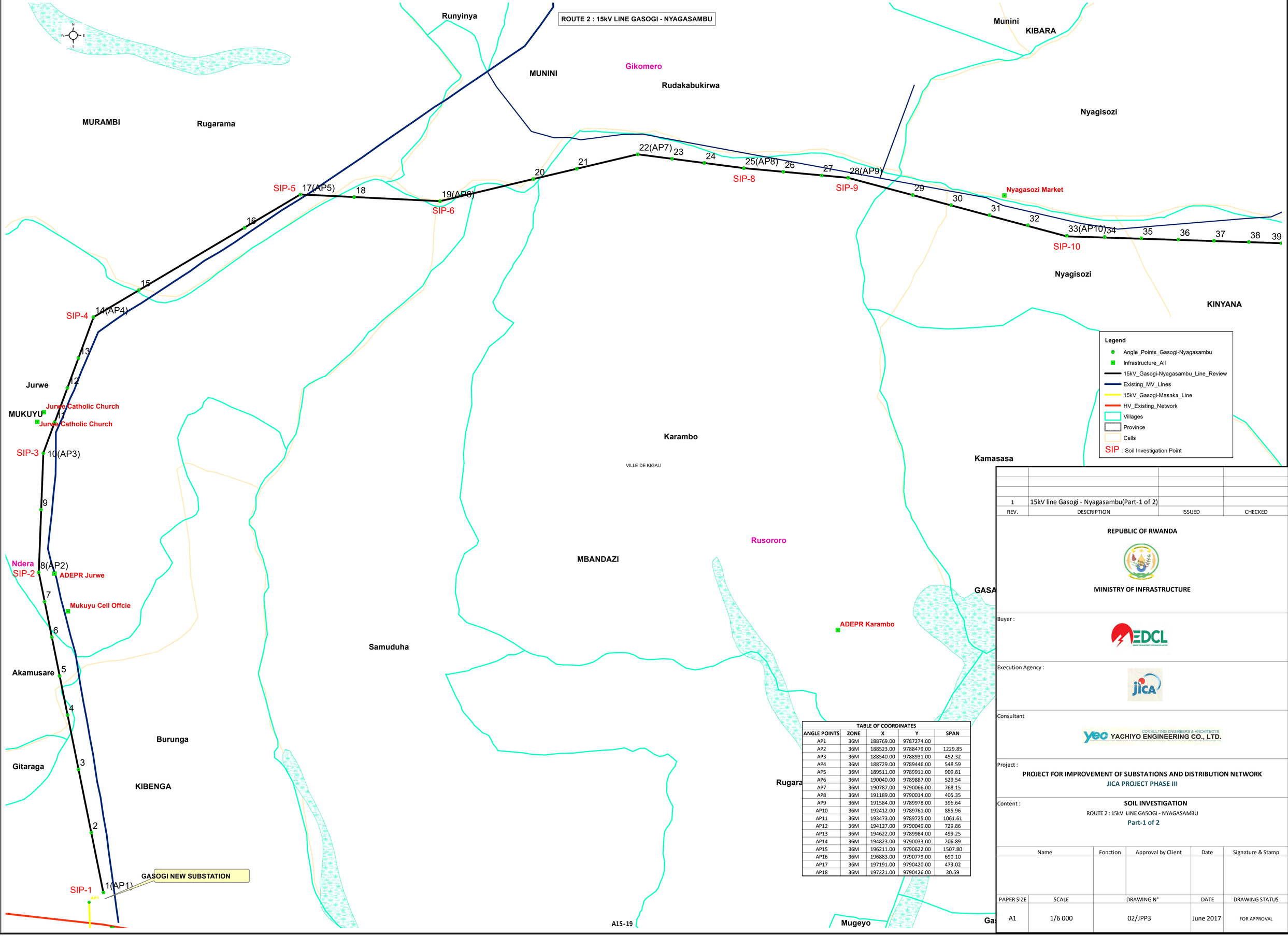
EXCAVATED SOIL

FOUNDATION TYPE

REFER TO THE DESIGN OF THE STRUCTURE

B. 15 kV Distribution line Gasogi substation-Nyagasambu

ROUTE 2 : 15kV LINE GASOGI - NYAGASAMBU



Legend

- Angle_Points_Gasogi-Nyagasambu
- Infrastructure_All
- 15kV_Gasogi-Nyagasambu_Line_Review
- Existing_MV_Lines
- 15kV_Gasogi-Masaka_Line
- HV_Existing_Network
- Villages
- Province
- Cells

SIP : Soil Investigation Point

TABLE OF COORDINATES

ANGLE POINTS	ZONE	X	Y	SPAN
AP1	36M	188769.00	9787274.00	
AP2	36M	188523.00	9788479.00	1229.85
AP3	36M	188540.00	9788931.00	452.32
AP4	36M	188729.00	9789446.00	548.59
AP5	36M	189511.00	9789911.00	909.81
AP6	36M	190040.00	9789887.00	529.54
AP7	36M	190787.00	9790066.00	768.15
AP8	36M	191189.00	9790014.00	405.35
AP9	36M	191584.00	9789978.00	396.64
AP10	36M	192412.00	9789761.00	855.96
AP11	36M	193473.00	9789725.00	1061.61
AP12	36M	194127.00	9790049.00	729.86
AP13	36M	194622.00	9789984.00	499.25
AP14	36M	194823.00	9790033.00	206.89
AP15	36M	196211.00	9790622.00	1507.80
AP16	36M	196883.00	9790779.00	690.10
AP17	36M	197191.00	9790420.00	473.02
AP18	36M	197221.00	9790426.00	30.59

REV.	DESCRIPTION	ISSUED	CHECKED
1	15kV line Gasogi - Nyagasambu(Part-1 of 2)		

REPUBLIC OF RWANDA

MINISTRY OF INFRASTRUCTURE

Buyer : EDCL

Execution Agency : JICA

Consultant : YACHIYO ENGINEERING CO., LTD. (CONSULTING ENGINEERS & ARCHITECTS)

Project :

PROJECT FOR IMPROVEMENT OF SUBSTATIONS AND DISTRIBUTION NETWORK

JICA PROJECT PHASE III

Content :

SOIL INVESTIGATION

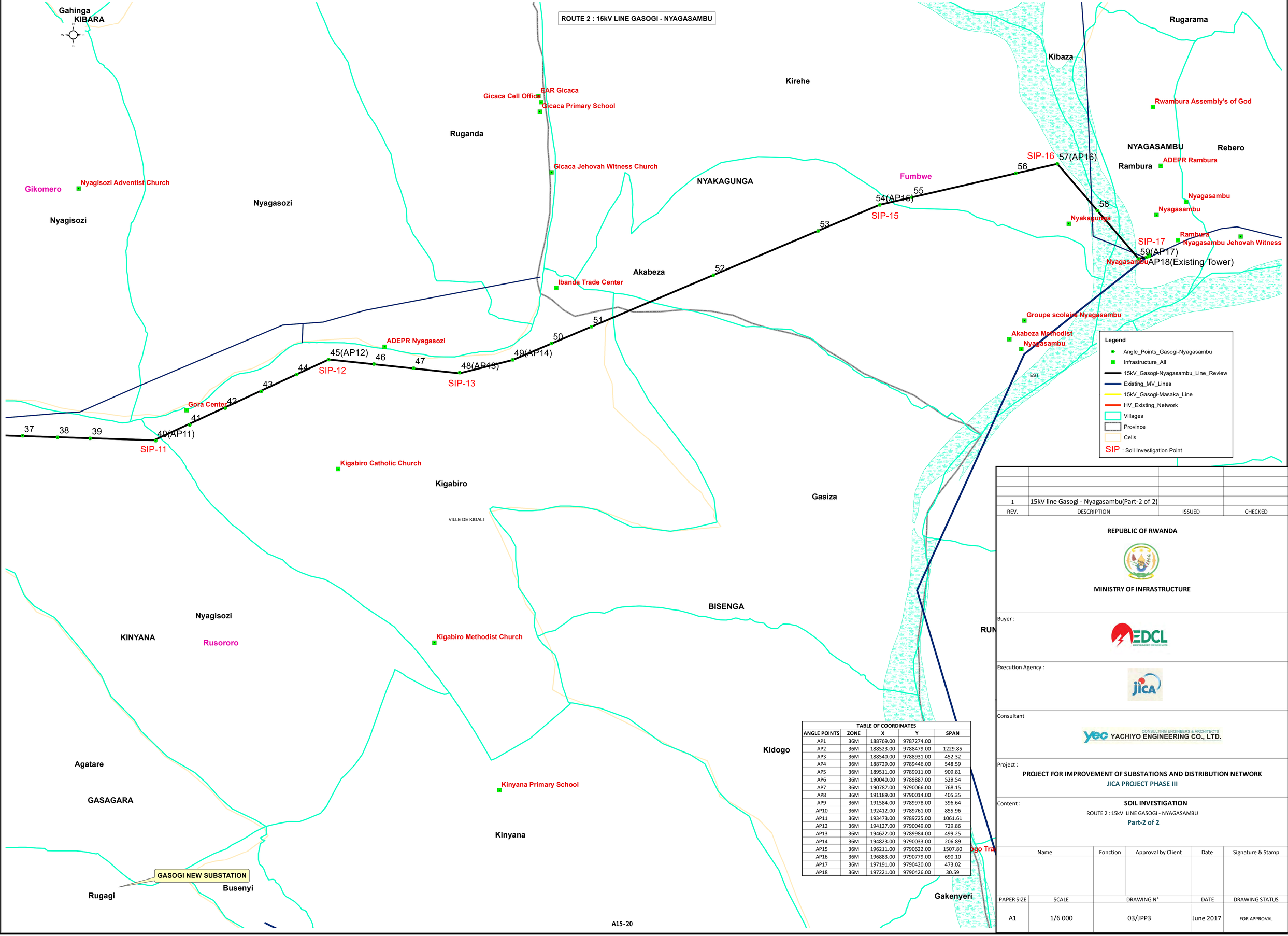
ROUTE 2 : 15kV LINE GASOGI - NYAGASAMBU

Part-1 of 2

Name	Fonction	Approval by Client	Date	Signature & Stamp

PAPER SIZE	SCALE	DRAWING N°	DATE	DRAWING STATUS
A1	1/6 000	02/JPP3	June 2017	FOR APPROVAL

ROUTE 2 : 15kV LINE GASOGI - NYAGASAMBU



Legend

- Angle_Points_Gasogi-Nyagasambu
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- HV_Existing_Network
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- Province
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SIP : Soil Investigation Point

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AP4	36M	188729.00	9789446.00	548.59
AP5	36M	189511.00	9789911.00	909.81
AP6	36M	190040.00	9789887.00	529.54
AP7	36M	190787.00	9790066.00	768.15
AP8	36M	191189.00	9790014.00	405.35
AP9	36M	191584.00	9789978.00	396.64
AP10	36M	192412.00	9789761.00	855.96
AP11	36M	193473.00	9789725.00	1061.61
AP12	36M	194127.00	9790049.00	729.86
AP13	36M	194622.00	9789984.00	499.25
AP14	36M	194823.00	9790033.00	206.89
AP15	36M	196211.00	9790622.00	1507.80
AP16	36M	196883.00	9790779.00	690.10
AP17	36M	197191.00	9790420.00	473.02
AP18	36M	197221.00	9790426.00	30.59

REV.	DESCRIPTION	ISSUED	CHECKED
1	15kV line Gasogi - Nyagasambu(Part-2 of 2)		

REPUBLIC OF RWANDA

MINISTRY OF INFRASTRUCTURE

Buyer : EDCL

Execution Agency : JICA

Consultant : YACHIYO ENGINEERING CO., LTD.

Project :

PROJECT FOR IMPROVEMENT OF SUBSTATIONS AND DISTRIBUTION NETWORK

JICA PROJECT PHASE III

Content :

SOIL INVESTIGATION

ROUTE 2 : 15kV LINE GASOGI - NYAGASAMBU

Part-2 of 2

Name	Fonction	Approval by Client	Date	Signature & Stamp

PAPER SIZE	SCALE	DRAWING N°	DATE	DRAWING STATUS
A1	1/6 000	03/JPP3	June 2017	FOR APPROVAL

Soil investigation point	Extraction depth of the sample	Classification according USCS	Observation	ENGINEERING PROPERTIES		EXCAVATION CONDITION	GEOLOGICAL UNIT Light penetrometer (GeoMIL 50 kN SPT), test without soil coring for sample taking
SIP 1 (15 kV line Gasogi - Nyagasambu)	3.70 - 4.00 m	Silty gravel poorly graded (GM)	Semi rock soil	- IP : / - Consistency Ic > 1 : very consistent ground - Compaction Backfill : . γ_{d}^{OPM} = 1.89 t / m^3 . W_{OPM} = 12.35 % - Natural soil : . γ_h = 1.64 t / m^3 . $W_{(N)}$ = 16.3 % . γ_s = 2.60 t / m^3	- Shear test : . Cuu = 31 kN /m^2 . ψ_{uu} = 23.03° - Chemical analysis : . pH = 5.9 . SO_4^{2} = 7.7 mg / L . Cl^- = 92 mg / L	Picks and shovels can be used.	

DESCRIPTION OF THE PIT	Depth (below existing ground level) cm	Soil Stratigraphy (observed in the well)	GEOTECHNICAL BEARING CAPACITIES			
			Allowable		ULS *	Ultimate
			(Mpa)	(Kpa)	(Mpa)	(Mpa)
Vegetable soil 0.00 - 0.30 m	0		0	0	0	0
	20		0.12	120	12	45
	40		0.18	180	18	65
Black Silty gravel poorly gradedl 0.30 - 2.30 m	60		0.60	600	60	94
	80		1.20	1200	120	160
	100		0.30	300	30	85
	120		0.33	330	33	90
	140		0.25	250	25	70
	160		0.50	500	50	110
	180		0.53	530	53	200
	200		0.95	950	95	280
	220		1.00	1000	100	390
	240		1.50	1500	150	500
Light reddish gray Silty gravel poorly gradedl 2.30 - 4.00 m	260					
	280					
	300					
	320					
	340					
	360					
	380					
	400					
	420					
	440					
	460					
	480					
	500					
	520					
	540					
	560					
	580					
	620					
	640					
	660					
	680					
	700					
	720					
	740					
	760					
	780					
	800					
	820					
	840					

* ULS : Ultimate Limit State

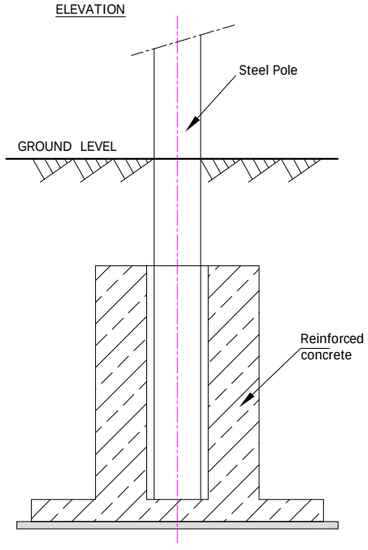
EXCAVATION (test pit)

EXCAVATED SOIL

20

FOUNDATION TYPE

ELEVATION



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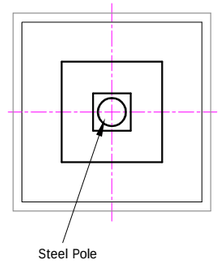


THE FOUNDATION DIMENSIONS COMPLY WITH THE STATIC BALANCE OF POST FIXING .

Soil investigation point	Extraction depth of the sample	Classification according USCS	Observation	ENGINEERING PROPERTIES		EXCAVATION CONDITION	GEOLOGICAL UNIT Light penetrometer (GeoMIL 50 kN SPT), test without soil coring for sample taking
SIP 2 (15 kV line Gasogi - Nyagasambu)	1.00 - 2.00 m	Silty sand poorly graded (SM)	Semi rock soil	- IP : 16.8 - Consistency Ic = 1.4 > 1 : very consistent ground - Compaction Backfill : . $\gamma_{d^{OPM}}$ = 1.92 t / m^3 . W_{OPM} = 13.40 % - Natural soil : . γ_h = 1.72 t / m^3 . $W_{(N)}$ = 14.6 % . γ_s = 2.68 t / m^3	- Shear test : . Cuu = 28 kN /m^2 . ψ_{uu} = 25.41° - Chemical analysis : . pH = 4.62 . SO_4^{2} = 6.7 mg / L . Cl^- = 113.4 mg / L	Pneumatique hammer	

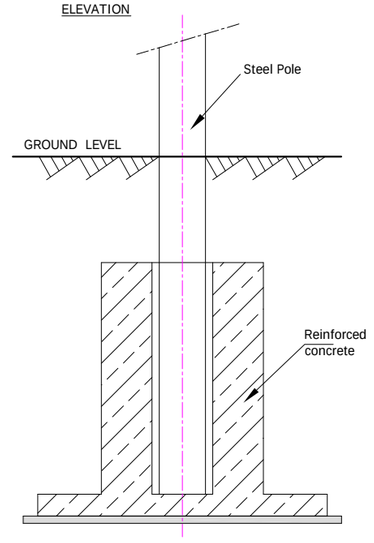
DESCRIPTION OF THE PIT	Depth (below existing ground level) cm	Soil Stratigraphy (observed in the well)	GEOTECHNICAL BEARING CAPACITIES			
			Allowable		ULS *	Ultimate
			(Mpa)	(Kpa)	(Mpa)	(Mpa)
Vegetable soil 0.00 - 0.30 m	0		0		0	0
	20		0.10	100	10	20
	40		0.20	200	20	40
Black Silty gravel poorly gradedl 0.30 - 2.30 m	60		0.10	100	10	30
	80		0.75	750	75	100
	100		1.05	1050	105	160
	120		1.30	1300	130	340
	140		1.50	1500	150	500
	160					
	180					
	200					
	220					
Light reddish gray Silty gravel poorly gradedl 2.30 - 4.00 m	240					
	260					
	280					
	300					
	320					
	340					
	360					
	380					
	400					
	420					
	440					
	460					
	480					
	500					
	520					
	540					
	560					
	580					
	620					
	640					
	660					
	680					
	700					
	720					
	740					
	760					
	780					
	800					
	820					
	840					

* ULS : Ultimate Limit State

EXCAVATION (test pit)

EXCAVATED SOIL

FOUNDATION TYPE



THE FOUNDATION DIMENSIONS COMPLY WITH THE STATIC BALANCE OF POST FIXING .

Soil investigation point	Extraction depth of the sample	Classification according USCS	Observation	ENGINEERING PROPERTIES		EXCAVATION CONDITION	GEOLOGICAL UNIT Light penetrometer (GeoMIL 50 kN SPT), test without soil coring for sample taking
SIP 3 (15 kV line Gasogi - Nyagasambu)	3.60 - 4.00 m	Silt of low plasticity (ML)	Semi rock soil	- IP : / - Consistency Ic > 1 : very consistent ground - Compaction Backfill : . γ_{d}^{OPM} = 1.83 t / m^3 . W_{OPM} = 14.20 % - Natural soil : . γ_h = 1.63 t / m^3 . $W_{(N)}$ = 17.2 % . γ_S = 2.60 t / m^3	- Shear test : . Cuu = 21 kN /m^2 . ψ_{uu} = 29.68° - Chemical analysis : . pH = 5.12 . SO_4^{2} = 8.1 mg / L . Cl^- = 99.7 mg / L	Pneumatique hammer	

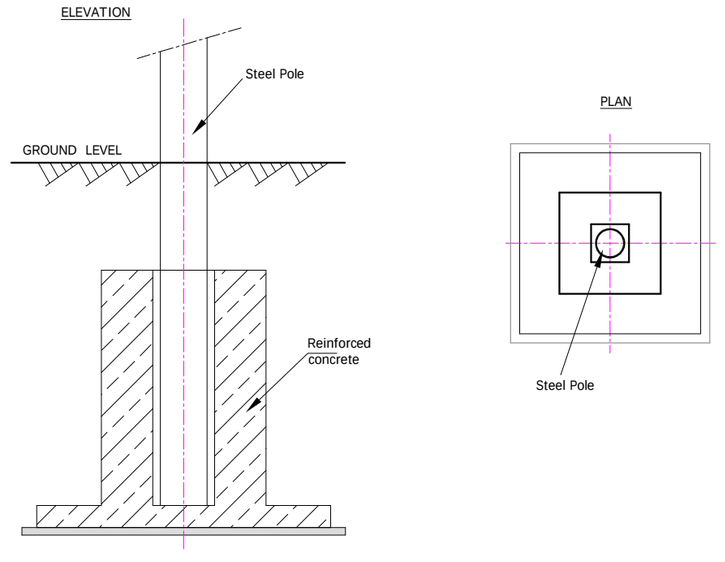
DESCRIPTION OF THE PIT	Depth (below existing ground level) cm	Soil Stratigraphy (observed in the well)	GEOTECHNICAL BEARING CAPACITIES			
			Allowable		ULS *	Ultimate
			(Mpa)	(Kpa)	(Mpa)	(Mpa)
Vegetable soil 0.00 - 0.30 m	0		0	0	0	0
	20		0.12	120	12	25
	40		0.05	50	5	50
	60		0.30	300	30	45
	80		0.20	200	20	55
	100		0.15	150	15	50
	120		0.20	200	20	48
	140		0.15	150	15	46
	160		0.30	300	30	48
Black Silty gravel poorly graded 0.30 - 3.00 m	180		0.65	650	65	95
	200		0.70	700	70	140
	220		0.65	650	65	160
	240		0.50	500	50	155
	260		0.45	450	45	150
	280		0.50	500	50	180
	300		0.45	450	45	215
Silt of low plasticity 3.00 - 4.00 m	320		0.50	500	50	220
	340		0.60	600	60	260
	360		0.65	650	65	300
	380		0.70	700	70	310
	400		0.70	700	70	350
	420		0.70	700	70	420
	440		0.75	750	75	500
	460					
	480					
	500					
	520					
	540					
	560					
	580					
	620					
	640					
	660					
	680					
	700					
	720					
	740					
	760					
	780					
	800					
	820					
	840					

* ULS : Ultimate Limit State

EXCAVATION (test pit)

EXCAVATED SOIL

FOUNDATION TYPE



THE FOUNDATION DIMENSIONS COMPLY WITH THE STATIC BALANCE OF POST FIXING .

Soil investigation point	Extraction depth of the sample	Classification according USCS	Observation	ENGINEERING PROPERTIES		EXCAVATION CONDITION	GEOLOGICAL UNIT Light penetrometer (GeoMIL 50 kN SPT), test without soil coring for sample taking
SIP 4 (15 kV line Gasogi - Nyagasambu)	3.60 - 4.00 m	Clay of intermediate plasticity (CI)	Sandy soil	- IP : 21 - Consistency Ic = 1.3 > 1 : very consistent ground - Compaction Backfill : . $\gamma_{d\,OPM}$ = 1.90 t / m^3 . W_{OPM} = 14.20 % - Natural soil : . γ_h = 1.64 t / m^3 . $W_{(N)}$ = 20.0 % . γ_s = 2. 72 t / m^3	- Shear test : . Cuu = 31 kN /m^2 . ψ_{uu} = 26.57° - Chemical analysis : . pH = 6.98 . SO_4^{2} = 22 mg / L . Cl^- = 159.3 mg / L	Picks and shovels can be used.	

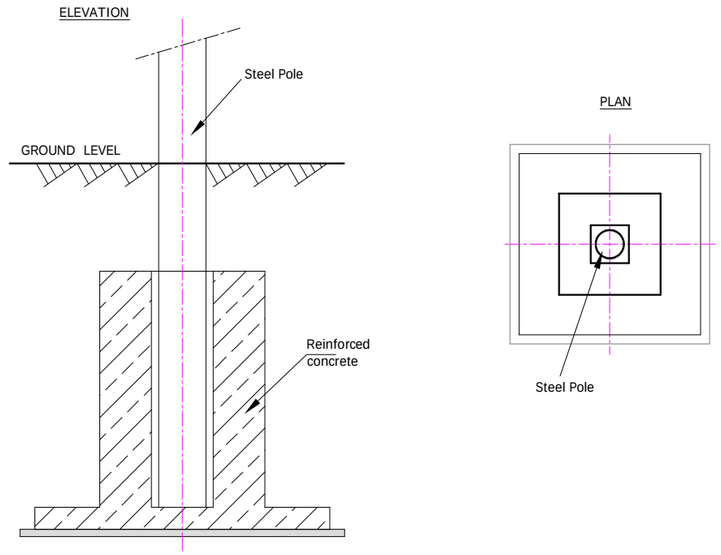
DESCRIPTION OF THE PIT	Depth (below existing ground level) cm	Soil Stratigraphy (observed in the well)	GEOTECHNICAL BEARING CAPACITIES			
			Allowable		ULS *	Ultimate
			(Mpa)	(Kpa)	(Mpa)	(Mpa)
Vegetable soil 0.00 - 0.30 m	0		0	0	0	0
	20		0.10	100	10	30
	40		0.50	500	50	65
	60		0.35	350	35	55
	80		0.25	250	25	58
	100		0.20	200	20	43
	120		0.13	130	13	42
	140		0.15	150	15	55
	160		0.25	250	25	55
Black Silty gravel poorly graded 0.30 - 3.00 m	180		0.20	200	20	62
	200		0.25	250	25	70
	220		0.60	600	60	80
	240		0.20	200	20	90
	260		0.20	200	20	100
	280		0.18	180	18	100
	300		0.20	200	20	110
	320		0.22	220	22	103
Silt of low plasticity 3.00 - 4.00 m	340		0.25	250	25	130
	360		0.15	150	15	155
	380		0.30	300	30	180
	400		0.35	350	35	213
	420		0.38	380	38	240
	440		0.70	700	70	265
	460		0.75	750	75	350
	480		0.80	800	80	400
	500		1.50	1500	150	500
	520					
	540					
	560					
	580					
	620					
	640					
	660					
	680					
	700					
	720					
	740					
	760					
	780					
	800					
	820					
	840					

* ULS : Ultimate Limit State

EXCAVATION (test pit)

EXCAVATED SOIL

FOUNDATION TYPE



THE FOUNDATION DIMENSIONS COMPLY WITH THE STATIC BALANCE OF POST FIXING .

Soil investigation point	Extraction depth of the sample	Classification according USCS	Observation	ENGINEERING PROPERTIES		EXCAVATION CONDITION	GEOLOGICAL UNIT Light penetrometer (GeoMIL 50 kN SPT), test without soil coring for sample taking
SIP 5 (15 kV line Gasogi - Nyagasambu)	1.00 - 2.00 m	Clay of intermediate plasticity (CI)	Lateritic zone	- IP : 17.5 - Consistency Ic = 1.32 > 1 : very consistent ground - Compaction Backfill : . $\gamma_{d^{OPM}}$ = 2.02 t / m^3 . W_{OPM} = 13.80 % - Natural soil : . γ_h = 1.65 t / m^3 . $W_{(N)}$ = 15.0 % . γ_s = 2. 90 t / m^3	- Shear test : . Cuu = 18 kN /m^2 . ψ_{uu} = 29.03° - Chemical analysis : . pH = 5.4 . SO_4^{2} = 16.6 mg / L . Cl^- = 77.8 mg / L	Picks and shovels can be used.	

DESCRIPTION OF THE PIT	Depth (below existing ground level) cm	Soil Stratigraphy (observed in the wet)	GEOTECHNICAL BEARING CAPACITIES			
			Allowable		ULS *	Ultimate
			(Mpa)	(Kpa)	(Mpa)	(Mpa)
Vegetable soil 0.00 - 0.30 m	0		0	0	0	0
	20		0.10	100	10	30
	40		0.50	500	50	65
Black clay of intermediate plasticity 0.30 - 1.80 m	60		0.35	350	35	55
	80		0.25	250	25	58
	100		0.20	200	20	43
	120		0.13	130	13	42
	140		0.15	150	15	55
	160		0.25	250	25	55
	180		0.20	200	20	62
Red Clay of intermediate plasticity 1.80 - 4.00 m	200		0.25	250	25	70
	220		0.60	600	60	80
	240		0.20	200	20	90
	260		0.20	200	20	100
	280		0.18	180	18	100
	300		0.20	200	20	110
	320		0.22	220	22	103
	340		0.25	250	25	130
	360		0.15	150	15	155
	380		0.30	300	30	180
	400		0.35	350	35	213
	420		0.38	380	38	240
	440		0.70	700	70	265
	460		0.75	750	75	350
	480		0.80	800	80	400
	500		1.50	1500	150	500
	520					
	540					
	560					
	580					
	620					
	640					
	660					
	680					
	700					
	720					
	740					
	760					
	780					
	800					
	820					
	840					

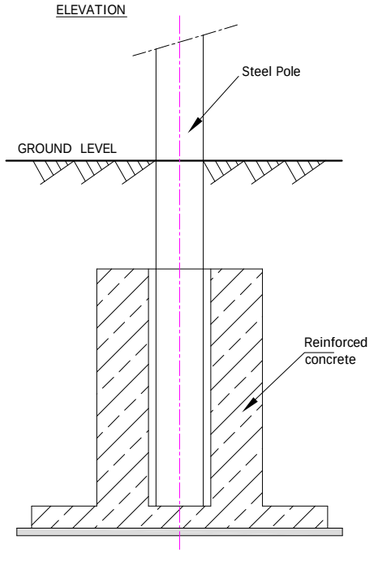
* ULS : Ultimate Limit State

EXCAVATION (test pit)

EXCAVATED SOIL

FOUNDATION TYPE

ELEVATION



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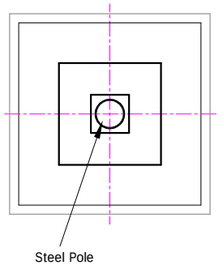


THE FOUNDATION DIMENSIONS COMPLY WITH THE STATIC BALANCE OF POST FIXING .

Soil investigation point	Extraction depth of the sample	Classification according USCS	Observation	ENGINEERING PROPERTIES		EXCAVATION CONDITION	GEOLOGICAL UNIT Light penetrometer (GeoMIL 50 kN SPT), test without soil coring for sample taking
SIP 6 (15 kV line Gasogi - Nyagasambu)	3.60 - 4.00 m	Clayey of gravel poorly graded (GC)	Lateritic zone	- IP : 15.7 - Consistency Ic = 1.60 > 1 : very consistent ground - Compaction Backfill : . γ_{d}^{OPM} = 2.0 t / m ^{3} . W_{OPM} = 11.20 % - Natural soil : . γ_h = 1.82 t / m^3 . $W_{(N)}$ = 14.2 % . γ_s = 2. 68 t / m^3	- Shear test : . Cuu = 6 kN /m ^{2} . ψ_{uu} = 38.48° - Chemical analysis : . pH = 4.34 . SO_4^{2} = 6.7 mg / L . Cl^- = 85 mg / L	Picks and shovels can be used.	

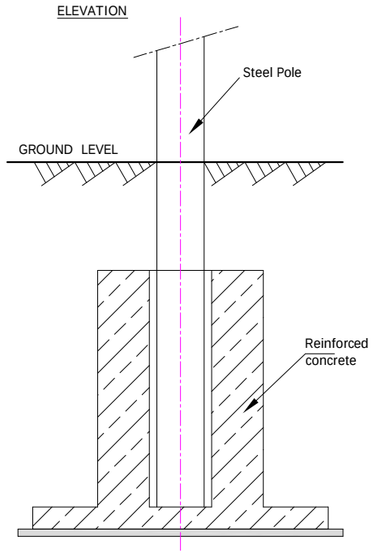
DESCRIPTION OF THE PIT	Depth (below existing ground level) cm	Soil Stratigraphy (observed in the well)	GEOTECHNICAL BEARING CAPACITIES			
			Allowable		ULS *	Ultimate
			(Mpa)	(Kpa)	(Mpa)	(Mpa)
Vegetable soil 0.00 - 0.30 m	0		0	0	0	0
	20		0.05	50	5	35
	40		0.15	150	15	42
	60		0.30	300	30	70
	80		0.80	800	80	105
	100		0.80	800	80	270
	120		1.00	1000	100	380
	140		1.50	1500	150	500
	160					
	180					
Red Clayey of gravel poorly graded 0.30 - 4.00 m	200					
	220					
	240					
	260					
	280					
	300					
	320					
	340					
	360					
	380					
	400					
	420					
	440					
	460					
	480					
	500					
	520					
	540					
	560					
	580					
	620					
	640					
	660					
	680					
	700					
	720					
	740					
	760					
	780					
	800					
	820					
	840					

* ULS : Ultimate Limit State

EXCAVATION (test pit)

EXCAVATED SOIL

FOUNDATION TYPE



THE FOUNDATION DIMENSIONS COMPLY WITH THE STATIC BALANCE OF POST FIXING .

Soil investigation point	Extraction depth of the sample	Classification according USCS	Observation	ENGINEERING PROPERTIES		EXCAVATION CONDITION	GEOLOGICAL UNIT Light penetrometer (GeoMIL 50 kN SPT), test without soil coring for sample taking
SIP 7 (15 kV line Gasogi - Nyagasambu)	3.60 - 4.00 m	Clayey of gravel poorly graded (GC)	Lateritic zone	- IP : 15.4 - Consistency Ic = 1.67 > 1 : very consistent ground - Compaction Backfill : . $\gamma_{d^{OPM}}$ = 2.03 t / m^3 . W_{OPM} = 10.0 % - Natural soil : . γ_h = 1.84 t / m^3 . $W_{(N)}$ = 14.3 % . γ_S = 2. 65 t / m^3	- Shear test : . Cuu = 14 kN /m^2 . ψ_{uu} = 24.23° - Chemical analysis : . pH = 4.34 . SO_4^{2} = 6.7 mg / L . Cl^- = 85 mg / L	Picks and shovels can be used.	

DESCRIPTION OF THE PIT	Depth (below existing ground level) cm	Soil Stratigraphy (observed in the well)	GEOTECHNICAL BEARING CAPACITIES			
			Allowable		ULS *	Ultimate
			(Mpa)	(Kpa)	(Mpa)	(Mpa)
Vegetable soil 0.00 - 0.30 m	0		0	0	0	0
	20		0.15	150	15	23
	40		0.30	300	30	45
	60		0.60	600	60	80
	80		0.25	250	25	50
	100		0.70	700	70	100
	120		0.80	800	80	120
	140		0.90	900	90	200
	160		1.05	1050	105	280
Red Clayey of gravel poorly graded 0.30 - 4.00 m	180		1.10	1100	110	325
	200		1.20	1200	120	360
	220		1.35	1350	135	400
	240		1.50	1500	150	500
	260					
	280					
	300					
	320					
	340					
	360					
	380					
	400					
	420					
	440					
	460					
	480					
	500					
	520					
	540					
	560					
	580					
	620					
	640					
	660					
	680					
	700					
	720					
	740					
	760					
	780					
	800					
	820					
	840					

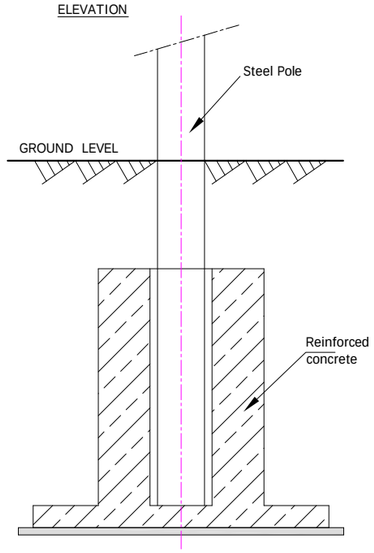
* ULS : Ultimate Limit State

EXCAVATION (test pit)

EXCAVATED SOIL

FOUNDATION TYPE

ELEVATION



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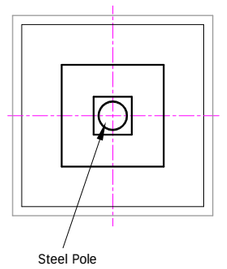


THE FOUNDATION DIMENSIONS COMPLY WITH THE STATIC BALANCE OF POST FIXING .

Soil investigation point	Extraction depth of the sample	Classification according USCS	Observation	ENGINEERING PROPERTIES		EXCAVATION CONDITION	GEOLOGICAL UNIT Light penetrometer (GeoMIL 50 kN SPT), test without soil coring for sample taking
SIP 9 (15 kV line Gasogi - Nyagasambu)	1.50 - 2.00 m	Clay of intermediate plasticity (CI)	Lateritic zone	- IP : 17.7 - Consistency Ic = 1.29 > 1 : very consistent ground - Compaction Backfill : . γ_{dOPM} = 1.9 t / m ^{3} . W_{OPM} = 14.20 % - Natural soil : . γ_h = 1.78 t / m^3 . $W_{(N)}$ = 15.0 % . γ_S = 2. 72 t / m^3	- Shear test : . Cuu = 25 kN /m^2 . ψ_{uu} = 29.90° - Chemical analysis : . pH = 7.03 . SO_4^{2} = 12 mg / L . Cl^- = 226.9 mg / L	Picks and shovels can be used.	

DESCRIPTION OF THE PIT	Depth (below existing ground level) cm	Soil Stratigraphy (observed in the well)	GEOTECHNICAL BEARING CAPACITIES			
			Allowable		ULS *	Ultimate
			(Mpa)	(Kpa)	(Mpa)	(Mpa)
	0		0	0	0	0
Vegetable soil 0.00 - 0.50 m	20		0.20	200	20	30
	40		0.10	100	10	20
	60		0.55	550	55	90
	80		0.80	800	80	190
	100		0.90	900	90	240
	120		1.00	1000	100	360
	140		1.50	1500	150	500
	160					
	180					
Red Clayey of gravel poorly graded 0.50 - 4.00 m	200					
	220					
	240					
	260					
	280					
	300					
	320					
	340					
	360					
	380					
	400					
	420					
	440					
	460					
	480					
	500					
	520					
	540					
	560					
	580					
	620					
	640					
	660					
	680					
	700					
	720					
	740					
	760					
	780					
	800					
	820					
	840					

* ULS : Ultimate Limit State

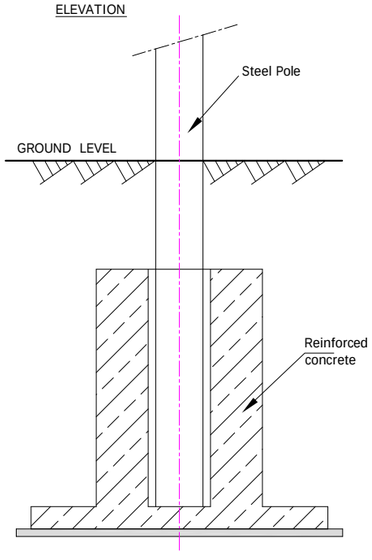
EXCAVATION (test pit)

EXCAVATED SOIL

27

FOUNDATION TYPE

ELEVATION



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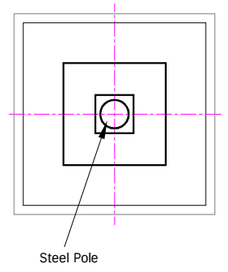


THE FOUNDATION DIMENSIONS COMPLY WITH THE STATIC BALANCE OF POST FIXING .

Soil investigation point	Extraction depth of the sample	Classification according USCS	Observation	ENGINEERING PROPERTIES		EXCAVATION CONDITION	GEOLOGICAL UNIT Light penetrometer (GeoMIL 50 kN SPT), test without soil coring for sample taking
SIP 10 (15 kV line Gasogi - Nyagasambu)	3.00 - 3.50 m	Brown clay of intermediate plasticity (CI)	Lateritic zone	- IP : 19.1 - Consistency Ic = 1.21 > 1 : very consistent ground - Compaction Backfill : . $\gamma_{d^{OPM}}$ = 1.94 t / m^3 . W_{OPM} = 13.20 % - Natural soil : . γ_h = 1.61 t / m^3 . $W_{(N)}$ = 15.0 % . γ_S = 2. 65 t / m^3	- Shear test : . Cuu = 17 kN /m^2 . ψ_{uu} = 24.90° - Chemical analysis : . pH = 6.71 . SO_4^{2} = 14.7 mg / L . Cl^- = 196.7 mg / L	Picks and shovels can be used.	

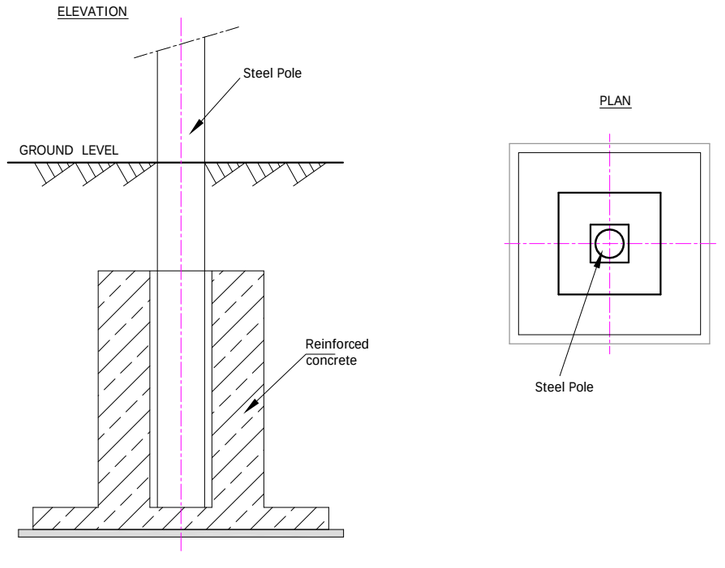
DESCRIPTION OF THE PIT	Depth (below existing ground level) cm	Soil Stratigraphy (observed in the well)	GEOTECHNICAL BEARING CAPACITIES			
			Allowable		ULS *	Ultimate
			(Mpa)	(Kpa)	(Mpa)	(Mpa)
Vegetable soil 0.00 - 0.30 m	0		0	0	0	0
	20		0.20	200	20	25
	40		0.20	200	20	30
	60		0.50	500	50	80
	80		0.85	850	85	130
	100		1.05	1050	105	260
	120		1.20	1200	120	340
	140		1.50	1500	150	500
	160					
Brown Clayey of gravel poorly graded 0.30 - 4.00 m	180					
	200					
	220					
	240					
	260					
	280					
	300					
	320					
	340					
	360					
	380					
	400					
	420					
	440					
	460					
	480					
	500					
	520					
	540					
	560					
	580					
	620					
	640					
	660					
	680					
	700					
	720					
	740					
	760					
	780					
	800					
	820					
	840					

* ULS : Ultimate Limit State

EXCAVATION (test pit)

EXCAVATED SOIL

FOUNDATION TYPE



THE FOUNDATION DIMENSIONS COMPLY WITH THE STATIC BALANCE OF POST FIXING .

Soil investigation point	Extraction depth of the sample	Classification according USCS	Observation	ENGINEERING PROPERTIES		EXCAVATION CONDITION	GEOLOGICAL UNIT Light penetrometer (GeoMIL 50 kN SPT), test without soil coring for sample taking
SIP 11 (15 kV line Gasogi - Nyagasambu)	3.50 - 4.00 m	Clayey of gravel poorly graded (GC)	Lateritic zone	- IP : 15.7 - Consistency Ic = 1.59 > 1 : very consistent ground - Compaction Backfill : . γ_{dOPM} = 1.67 t / m^3 . W_{OPM} = 22.22 % - Natural soil : . γ_h = 1.93 t / m^3 . $W_{(N)}$ = 18.0 % . γ_s = 2. 76 t / m^3	- Shear test : . Cuu = 21 kN /m^2 . ψ_{uu} = 24.94° - Chemical analysis : . pH = 4.86 . SO_4^{2} = 5.9 mg / L . Cl^- = 120.5 mg / L	Picks and shovels can be used.	

DESCRIPTION OF THE PIT	Depth (below existing ground level) cm	Soil Stratigraphy (observed in the well)	GEOTECHNICAL BEARING CAPACITIES			
			Allowable		ULS *	Ultimate
			(Mpa)	(Kpa)	(Mpa)	(Mpa)
Vegetable soil 0.00 - 0.30 m	0		0	0	0	0
	20		0.10	100	10	15
	40		0.45	450	45	55
Black Clayey of intermediate plasticity 0.30 - 1.30 m	60		0.70	700	70	100
	80		0.60	600	60	140
	100		0.85	850	85	200
	120		0.60	600	60	230
	140		0.90	900	90	280
Red Clayey gravel poorly graded 1.30 - 4.00 m	160		0.80	800	80	340
	180		0.60	600	60	340
	200		0.70	700	70	360
	220		0.65	650	65	380
	240		1.00	1000	100	390
	260		1.50	1500	150	500
	280					
	300					
	320					
	340					
	360					
	380					
	400					
	420					
	440					
	460					
	480					
	500					
	520					
	540					
	560					
	580					
	620					
	640					
	660					
	680					
	700					
	720					
	740					
	760					
	780					
	800					
	820					
	840					

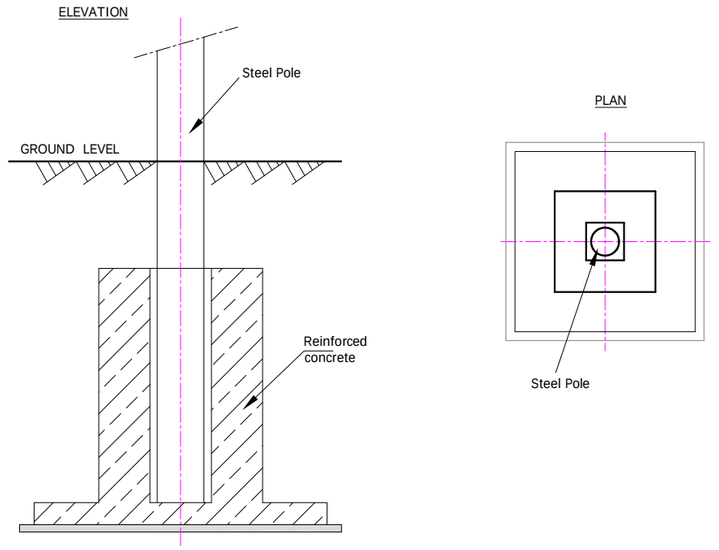
* ULS : Ultimate Limit State

EXCAVATION (test pit)

EXCAVATED SOIL

29

FOUNDATION TYPE



THE FOUNDATION DIMENSIONS COMPLY WITH THE STATIC BALANCE OF POST FIXING .

Soil investigation point	Extraction depth of the sample	Classification according USCS	Observation	ENGINEERING PROPERTIES		EXCAVATION CONDITION	GEOLOGICAL UNIT Light penetrometer (GeoMIL 50 kN SPT), test without soil coring for sample taking
SIP 12 (15 kV line Gasogi - Nyagasambu)	3.60 - 4.00 m	Clayey of gravel poorly graded (GC)	Lateritic zone	- IP : 14.7 - Consistency Ic = 1.63 > 1 : very consistent ground - Compaction Backfill : . $\gamma_{d^{OPM}}$ = 2.0 t / m ^{3} . W_{OPM} = 10.40 % - Natural soil : . γ_h = 1.81 t / m^3 . $W_{(N)}$ = 13.2 % . γ_s = 2. 65 t / m^3	- Shear test : . Cuu = 1 kN /m ^{2} . ψ_{uu} = 39.18° - Chemical analysis : . pH = 6.09 . SO_4^{2} = 12.2 mg / L . Cl^- = 178 mg / L	Picks and shovels can be used.	

DESCRIPTION OF THE PIT	Depth (below existing grand level) cm	Soil Stratigraphy (observed in the well)	GEOTECHNICAL BEARING CAPACITIES			
			Allowable		ULS *	Ultimate
			(Mpa)	(Kpa)	(Mpa)	(Mpa)
Vegetable soil 0.00 - 0.50 m	0		0	0	0	0
	20		0.1	100	10	20
	40		0.25	250	25	45
	60		0.55	550	55	80
	80		0.70	700	70	105
Brown Clayey of intermediate plasticity 0.50 - 2.00 m	100		0.45	450	45	130
	120		0.60	600	60	180
	140		0.60	600	60	240
	160		0.80	800	80	220
	180		0.85	850	85	360
	200		1.00	1000	100	390
	220		1.10	1100	110	400
Red Clayey gravel poorly graded 2.00 - 4.00 m	240		1.50	1500	150	500
	260					
	280					
	300					
	320					
	340					
	360					
	380					
	400					
	420					
	440					
	460					
	480					
	500					
	520					
	540					
	560					
	580					
	620					
	640					
	660					
	680					
	700					
	720					
	740					
	760					
	780					
	800					
	820					
	840					

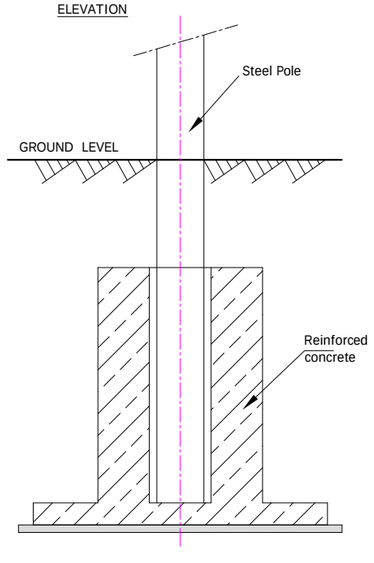
* ULS : Ultimate Limit State

EXCAVATION (test pit)

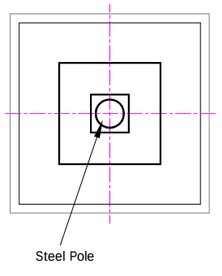
EXCAVATED SOIL

FOUNDATION TYPE

ELEVATION



PLAN



THE FOUNDATION DIMENSIONS COMPLY WITH THE STATIC BALANCE OF POST FIXING .

Soil investigation point	Extraction depth of the sample	Classification according USCS	Observation	ENGINEERING PROPERTIES		EXCAVATION CONDITION	GEOLOGICAL UNIT Light penetrometer (GeoMIL 50 kN SPT), test without soil coring for sample taking
SIP 13 (15 kV line Gasogi - Nyagasambu)	3.60 - 4.00 m	Clay of intermediate plasticity (CI)	Clayey soil	- IP : 21 - Consistency Ic = 1.57 > 1 : very consistent ground - Compaction Backfill : . $\gamma_{d^{OPM}}$ = 1.77 t / m^3 . W_{OPM} = 16.40 % - Natural soil : . γ_h = 1.62 t / m^3 . $W_{(N)}$ = 13.3 % . γ_s = 2. 60 t / m^3	- Shear test : . Cuu = 30 kN / m^2 . ψ_{uu} = 25.64° - Chemical analysis : . pH = 6.43 . SO_4^{2} = 14.4 mg / L . Cl^- = 200.3 mg / L	Picks and shovels can be used.	

DESCRIPTION OF THE PIT	Depth (below existing ground level) cm	Soil Stratigraphy (observed in the well)	GEOTECHNICAL BEARING CAPACITIES			
			Allowable		ULS *	Ultimate
			(Mpa)	(Kpa)	(Mpa)	(Mpa)
	0		0	0	0	0
Vegetable soil 0.00 - 0.50 m	20		0.05	50	5	13
	40		0.15	150	15	30
	60		0.45	450	45	60
	80		0.75	750	75	100
	100		0.45	450	45	135
	120		0.90	900	90	200
	140		0.60	600	60	220
	160		0.80	800	80	275
	180		0.75	750	75	330
	200		0.80	800	80	340
	220		1.00	1000	100	390
Clayey of intermediate plasticity 0.50 - 4.00 m	240		1.25	1250	125	420
	260		1.50	1500	150	500
	280					
	300					
	320					
	340					
	360					
	380					
	400					
	420					
	440					
	460					
	480					
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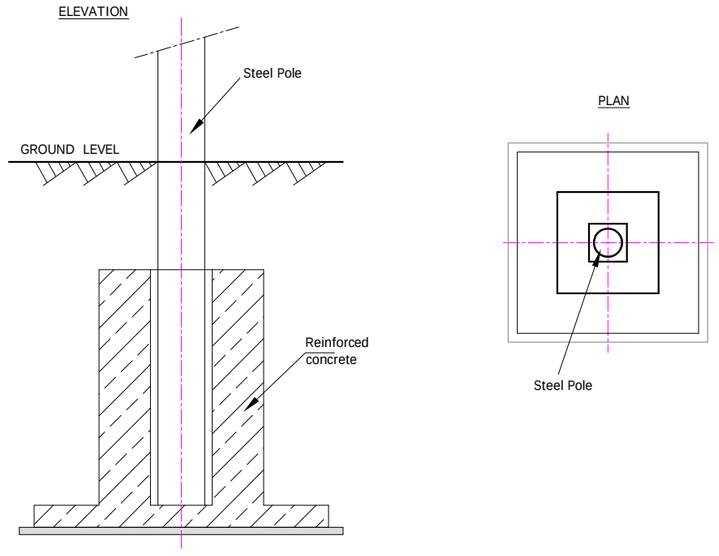
	620					
	640					
	660					
	680					
	700					
	720					
	740					
	760					
	780					
	800					
	820					
	840					

* ULS : Ultimate Limit State

EXCAVATION (test pit)

EXCAVATED SOIL

FOUNDATION TYPE



THE FOUNDATION DIMENSIONS COMPLY WITH THE STATIC BALANCE OF POST FIXING .

Soil investigation point	Extraction depth of the sample	Classification according USCS	Observation	ENGINEERING PROPERTIES		EXCAVATION CONDITION	GEOLOGICAL UNIT Light penetrometer (GeoMIL 50 kN SPT), test without soil coring for sample taking
SIP 15 (15 kV line Gasogi - Nyagasambu)	3.60 - 4.00 m	Clay of intermediate plasticity (CI)	Clayey soil	- IP : 16.3 - Consistency Ic = 1.42 > 1 : very consistent ground - Compaction Backfill : . $\gamma_{d^{OPM}}$ = 2.01 t / m^3 . W_{OPM} = 12.40 % - Natural soil : . γ_h = 1.78 t / m^3 . $W_{(N)}$ = 13.3 % . γ_S = 2. 75 t / m^3	- Shear test : . Cuu = 12 kN /m^2 . ψ_{uu} = 30.54° - Chemical analysis : . pH = 7.1 . SO_4^{2} = 19.4 mg / L . Cl^- = 81 mg / L	Picks and shovels can be used.	

DESCRIPTION OF THE PIT	Depth (below existing ground level) cm	Soil Stratigraphy (observed in the well)	GEOTECHNICAL BEARING CAPACITIES			
			Allowable		ULS *	Ultimate
			(Mpa)	(Kpa)	(Mpa)	(Mpa)
	0		0	0	0	0
Vegetable soil 0.00 - 0.50 m	20		0.15	150	15	25
	40		0.30	300	30	43
	60		0.45	450	45	70
	80		0.90	900	90	230
	100		1.25	1250	125	390
	120		1.50	1500	150	500
	140					
	160					
	180					
	200					
Clayey of intermediate plasticity 0.50 - 4.00 m	220					
	240					
	260					
	280					
	300					
	320					
	340					
	360					
	380					
	400					
	420					
	440					
	460					
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	540					
	560					
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	620					
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	660					
	680					
	700					
	720					
	740					
	760					
	780					
	800					
	820					
	840					

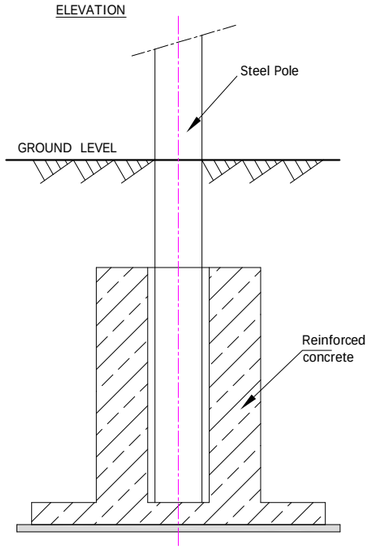
* ULS : Ultimate Limit State

EXCAVATION (test pit)

EXCAVATED SOIL

FOUNDATION TYPE

ELEVATION



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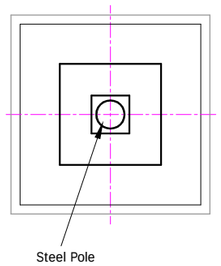

THE FOUNDATION DIMENSIONS COMPLY WITH THE STATIC BALANCE OF POST FIXING .

Soil investigation point	Extraction depth of the sample	Classification according USCS	Observation	ENGINEERING PROPERTIES		EXCAVATION CONDITION	GEOLOGICAL UNIT Light penetrometer (GeoMIL 50 kN SPT), test without soil coring for sample taking
SIP 16 (15 kV line Gasogi - Nyagasambu)	3.40 - 4.00 m	Clayey of gravel poorly graded (GC)	Lateritic zone	- IP : 15.2 - Consistency Ic = 1.63 > 1 : very consistent ground - Compaction Backfill : . $\gamma_{d^{OPM}}$ = 1.73 t / m^3 . W_{OPM} = 20.60 % - Natural soil : . γ_h = 1.93 t / m^3 . $W_{(N)}$ = 18 % . γ_s = 2. 80 t / m^3	- Shear test : . Cuu = 17 kN /m^2 . ψ_{uu} = 21.80° - Chemical analysis : . pH = 4.73 . SO_4^{2} = 62.6 mg / L . Cl^- = 213 mg / L	Picks and shovels can be used; preferably use pneumatic hammer.	

DESCRIPTION OF THE PIT	Depth (below existing ground level) cm	Soil Stratigraphy (observed in the well)	GEOTECHNICAL BEARING CAPACITIES			
			Allowable		ULS *	Ultimate
			(Mpa)	(Kpa)	(Mpa)	(Mpa)
Vegetable soil 0.00 - 0.50 m	0		0	0	0	0
	20		0.20	200	20	40
	40		0.15	150	15	30
	60		0.80	800	80	120
Clayey of intermediate plasticity 0.50 - 4.00 m	80		1.00	1000	100	350
	100		1.20	1200	120	400
	120		1.50	1500	150	500
	140					
	160					
	180					
	200					
	220					
	240					
	260					
	280					
	300					
	320					
	340					
	360					
	380					
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	560					
	580					
	620					
	640					
	660					
	680					
	700					
	720					
	740					
	760					
	780					
	800					
	820					
	840					

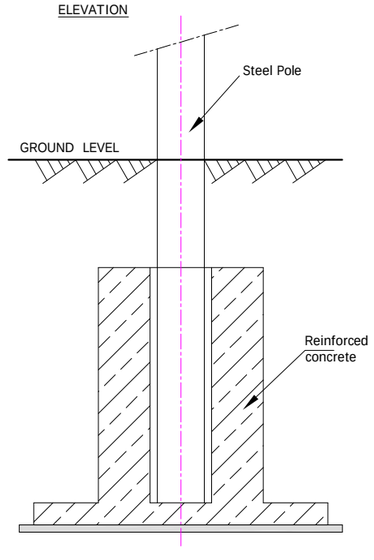
* ULS : Ultimate Limit State

EXCAVATION (test pit)

EXCAVATED SOIL

FOUNDATION TYPE

ELEVATION



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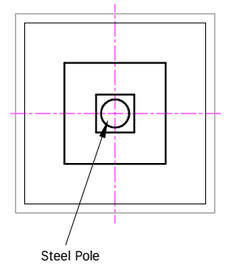


THE FOUNDATION DIMENSIONS COMPLY WITH THE STATIC BALANCE OF POST FIXING .

Soil investigation point	Extraction depth of the sample	Classification according USCS	Observation	ENGINEERING PROPERTIES		EXCAVATION CONDITION	GEOLOGICAL UNIT Light penetrometer (GeoMIL 50 kN SPT), test without soil coring for sample taking
SIP 17 (15 kV line Gasogi - Nyagasambu)	0.50 - 1.00 m	Silt of intermediate plasticity (MI)	Clayey soil	- IP : 20.1 - Consistency Ic = 1.31 > 1 : very consistent ground - Compaction Backfill : . γ_{dOPM} = 1.78 t / m^3 . W_{OPM} = 19.68 % - Natural soil : . γ_h = 1.76 t / m^3 . $W_{(N)}$ = 19 % . γ_s = 2. 84 t / m^3	- Shear test : . Cuu = 20 kN /m^2 . ψ_{uu} = 26.57° - Chemical analysis : . pH = 6.81 . SO_4^{2} = 12.4 mg / L . Cl^- = 186.8 mg / L	Picks and shovels can be used.	

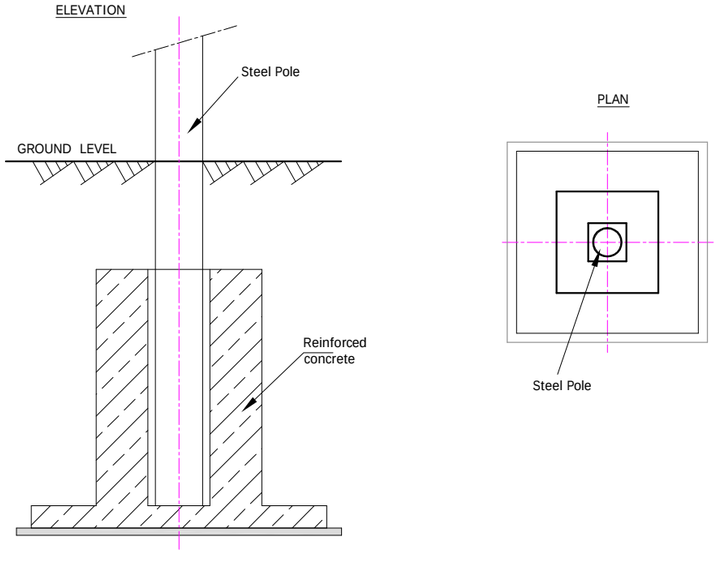
DESCRIPTION OF THE PIT	Depth (below existing ground level) cm	Soil Stratigraphy (observed in the well)	GEOTECHNICAL BEARING CAPACITIES			
			Allowable		ULS *	Ultimate
			(Mpa)	(Kpa)	(Mpa)	(Mpa)
Vegetable soil 0.00 - 0.30 m	0		0	0	0	0
	20		0.10	100	20	50
	40		0.12	120	25	45
	60		0.22	220	45	70
	80		0.15	150	30	80
	100		0.05	50	10	45
	120		0.14	140	28	45
	140		0.15	150	30	50
	160		0.04	40	8	40
	180		0.04	40	8	50
Black clay 0.30 - 4.00 m	200		0.05	50	10	55
	220		0.05	50	10	55
	240		0.05	50	10	50
	260		0.04	40	8	60
	280		0.04	40	8	55
	300		0.07	70	15	65
	320		0.10	100	20	70
	340		0.12	120	25	100
	360		0.07	70	15	120
	380		0.10	100	20	150
	400		0.20	200	40	180
	420		0.19	190	38	200
	440		0.20	200	40	250
	460		0.20	200	40	270
	480		0.25	250	50	300
	500		0.27	270	55	350
	520		0.40	400	80	380
	540		0.37	370	75	500
	560					
	580					
	620					
	640					
	660					
	680					
	700					
	720					
	740					
	760					
	780					
	800					
	820					
	840					

* ULS : Ultimate Limit State

EXCAVATION (test pit)

EXCAVATED SOIL

FOUNDATION TYPE



THE FOUNDATION DIMENSIONS COMPLY WITH THE STATIC BALANCE OF POST FIXING .

C. 15 kV Distribution line Gasogi substation-Masaka hospital

ROUTE 3 : 15kV LINE GASOGI - MASAKA(Line Length : 8.481km)

GASOGI NEW SUBSTATION

SIP-1 1(AP2) 2 3 4 5(AP3) SIP-3 6 7(AP4) SIP-4 8 9 10(AP5) SIP-5 11(AP6) SIP-6 12 13 14 15 16(AP7) 17 18 19 20 21(AP8) SIP-8 22 23 24 25 26 27 28(AP9) SIP-9 29 30(AP10) SIP-10 31(AP11New) SIP-12 32 33 34(AP12New) SIP-13 35(AP13New) 36(AP14New) 37(AP15New) SIP-15 38(AP15) 39 40 41 42 SIP-16 44(AP17New) 45(AP18New) SIP-17 46 47(AP19New) SIP-19

Akamusare
MUKUYU
Kira
Rugagi
Rugarama
Samuduha
Burunga
KIBENGA
Poste de transformation Electrique de Gasabo
Eglise de Dieu
Abanyabutayu Church
Ryabazana
Mbandazi Cell Offcie
Mbandazi Catholic Church
Mbandazi Primary School
EER Mbandazi
GASAGARA
Gitaraga
Burunga Trade Center
Kira
Akasemuromba
Gasagara
Gasagara Cell Offcie
Gasagara Methodist Church
Kataruha Adventist Church
ADEPR Bukemba
Mugeyo
Bucyemba Center
MBANDAZI
Gashure
ADEPR Gashure
Bucyemba
Kataruha
Ruhangare
BWIZA
Bwiza Cell Office
Rugende
CYARUZINGE
Ndera
Gisura
Ruhangare Secondary School
Ruhangare Primary School
Bwiza Football Playground
Bwiza Methodist Church
Gatare
ADEPR Gisura
Poste de Santé Mbandazi
Gisura Adventist Church
Akarwasa
EAR Gasogi
Gasogi Nursery School
Mukagarama
Cyeru
Ruhangare
Gasharu
Ruhogo
Akagarama Adventist Church
Karubibi
VILLE DE KIGALI
Akagarama Hope Church
ADEPR Mbandazi
ADEPR Munini
Nyagakombe
Rusororo
Karubibi Catholic Church
Munini
RUDASHYA
AKINYAMBO
Ayabakora
Protestant
KABUGA II
Ruhangare
Rudashya Cell Offcie
Kamahoro
Foundation of Peace Church
Protestant
Kacyinyaga
Mataba
Nyakagezi
Kanyinya
Gisharara
EAR Church
Rusororo Primary School
Adventist Church
NYAGAHINGA
RIVIERA High School
Kigarama
Kabutare
Solace Health Clinic
Nyarucundura
Runyonza
Cyugamo
GAKO
Masaka
Kiyovu
Bwiza
Nyange
GITARAGA
CYIMO
MASAKA HOSPITAL
Nyakagunga
Murambi
Kabeza
Rebero

Legend
- Masaka_Towers
- SIP : Soil Investigation Point
- Angle_Points_Gasogi-Masaka
- Infrastructure_All
- Gasogi-Masaka_Line_Review
- New_Line_Gasogi-Masaka
- 15kV_Gasogi-Masaka_Line_Initial
- Existing_MV_Lines
- HV_Existing_Network
- Villages
- Province
- Cells
- Sectors

REV.	DESCRIPTION	ISSUED	CHECKED
1	15kV line Gasogi - Masaka		

REPUBLIC OF RWANDA

MINISTRY OF INFRASTRUCTURE

Buyer : EDCL

Execution Agency : JICA

Consultant : YACHIYO ENGINEERING CO., LTD. (CONSULTING ENGINEERS & ARCHITECTS)

Project :
PROJECT FOR IMPROVEMENT OF SUBSTATIONS AND DISTRIBUTION NETWORK
JICA PROJECT PHASE III

Content :
SOIL INVESTIGATION
ROUTE 3 : 15kV LINE GASOGI - MASAKA

Name	Fonction	Approval by Client	Date	Signature & Stamp

PAPER SIZE	SCALE	DRAWING N°	DATE	DRAWING STATUS
A1	1/10 000	03/JPP3	June 2017	FOR APPROVAL

Soil investigation point	Extraction depth of the sample	Classification according USCS	Observation	ENGINEERING PROPERTIES		EXCAVATION CONDITION	GEOLOGICAL UNIT Light penetrometer (GeoMIL 50 kN SPT), test without soil coring for sample taking
SIP 1 (15 kV line Gasogi - Masaka)	3.80 - 4.00 m	Clay of intermediate plasticity (CI)	Lateritic zone	- IP : 18.6 - Consistency Ic = 1.05 > 1 : very consistent ground - Compaction Backfill : . $\gamma_{d^{OPM}}$ = 1.83 t / m^3 . W_{OPM} = 17.20 % - Natural soil : . γ_h = 1.90 t / m^3 . $W_{(N)}$ = 20.7 % . γ_s = 2.75 t / m^3	- Shear test : . Cuu = 28 kN /m^2 . ψ_{uu} = 23.51° - Chemical analysis : . pH = 5.11 . SO_4^{2} = 13 mg / L . Cl^- = 122 mg / L	Picks and shovels can be used.	

DESCRIPTION OF THE PIT	Depth (below existing ground level) cm	Soil Stratigraphy (observed in the wel l)	GEOTECHNICAL BEARING CAPACITIES			
			Allowable		ULS *	Ultimate
			(Mpa)	(Kpa)	(Mpa)	(Mpa)
Vegetable soil 0.00 - 0.40 m	0		0	0	0	0
	20		0.10	100	10	35
	40		0.30	300	30	55
	60		0.25	250	25	60
	80		0.38	380	38	65
	100		1.00	1000	100	150
	120		1.25	1250	125	240
	140		0.90	900	90	130
Black silty gravel poorly graded 0.40 - 3.40 m	160		1.20	1200	120	180
	180		1.30	1300	130	230
	200		1.40	1400	140	250
	220		1.35	1350	135	350
	240		1.20	1200	120	380
	260		1.00	1000	100	340
	280		1.50	1500	150	500
	300					
	320					
	340					
Clay of intermediate plasticity 3.40 - 4.00 m	360					
	380					
	400					
	420					
	440					
	460					
	480					
	500					
	520					
	540					
	560					
	580					
	620					
	640					
	660					
	680					
	700					
	720					
	740					
	760					
	780					
	800					
	820					
	840					

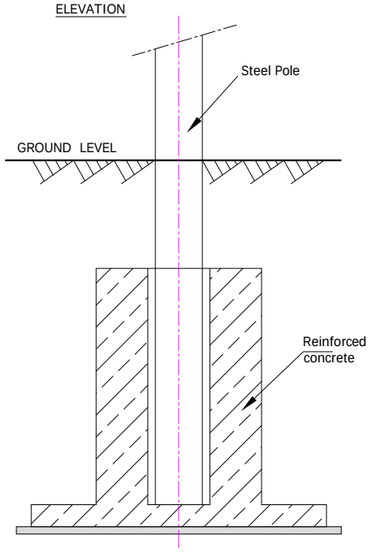
* ULS : Ultimate Limit State

EXCAVATION (test pit)

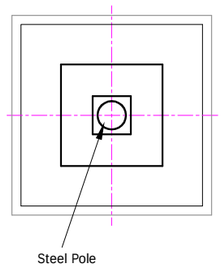
EXCAVATED SOIL

FOUNDATION TYPE

ELEVATION



PLAN



THE FOUNDATION DIMENSIONS COMPLY WITH THE STATIC BALANCE OF POST FIXING .

Soil investigation point	Extraction depth of the sample	Classification according USCS	Observation	ENGINEERING PROPERTIES		EXCAVATION CONDITION	GEOLOGICAL UNIT Light penetrometer (GeoMIL 50 kN SPT), test without soil coring for sample taking
SIP 3 (15 kV line Gasogi - Masaka)	3.75 - 4.00 m	Silty sand poorly graded (SM)	Lateritic zone	- IP : / - Consistency Ic > 1 very consistent ground - Compaction Backfill : . $\gamma_{d^{OPM}}$ = 1.68 t / m^3 . W_{OPM} = 22.40 % - Natural soil : . γ_h = 1.70 t / m^3 . $W_{(N)}$ = 20.60 % . γ_S = 2.80 t / m^3	- Shear test : . Cuu = 9 kN /m^2 . ψ_{uu} = 30.54° - Chemical analysis : . pH = 6.26 . SO_4^{2} = 59.2 mg / L . Cl^- = 99.3 mg / L	Picks and shovels can be used.	

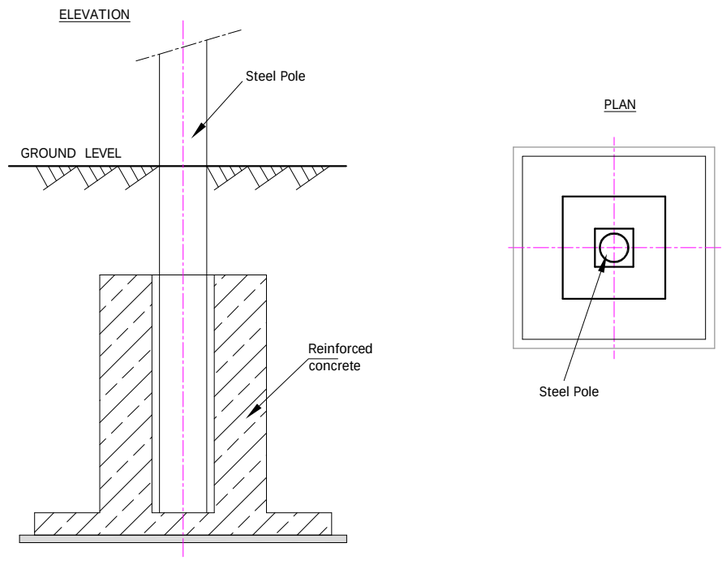
DESCRIPTION OF THE PIT	Depth (below existing ground level) cm	Soil Stratigraphy (observed in the well)	GEOTECHNICAL BEARING CAPACITIES			
			Allowable		ULS *	Ultimate
			(Mpa)	(Kpa)	(Mpa)	(Mpa)
Vegetable soil 0.00 - 0.30 m	0		0	0	0	0
	20		0.70	700	70	100
	40		1.23	1230	123	160
	60		0.70	700	70	85
	80		1.05	1050	105	180
	100		1.25	1250	125	420
	120		1.50	1500	150	500
	140					
	160					
	180					
Silty sand poorly graded 0.30 - 4.00 m	200					
	220					
	240					
	260					
	280					
	300					
	320					
	340					
	360					
	380					
	400					
	420					
	440					
	460					
	480					
	500					
	520					
	540					
	560					
	580					
	620					
	640					
	660					
	680					
	700					
	720					
	740					
	760					
	780					
	800					
	820					
	840					

* ULS : Ultimate Limit State

EXCAVATION (test pit)

EXCAVATED SOIL

FOUNDATION TYPE



THE FOUNDATION DIMENSIONS COMPLY WITH THE STATIC BALANCE OF POST FIXING .

Soil investigation point	Extraction depth of the sample	Classification according USCS	Observation	ENGINEERING PROPERTIES		EXCAVATION CONDITION	GEOLOGICAL UNIT Light penetrometer (GeoMIL 50 kN SPT), test without soil coring for sample taking
SIP 4 (15 kV line Gasogi - Masaka)	3.50 - 4.00 m	Clayey gravel poorly graded (GC)	Semi rock soil	- IP : 16.4 - Consistency Ic = 1.40 > 1 very consistent ground - Compaction Backfill : . $\gamma_{d\,OPM}$ = 2.02 t / m^3 . W_{OPM} = 12.40 % - Natural soil : . γ_h = 1.98 t / m^3 . $W_{(N)}$ = 16.30 % . γ_s = 2.78 t / m^3	- Shear test : . Cuu = 10 kN /m^2 . ψ_{uu} = 26.10° - Chemical analysis : . pH = 6.15 . SO_4^{2} = 18 mg / L . Cl^- = 79 mg / L	Picks and shovels can be used; preferably use pneumatic hammer.	

DESCRIPTION OF THE PIT	Depth (below existing ground level) cm	Soil Stratigraphy (observed in the well)	GEOTECHNICAL BEARING CAPACITIES			
			Allowable		ULS *	Ultimate
			(Mpa)	(Kpa)	(Mpa)	(Mpa)
Vegetable soil 0.00 - 0.80 m	0		0	0	0	0
	20		1.05	1050	105	130
	40		0.85	850	85	100
	60		0.60	600	60	80
	80		1.00	1000	100	120
Clayey gravel poorly graded 0.80 - 4.00 m	100		1.40	1400	140	260
	120		1.35	1350	135	380
	140		1.50	1500	150	500
	160					
	180					
	200					
	220					
	240					
	260					
	280					
	300					
	320					
	340					
	360					
	380					
	400					
	420					
	440					
	460					
	480					
	500					
	520					
	540					
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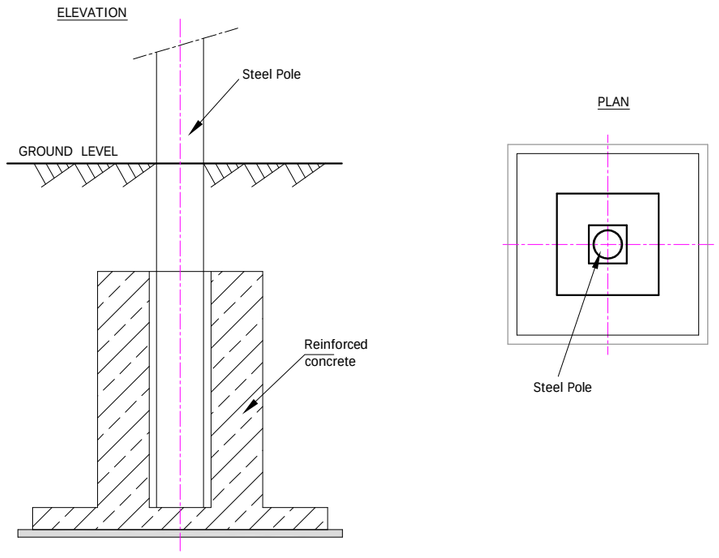
EXCAVATION (test pit)

EXCAVATED SOIL

FOUNDATION TYPE



THE FOUNDATION DIMENSIONS COMPLY WITH THE STATIC BALANCE OF POST FIXING .

Soil investigation point	Extraction depth of the sample	Classification according USCS	Observation	ENGINEERING PROPERTIES		EXCAVATION CONDITION	GEOLOGICAL UNIT Light penetrometer (GeoMIL 50 kN SPT), test without soil coring for sample taking
SIP 5 (15 kV line Gasogi - Masaka)	3.70 - 4.00 m	Silty gravel poorly graded (GM)	Semi rock soil	- IP : / - Consistency Ic > 1 very consistent ground - Compaction Backfill : . $\gamma_{d\,OPM}$ = 2.03 t / m^3 . W_{OPM} = 10.62 % - Natural soil : . γ_h = 1.72 t / m^3 . $W_{(N)}$ = 14 % . γ_s = 2.70 t / m^3	- Shear test : . Cuu = 4 kN /m^2 . ψ_{uu} = 27.02° - Chemical analysis : . pH = 5.79 . SO_4^{2} = 7.6 mg / L . Cl^- = 78 mg / L	Picks and shovels can be used; preferably use pneumatic hammer.	

DESCRIPTION OF THE PIT	Depth (below existing ground level) cm	Soil Stratigraphy (observed in the well)	GEOTECHNICAL BEARING CAPACITIES			
			Allowable		ULS *	Ultimate
			(Mpa)	(Kpa)	(Mpa)	(Mpa)
	0		0	0	0	0
Vegetable soil 0.00 - 0.50 m	20		0.30	300	30	45
	40		0.35	350	35	48
	60		0.35	350	35	45
	80		0.33	330	33	45
	100		0.65	650	65	110
	120		0.75	750	75	120
	140		1.00	1000	100	240
Clayey gravel poorly graded 0.50 - 3.50 m	160		1.23	1230	123	300
	180		0.80	800	80	170
	200		1.30	1300	130	250
	220		1.40	1400	140	400
	240		1.50	1500	150	500
	260					
	280					
	300					
	320					
	340					
Silty gravel poorly graded 3.50 - 4.00 m	360					
	380					
	400					
	420					
	440					
	460					
	480					
	500					
	520					
	540					
	560					
	580					
	620					
	640					
	660					
	680					
	700					
	720					
	740					
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	780					
	800					
	820					
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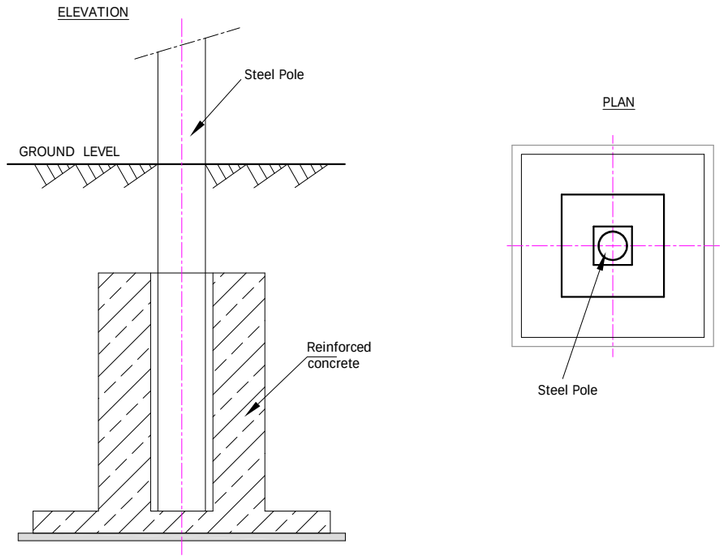
* ULS : Ultimate Limit State

EXCAVATION (test pit)

EXCAVATED SOIL

FOUNDATION TYPE



THE FOUNDATION DIMENSIONS COMPLY WITH THE STATIC BALANCE OF POST FIXING .

Soil investigation point	Extraction depth of the sample	Classification according USCS	Observation	ENGINEERING PROPERTIES		EXCAVATION CONDITION	GEOLOGICAL UNIT Light penetrometer (GeoMIL 50 kN SPT), test without soil coring for sample taking
SIP 6 (15 kV line Gasogi - Masaka)	3.60 - 4.00 m	Silty gravel poorly graded (GM)	Semi rock soil	- IP : 15.2 - Consistency Ic = 1.38 > 1 very consistent ground - Compaction Backfill : . $\gamma_{d^{OPM}}$ = 2.02 t / m^3 . W_{OPM} = 11.36 % - Natural soil : . γ_h = 1.90 t / m^3 . $W_{(N)}$ = 18 % . γ_s = 2.72 t / m^3	- Shear test : . Cuu = 14 kN /m^2 . ψ_{uu} = 25.41° - Chemical analysis : . pH = 7.1 . SO_4^{2} = 9.4 mg / L . Cl^- = 201.7 mg / L	Picks and shovels can be used.	

DESCRIPTION OF THE PIT	Depth (below existing ground level) cm	Soil Stratigraphy (observed in the well)	GEOTECHNICAL BEARING CAPACITIES			
			Allowable		ULS *	Ultimate
			(Mpa)	(Kpa)	(Mpa)	(Mpa)
	0		0	0	0	0
Vegetable soil 0.00 - 0.50 m	20		0.10	100	10	20
	40		0.25	250	25	55
	60		0.27	270	27	60
	80		0.25	250	25	62
	100		0.25	250	25	64
	120		0.22	220	22	72
	140		0.17	170	17	80
	160		0.25	250	25	90
Clayey gravel poorly graded 0.50 - 3.00 m	180		0.45	450	45	90
	200		0.45	450	45	100
	220		0.30	300	30	140
	240		0.40	400	40	180
	260		0.45	450	45	200
	280		0.30	300	30	200
	300		0.25	250	25	150
Silty gravel poorly graded 3.00 - 4.00 m	320		0.70	700	70	280
	340		1.30	1300	130	350
	360		1.50	1500	150	500
	380					
	400					
	420					
	440					
	460					
	480					
	500					
	520					
	540					
	560					
	580					
	620					
	640					
	660					
	680					
	700					
	720					
	740					
	760					
	780					
	800					
	820					
	840					

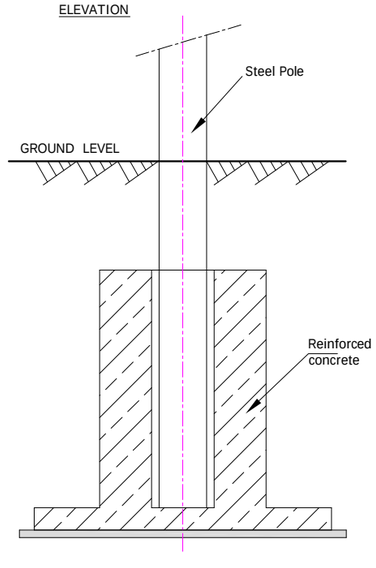
* ULS : Ultimate Limit State

EXCAVATION (test pit)

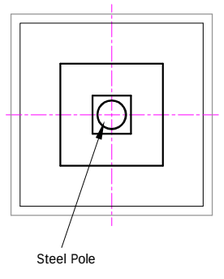
EXCAVATED SOIL

FOUNDATION TYPE

ELEVATION



PLAN



THE FOUNDATION DIMENSIONS COMPLY WITH THE STATIC BALANCE OF POST FIXING .

Soil investigation point	Extraction depth of the sample	Classification according USCS	Observation	ENGINEERING PROPERTIES		EXCAVATION CONDITION	GEOLOGICAL UNIT Light penetrometer (GeoMIL 50 kN SPT), test without soil coring for sample taking
SIP 8 (15 kV line Gasogi - Masaka)	3.80 - 4.00 m	Silty gravel poorly graded (GM)	Sandy soil	- IP : / - Consistency Ic > 1 very consistent ground - Compaction Backfill : . $\gamma_{d^{OPM}}$ = 2.06 t / m^3 . W_{OPM} = 10.40 % - Natural soil : . γ_h = 1.63 t / m^3 . $W_{(N)}$ = 18.3 % . γ_S = 2.77 t / m^3	- Shear test : . Cuu = 4 kN /m^2 . ψ_{uu} = 25.70° - Chemical analysis : . pH = 5.22 . SO_4^{2} = 5 mg / L . Cl^- = 85 mg / L	Picks and shovels can be used.	

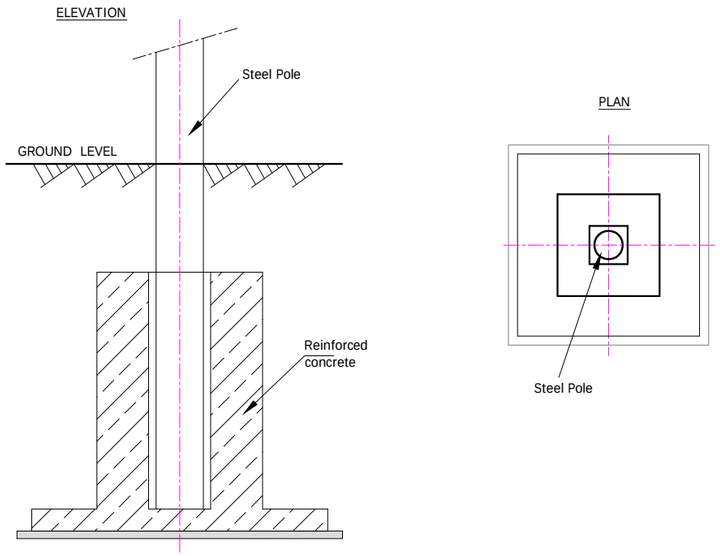
DESCRIPTION OF THE PIT	Depth (below existing ground level) cm	Soil Stratigraphy (observed in the well)	GEOTECHNICAL BEARING CAPACITIES			
			Allowable		ULS *	Ultimate
			(Mpa)	(Kpa)	(Mpa)	(Mpa)
	0		0	0	0	0
Vegetable soil 0.00 - 0.40 m	20		0.15	150	15	20
	40		0.85	850	85	100
	60		0.55	550	55	80
	80		1.10	1100	110	290
	100		1.30	1300	130	360
	120		1.50	1500	150	500
	140					
	160					
	180					
Silty gravel poorly graded 0.40 - 4.00 m	200					
	220					
	240					
	260					
	280					
	300					
	320					
	340					
	360					
	380					
	400					
	420					
	440					
	460					
	480					
	500					
	520					
	540					
	560					
	580					
	620					
	640					
	660					
	680					
	700					
	720					
	740					
	760					
	780					
	800					
	820					
	840					

* ULS : Ultimate Limit State

EXCAVATION (test pit)

EXCAVATED SOIL

FOUNDATION TYPE



THE FOUNDATION DIMENSIONS COMPLY WITH THE STATIC BALANCE OF POST FIXING .

Soil investigation point	Extraction depth of the sample	Classification according USCS	Observation	ENGINEERING PROPERTIES		EXCAVATION CONDITION	GEOLOGICAL UNIT Light penetrometer (GeoMIL 50 kN SPT), test without soil coring for sample taking
SIP 9 (15 kV line Gasogi - Masaka)	3.70 - 4.00 m	Clayey gravel poorly graded (GC)	Semi rock soil	- IP : 16.5 - Consistency Ic = 1.38 > 1 very consistent ground - Compaction Backfill : . $\gamma_{d^{OPM}}$ = 1.94 t / m^3 . W_{OPM} = 15.20 % - Natural soil : . γ_h = 1.88 t / m^3 . $W_{(N)}$ = 17.3 % . γ_S = 2.88 t / m^3	- Shear test : . Cuu = 20 kN /m^2 . ψ_{uu} = 23.75° - Chemical analysis : . pH = 6.75 . SO_4^{2} = 9.2 mg / L . Cl^- = 226.9 mg / L	Picks and shovels can be used.	

DESCRIPTION OF THE PIT	Depth (below existing ground level) cm	Soil Stratigraphy (observed in the well)	GEOTECHNICAL BEARING CAPACITIES			
			Allowable		ULS *	Ultimate
			(Mpa)	(Kpa)	(Mpa)	(Mpa)
Vegetable soil 0.00 - 0.30 m	0		0	0	0	0
	20		0.20	200	20	45
	40		0.18	180	18	40
	60		0.70	700	70	105
	80		1.10	1100	110	205
	100		1.35	1350	135	350
	120		1.40	1400	140	400
	140		1.50	1500	150	500
	160					
	180					
Clayey gravel poorly graded 0.30 - 4.00 m	200					
	220					
	240					
	260					
	280					
	300					
	320					
	340					
	360					
	380					
	400					
	420					
	440					
	460					
	480					
	500					
	520					
	540					
	560					
	580					
	620					
	640					
	660					
	680					
	700					
	720					
	740					
	760					
	780					
	800					
	820					
	840					

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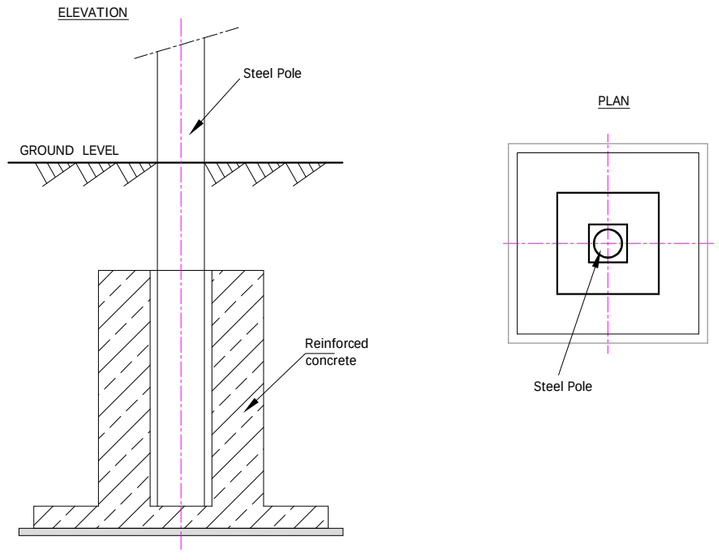
EXCAVATION (test pit)

EXCAVATED SOIL

FOUNDATION TYPE



THE FOUNDATION DIMENSIONS COMPLY WITH THE STATIC BALANCE OF POST FIXING .

Soil investigation point	Extraction depth of the sample	Classification according USCS	Observation	ENGINEERING PROPERTIES		EXCAVATION CONDITION	GEOLOGICAL UNIT Light penetrometer (GeoMIL 50 kN SPT), test without soil coring for sample taking
SIP 10 (15 kV line Gasogi - Masaka)	3.70 - 4.00 m	Clay of intermediate plasticity (CI)	Lateritic zone	- IP : 19.9 - Consistency Ic = 1.11 > 1 very consistent ground - Compaction Backfill : . γ_{d}^{OPM} = 1.82 t / m^3 . W_{OPM} = 18.40 % - Natural soil : . γ_h = 1.87 t / m^3 . $W_{(N)}$ = 22.3 % . γ_s = 2.78 t / m^3	- Shear test : . Cuu = 38 kN /m^2 . ψ_{uu} = 21.31° - Chemical analysis : . pH = 6.83 . SO_4^{2} = 8.8 mg / L . Cl^- = 199.4 mg / L	Picks and shovels can be used.	

DESCRIPTION OF THE PIT	Depth (below existing ground level) cm	Soil Stratigraphy (observed in the well)	GEOTECHNICAL BEARING CAPACITIES			
			Allowable		ULS *	Ultimate
			(Mpa)	(Kpa)	(Mpa)	(Mpa)
Vegetable soil 0.00 - 0.30 m	0		0	0	0	0
	20		0.20	200	20	50
	40		0.40	400	40	60
	60		0.55	550	55	80
	80		0.50	500	50	100
	100		0.25	250	25	70
	120		0.35	350	35	70
	140		0.35	350	35	90
	160		0.30	300	30	110
	180		0.25	250	25	130
Clay of intermediate plasticity 0.30 - 4.00 m	200		0.23	230	23	125
	220		0.22	220	22	135
	240		0.28	280	28	150
	260		0.28	280	28	135
	280		0.30	300	30	180
	300		0.35	350	35	185
	320		0.60	600	60	250
	340		0.55	550	55	300
	360		0.40	400	40	280
	380		0.90	900	90	330
	400		0.55	550	55	310
	420		0.55	550	55	290
	440		0.73	730	73	330
	460		1.38	1380	138	340
	480		1.43	1430	143	400
	500		1.50	1500	150	500
	520					
	540					
	560					
	580					
	620					
	640					
	660					
	680					
	700					
	720					
	740					
	760					
	780					
	800					
	820					
	840					

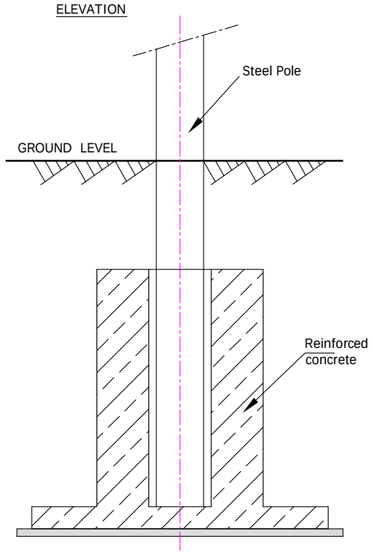
* ULS : Ultimate Limit State

EXCAVATION (test pit)

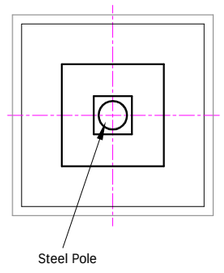
EXCAVATED SOIL

FOUNDATION TYPE

ELEVATION



PLAN



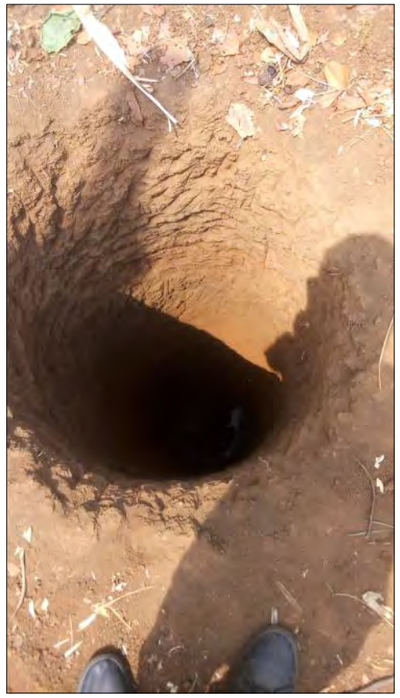
THE FOUNDATION DIMENSIONS COMPLY WITH THE STATIC BALANCE OF POST FIXING .

Soil investigation point	Extraction depth of the sample	Classification according USCS	Observation	ENGINEERING PROPERTIES		EXCAVATION CONDITION	GEOLOGICAL UNIT Light penetrometer (GeoMIL 50 kN SPT), test without soil coring for sample taking
SIP 12 (15 kV line Gasogi - Masaka)	3.50 - 4.00 m	Clay of intermediate plasticity (CI)	Lateritic zone	- IP : 19.9 - Consistency Ic = 1.11 > 1 very consistent ground - Compaction Backfill : . $\gamma_{d^{OPM}}$ = 1.82 t / m^3 . W_{OPM} = 18.40 % - Natural soil : . γ_h = 1.87 t / m^3 . $W_{(N)}$ = 22.3 % . γ_s = 2.78 t / m^3	- Shear test : . Cuu = 38 kN /m^2 . ψ_{uu} = 21.31° - Chemical analysis : . pH = 6.83 . SO_4^{2} = 8.8 mg / L . Cl^- = 199.4 mg / L	Picks and shovels can be used.	

DESCRIPTION OF THE PIT	Depth (below existing ground level) cm	Soil Stratigraphy (observed in the well)	GEOTECHNICAL BEARING CAPACITIES			
			Allowable		ULS *	Ultimate
			(Mpa)	(Kpa)	(Mpa)	(Mpa)
Vegetable soil 0.00 - 0.50 m	0		0	0	0	0
	20		0.10	100	10	30
	40		0.50	500	50	60
	60		0.45	450	45	80
	80		0.55	550	55	80
	100		0.60	600	60	130
	120		0.90	900	90	200
	140		0.95	950	95	250
	160		0.90	900	90	280
	180		1.00	1000	100	360
	200		1.45	1450	145	400
Clay of intermediate plasticity 0.50 - 4.00 m	220		1.50	1500	150	500
	240					
	260					
	280					
	300					
	320					
	340					
	360					
	380					
	400					
	420					
	440					
	460					
	480					
	500					
	520					
	540					
	560					
	580					
	620					
	640					
	660					
	680					
	700					
	720					
	740					
	760					
	780					
	800					
	820					
	840					

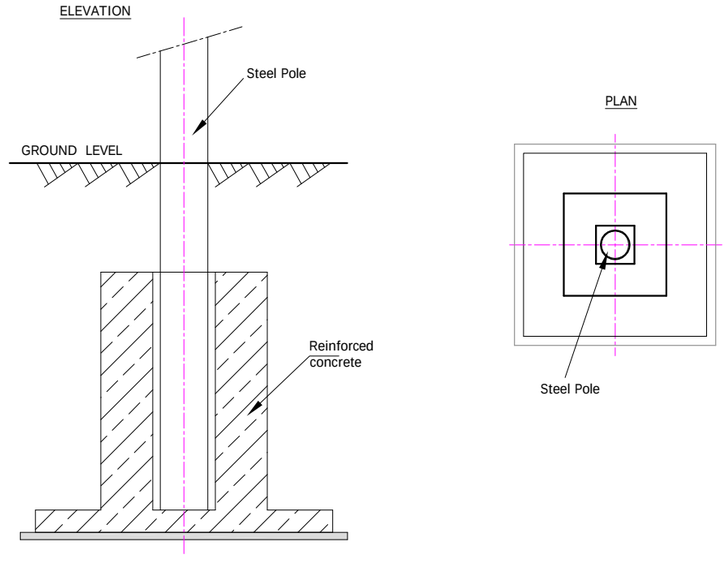
* ULS : Ultimate Limit State

EXCAVATION (test pit)



EXCAVATED SOIL

FOUNDATION TYPE



THE FOUNDATION DIMENSIONS COMPLY WITH THE STATIC BALANCE OF POST FIXING .

Soil investigation point	Extraction depth of the sample	Classification according USCS	Observation	ENGINEERING PROPERTIES		EXCAVATION CONDITION	GEOLOGICAL UNIT Light penetrometer (GeoMIL 50 kN SPT), test without soil coring for sample taking
SIP 13 (15 kV line Gasogi - Masaka)	3.60 - 4.00 m	Clay of intermediate plasticity (CI)	Clayey soil	- IP : 20.7 - Consistency Ic = 1.12 > 1 very consistent ground - Compaction Backfill : . $\gamma_{d^{OPM}}$ = 1.73 t / m^3 . W_{OPM} = 20.0 % - Natural soil : . γ_h = 1.70 t / m^3 . $W_{(N)}$ = 21.0 % . γ_s = 2.77 t / m^3	- Shear test : . Cuu = 45 kN /m^2 . ψ_{uu} = 20.30° - Chemical analysis : . pH = 6.64 . SO_4^{2} = 12.2 mg / L . Cl^- = 213.1 mg / L	Picks and shovels can be used.	

DESCRIPTION OF THE PIT	Depth (below existing ground level) cm	Soil Stratigraphy (observed in the well)	GEOTECHNICAL BEARING CAPACITIES			
			Allowable		ULS *	Ultimate
			(Mpa)	(Kpa)	(Mpa)	(Mpa)
Vegetable soil 0.00 - 0.30 m	0		0	0	0	0
	20		0.60	600	60	80
	40		0.85	850	85	100
Clay of intermediate plasticity 0.30 - 4.00 m	60		0.95	950	95	130
	80		1.00	1000	100	160
	100		0.40	400	40	90
	120		0.30	300	30	70
	140		0.25	250	25	65
	160		0.28	280	28	80
	180		0.30	300	30	95
	200		0.25	250	25	100
	220		0.30	300	30	140
	240		0.30	300	30	155
	260		0.40	400	40	180
	280		0.70	700	70	260
	300		0.75	750	75	300
	320		0.40	400	40	280
	340		0.40	400	40	290
	360		0.45	450	45	313
	380		0.85	850	85	330
	400		0.75	750	75	360
	420		0.70	700	70	365
	440		0.85	850	85	340
	460		0.95	950	95	350
	480		1.20	1200	120	300
	500		1.23	1230	123	350
	520		1.30	1300	130	405
	540		1.50	1500	150	500
	560					
	580					
	620					
	640					
	660					
	680					
	700					
	720					
	740					
	760					
	780					
	800					
	820					
	840					

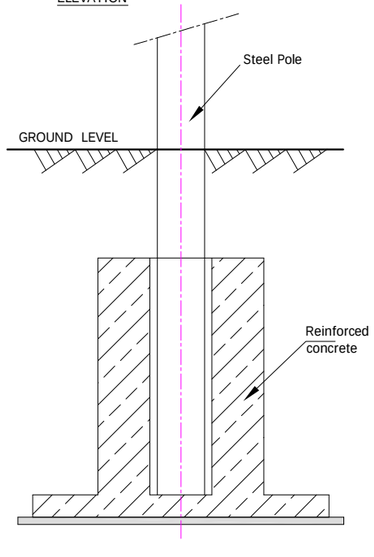
* ULS : Ultimate Limit State

EXCAVATION (test pit)

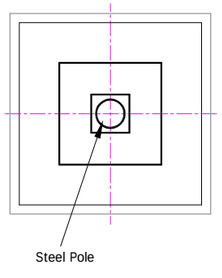
EXCAVATED SOIL

FOUNDATION TYPE

ELEVATION



PLAN



THE FOUNDATION DIMENSIONS COMPLY WITH THE STATIC BALANCE OF POST FIXING .

Soil investigation point	Extraction depth of the sample	Classification according USCS	Observation	ENGINEERING PROPERTIES		EXCAVATION CONDITION	GEOLOGICAL UNIT Light penetrometer (GeoMIL 50 kN SPT), test without soil coring for sample taking
SIP 15 (15 kV line Gasogi - Masaka)	3.80 - 4.00 m	Clay of intermediate plasticity (CI)	Clayey soil (with laterit)	- IP : 20.7 - Consistency Ic = 1.45 > 1 very consistent ground - Compaction Backfill : . $\gamma_{d^{OPM}}$ = 1.78 t / m^3 . W_{OPM} = 18.0 % - Natural soil : . γ_h = 1.61 t / m^3 . $W_{(N)}$ = 14.9 % . γ_s = 2.75 t / m^3	- Shear test : . Cuu = 41 kN /m^2 . ψ_{uu} = 26.10° - Chemical analysis : . pH = 6.55 . SO_4^{2} = 9.7 mg / L . Cl^- = 218.5 mg / L	Picks and shovels can be used.	

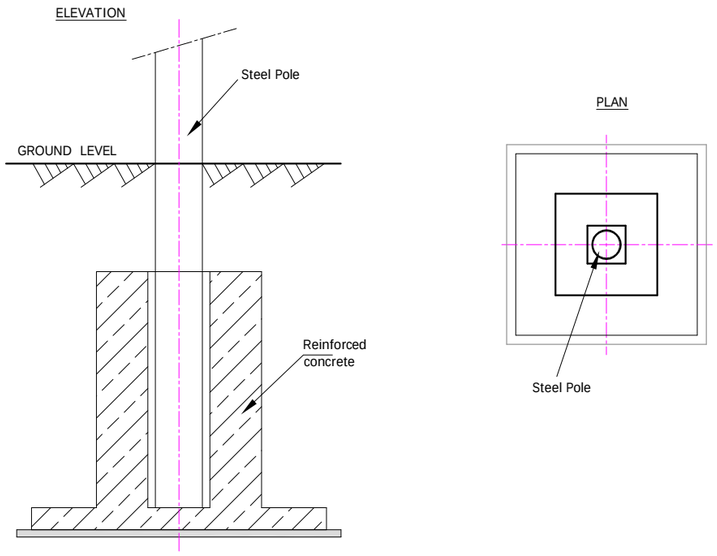
DESCRIPTION OF THE PIT	Depth (below existing ground level) cm	Soil Stratigraphy (observed in the well)	GEOTECHNICAL BEARING CAPACITIES			
			Allowable		ULS *	Ultimate
			(Mpa)	(Kpa)	(Mpa)	(Mpa)
	0		0	0	0	0
Vegetable soil 0.00 - 0.60 m	20		0.55	550	55	80
	40		0.45	450	45	125
	60		1.00	1000	100	300
Clay of intermediate plasticity 0.60 - 4.00 m	80		1.20	1200	120	370
	100		1.40	1400	140	400
	120		1.50	1500	150	500
	140					
	160					
	180					
	200					
	220					
	240					
	260					
	280					
	300					
	320					
	340					
	360					
	380					
	400					
	420					
	440					
	460					
	480					
	500					
	520					
	540					
	560					
	580					
	620					
	640					
	660					
	680					
	700					
	720					
	740					
	760					
	780					
	800					
	820					
	840					

* ULS : Ultimate Limit State

EXCAVATION (test pit)

EXCAVATED SOIL

FOUNDATION TYPE



THE FOUNDATION DIMENSIONS COMPLY WITH THE STATIC BALANCE OF POST FIXING .

Soil investigation point	Extraction depth of the sample	Classification according USCS	Observation	ENGINEERING PROPERTIES		EXCAVATION CONDITION	GEOLOGICAL UNIT Light penetrometer (GeoMIL 50 kN SPT), test without soil coring for sample taking
SIP 16 (15 kV line Gasogi - Masaka)	3.40 - 4.00 m	Clay of intermediate plasticity (CI)	Lateritic zone	- IP : 19.2 - Consistency Ic = 1.15 > 1 very consistent ground - Compaction Backfill : . $\gamma_{d\,OPM}$ = 1.77 t / m^3 . W_{OPM} = 20.40 % - Natural soil : . γ_h = 1.69 t / m^3 . $W_{(N)}$ = 20.3 % . γ_S = 2.84 t / m^3	- Shear test : . Cuu = 39 kN /m^2 . ψ_{uu} = 22.29° - Chemical analysis : . pH = 4.91 . SO_4^{2} = 6.9 mg / L . Cl^- = 113.3 mg / L	Picks and shovels can be used.	

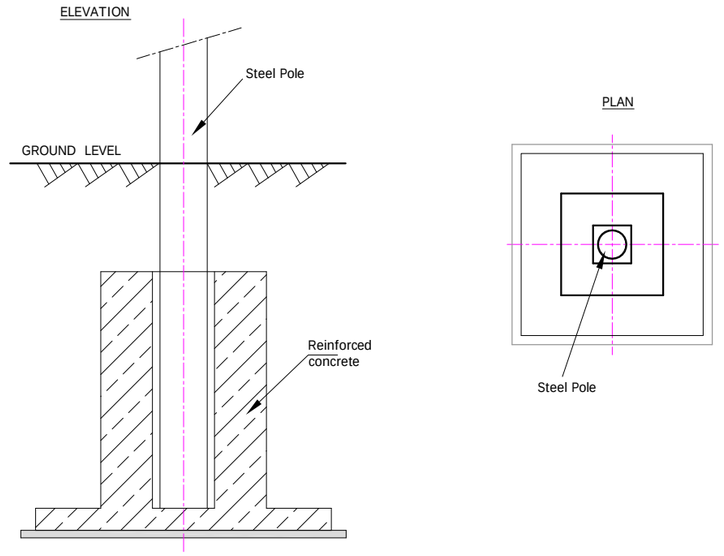
DESCRIPTION OF THE PIT	Depth (below existing ground level) cm	Soil Stratigraphy (observed in the well)	GEOTECHNICAL BEARING CAPACITIES			
			Allowable		ULS *	Ultimate
			(Mpa)	(Kpa)	(Mpa)	(Mpa)
Vegetable soil 0.00 - 0.25 m	0		0	0	0	0
	20		0.60	600	60	90
	40		0.43	430	43	120
	60		0.75	750	75	140
	80		0.93	930	93	260
	100		1.10	1100	110	380
	120		1.20	1200	120	420
	140		1.50	1500	150	500
	160					
	180					
	200					
Clay of intermediate plasticity 0.25 - 4.00 m	220					
	240					
	260					
	280					
	300					
	320					
	340					
	360					
	380					
	400					
	420					
	440					
	460					
	480					
	500					
	520					
	540					
	560					
	580					
	620					
	640					
	660					
	680					
	700					
	720					
	740					
	760					
	780					
	800					
	820					
	840					

* ULS : Ultimate Limit State

EXCAVATION (test pit)

EXCAVATED SOIL

FOUNDATION TYPE



THE FOUNDATION DIMENSIONS COMPLY WITH THE STATIC BALANCE OF POST FIXING .

Soil investigation point	Extraction depth of the sample	Classification according USCS	Observation	ENGINEERING PROPERTIES		EXCAVATION CONDITION	GEOLOGICAL UNIT Light penetrometer (GeoMIL 50 kN SPT), test without soil coring for sample taking
SIP 17 (15 kV line Gasogi - Masaka)	2.50 - 3.50 m	Clay of intermediate plasticity (CI)	Clayey soil	- IP : 15.7 - Consistency Ic = 1.55 > 1 very consistent ground - Compaction Backfill : . γ_{d}^{OPM} = 1.87 t / m^3 . W_{OPM} = 15.65 % - Natural soil : . γ_h = 1.63 t / m^3 . $W_{(N)}$ = 13.5 % . γ_S = 2.75 t / m^3	- Shear test : . Cuu = 19 kN /m^2 . ψ_{uu} = 31.59° - Chemical analysis : . pH = 6.49 . SO_4^{2} = 11.7 mg / L . Cl^- = 208.4 mg / L	Picks and shovels can be used.	

DESCRIPTION OF THE PIT	Depth (below existing ground level) cm	Soil Stratigraphy (observed in the well)	GEOTECHNICAL BEARING CAPACITIES			
			Allowable		ULS *	Ultimate
			(Mpa)	(Kpa)	(Mpa)	(Mpa)
Vegetable soil 0.00 - 0.25 m	0		0	0	0	0
	20		0.55	550	55	90
	40		0.50	500	50	70
	60		0.45	450	45	65
	80		0.50	500	50	80
	100		0.40	400	40	63
	120		0.30	300	30	70
	140		0.35	350	35	80
	160		0.30	300	30	60
	180		0.25	250	25	50
	200		0.30	300	30	70
	220		0.40	400	40	90
Clay of intermediate plasticity 0.40 - 4.00 m	240		0.50	500	50	110
	260		0.60	600	60	120
	280		0.65	650	65	150
	300		0.65	650	65	165
	320		0.70	700	70	223
	340		0.50	500	50	230
	360		0.55	550	55	230
	380		0.65	650	65	255
	400		0.60	600	60	280
	420		0.63	630	63	300
	440		0.60	600	60	305
	460		0.70	700	70	325
	480		0.83	830	83	383
	500		1.00	1000	100	390
	520		1.15	1150	115	420
	540		1.50	1500	150	500
	560					
	580					
	620					
	640					
	660					
	680					
	700					
	720					
	740					
	760					
	780					
	800					
	820					
	840					

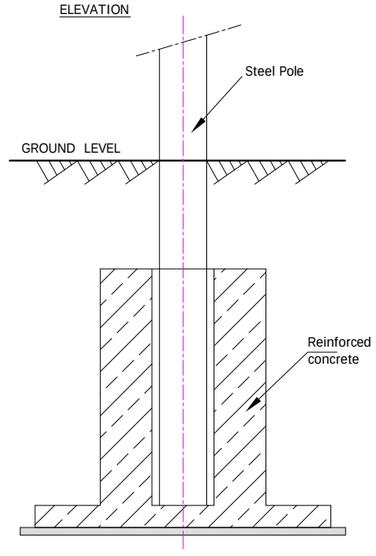
* ULS : Ultimate Limit State

EXCAVATION (test pit)

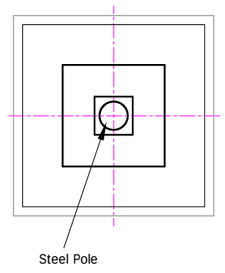
EXCAVATED SOIL

FOUNDATION TYPE

ELEVATION



PLAN



THE FOUNDATION DIMENSIONS COMPLY WITH THE STATIC BALANCE OF POST FIXING .

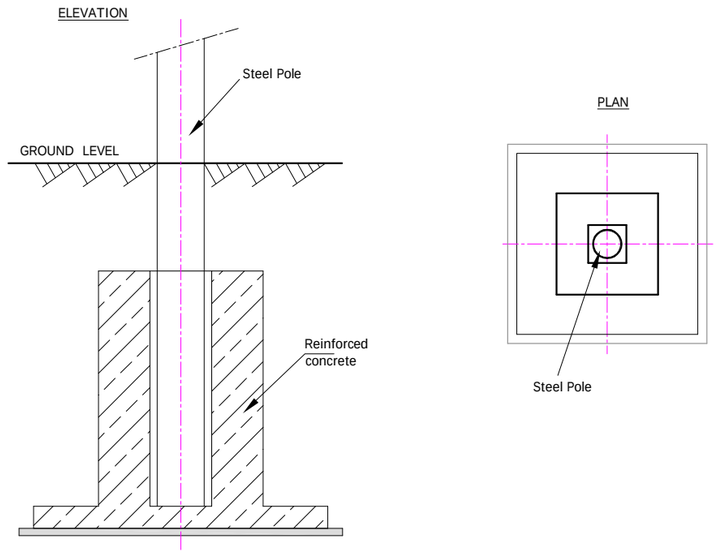
Soil investigation point	Extraction depth of the sample	Classification according USCS	Observation	ENGINEERING PROPERTIES		EXCAVATION CONDITION	GEOLOGICAL UNIT Light penetrometer (GeoMIL 50 kN SPT), test without soil coring for sample taking
SIP 18 (15 kV line Gasogi - Masaka)	Visual observation	Clay of intermediate plasticity (CI)	Clayey soil : Soil of the same physical & mechanical nature as the soil of the Sip 17	- IP : 16.4 - Consistency Ic = 1.55 > 1 very consistent ground - Compaction Backfill : . γ_{d}^{OPM} = 1.84 t / m^3 . W_{OPM} = 15.20 % - Natural soil : . γ_h = 1.73 t / m^3 . $W_{(N)}$ = 15 % . γ_s = 2.70 t / m^3	- Shear test : . Cuu = 21 kN /m^2 . ψ_{uu} = 26.79° - Chemical analysis : . pH = 4. 94 . SO_4^{2} = 65.2 mg / L . Cl^- = 102.2 mg / L	Picks and shovels can be used.	

DESCRIPTION OF THE PIT	Depth (below existing ground level) cm	Soil Stratigraphy (observed in the well)	GEOTECHNICAL BEARING CAPACITIES			
			Allowable		ULS *	Ultimate
			(Mpa)	(Kpa)	(Mpa)	(Mpa)
Vegetable soil 0.00 - 0.25 m	0		0	0	0	0
	20		0.50	500	50	65
	40		0.25	250	25	62
	60		0.20	200	20	56
	80		0.20	200	20	42
	100		0.25	250	25	60
	120		0.30	300	30	60
	140		0.20	200	20	45
	160		0.30	300	30	63
	180		0.40	400	40	50
Clay of intermediate plasticity 0.25 - 4.00 m	200		0.40	400	40	80
	220		0.35	350	35	80
	240		0.50	500	50	100
	260		0.65	650	65	125
	280		0.55	550	55	150
	300		0.70	700	70	180
	320		0.63	630	63	180
	340		0.70	700	70	240
	360		0.65	650	65	235
	380		0.35	350	35	245
	400		0.65	650	65	270
	420		0.62	620	62	280
	440		0.65	650	65	310
	460		0.70	700	70	320
	480		0.80	800	80	330
	500		1.00	1000	100	400
	520		1.50	1500	150	500
	540					
	560					
	580					
	620					
	640					
	660					
	680					
	700					
	720					
	740					
	760					
	780					
	800					
	820					
	840					

* ULS : Ultimate Limit State

EXCAVATED SOIL

FOUNDATION TYPE



THE FOUNDATION DIMENSIONS COMPLY WITH THE STATIC BALANCE OF POST FIXING .

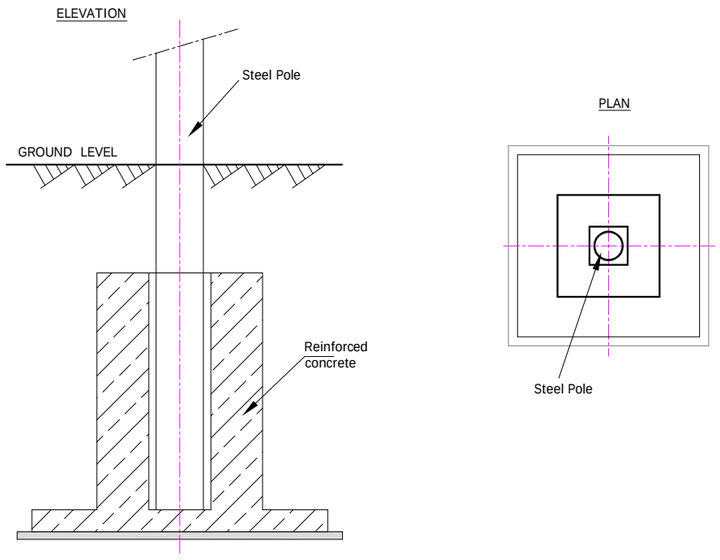
Soil investigation point	Extraction depth of the sample	Classification according USCS	Observation	ENGINEERING PROPERTIES		EXCAVATION CONDITION	GEOLOGICAL UNIT Light penetrometer (GeoMIL 50 kN SPT), test without soil coring for sample taking
SIP 19 (15 kV line Gasogi - Masaka)	Visual observation	Clay of intermediate plasticity (CI)	Clayey zone : Soil of the same physical & mechanical nature as the soil of the Sip 17	- IP : 19.0 - Consistency Ic = 1.17 > 1 very consistent ground - Compaction Backfill : . $\gamma_{d^{OPM}}$ = 1.70 t / m^3 . W_{OPM} = 19.40 % - Natural soil : . γ_h = 1.70 t / m^3 . $W_{(N)}$ = 21 % . γ_s = 2.68 t / m^3	- Shear test : . Cuu = 48 kN /m^2 . ψ_{uu} = 19.29° - Chemical analysis : . pH = 5.72 . SO_4^{2} = 4.2 mg / L . Cl^- = 63.8 mg / L	Picks and shovels can be used.	

DESCRIPTION OF THE PIT	Depth (below existing ground level) cm	Soil Stratigraphy (observed in the well)	GEOTECHNICAL BEARING CAPACITIES			
			Allowable		ULS *	Ultimate
			(Mpa)	(Kpa)	(Mpa)	(Mpa)
Vegetable soil 0.00 - 0.20 m	0		0	0	0	0
	20		0.20	200	20	70
Clay of intermediate plasticity 0.20 - 4.00 m	40		0.30	300	30	60
	60		0.25	250	25	55
	80		0.20	200	20	40
	100		0.18	180	18	38
	120		0.20	200	20	35
	140		0.35	350	35	60
	160		0.40	400	40	80
	180		0.45	450	45	80
	200		0.40	400	40	90
	220		0.55	550	55	100
	240		0.65	650	65	160
	260		0.80	800	80	230
	280		0.95	950	95	300
	300		1.00	1000	100	360
	320		1.10	1100	110	400
	340		1.20	1200	120	500
	360					
	380					
	400					
	420					
	440					
	460					
	480					
	500					
	520					
	540					
	560					
	580					
	620					
	640					
	660					
	680					
	700					
	720					
	740					
	760					
	780					
	800					
	820					
	840					

* ULS : Ultimate Limit State

EXCAVATED SOIL

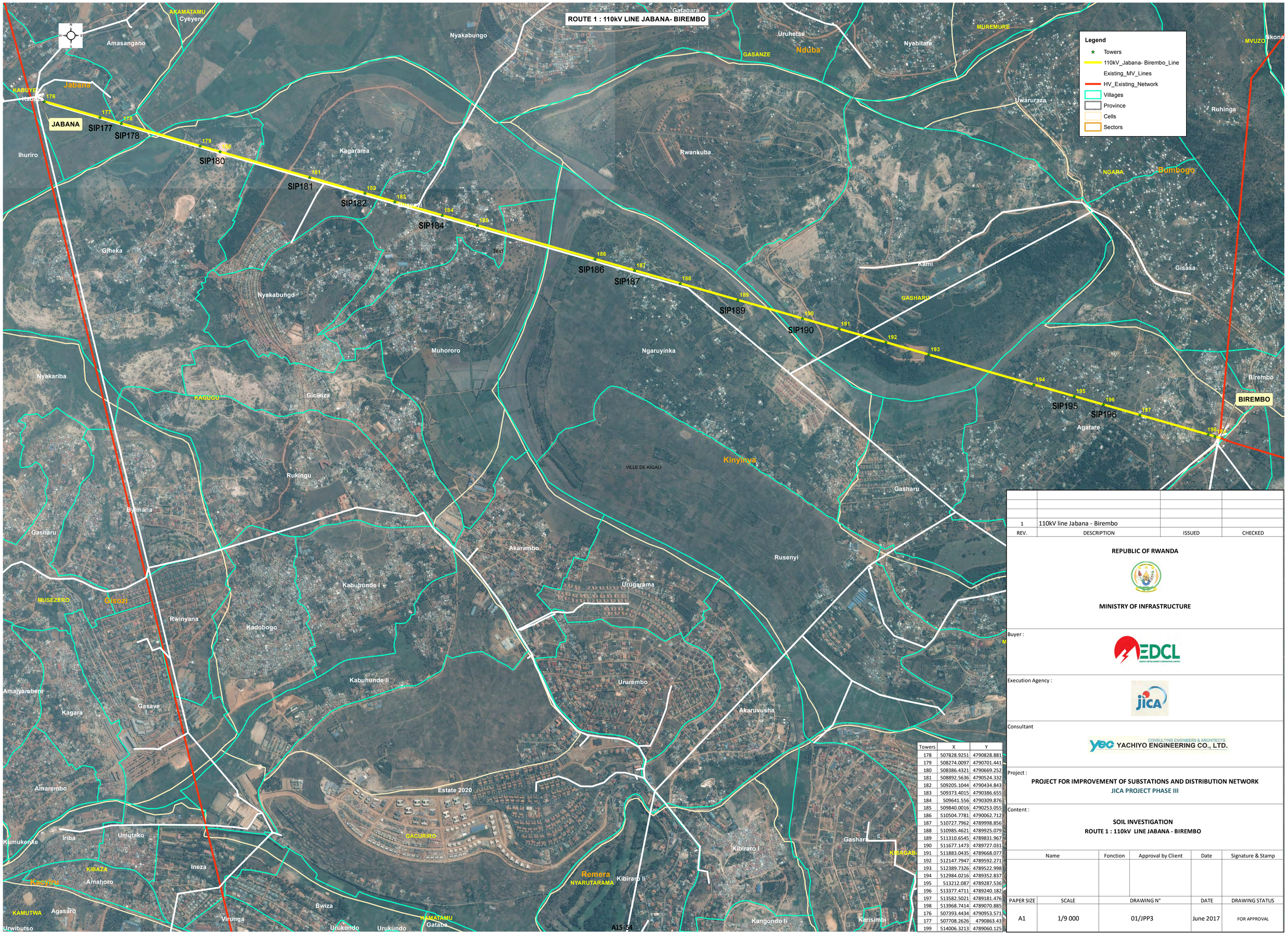
FOUNDATION TYPE



THE FOUNDATION DIMENSIONS COMPLY WITH THE STATIC BALANCE OF POST FIXING .

D. Reconstruction of transmission 110 kV line Jabana-Birembo

ROUTE 1 : 110kV LINE JABANA- BIREMBO



Towers	X	Y
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179	508274.0097	4790701.441
180	508386.4321	4790669.252
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182	509205.1044	4790434.843
183	509373.4015	4790386.655
184	509641.556	4790309.876
185	509840.0016	4790253.055
186	510504.7781	4790062.712
187	510727.7962	4789998.856
188	510985.4621	4789925.079
189	511310.6545	4789831.967
190	511677.1473	4789727.031
191	511883.0435	4789668.077
192	512147.7947	4789592.271
193	512389.7326	4789522.998
194	512984.0216	4789352.837
195	513212.087	4789287.536
196	513377.4711	4789240.182
197	513582.5021	4789181.476
198	513968.7414	4789070.885
176	507393.4434	4790953.571
177	507708.2626	4790863.43
199	514006.3213	4789060.125

REV.	DESCRIPTION	ISSUED	CHECKED
1	110kV line Jabana - Birembo		

REPUBLIC OF RWANDA

MINISTRY OF INFRASTRUCTURE

Buyer : EDCL

Execution Agency : JICA

Consultant : YACHIYO ENGINEERING CO., LTD.

Project :

PROJECT FOR IMPROVEMENT OF SUBSTATIONS AND DISTRIBUTION NETWORK

JICA PROJECT PHASE III

Content :

SOIL INVESTIGATION

ROUTE 1 : 110kV LINE JABANA - BIREMBO

Name	Fonction	Approval by Client	Date	Signature & Stamp

PAPER SIZE	SCALE	DRAWING N°	DATE	DRAWING STATUS
A1	1/9 000	01/JPP3	June 2017	FOR APPROVAL

Soil investigation point	Extraction depth of the sample	Classification according USCS	Observation	ENGINEERING PROPERTIES		EXCAVATION CONDITION	GEOLOGICAL UNIT Light penetrometer (GeoMIL 50 kN SPT), test without soil coring for sample taking
SIP 176 (110 kV line Jabana - Birembo)	0.50 - 1.00 m	Clay of intermediate plasticity (CI)	Swampy area	- IP : 19.3 - Consistency Ic = 1.16 > 1 : very consistent ground - Compaction Backfill : . γ_{dOPM} = 1.83 t / m^3 . W_{OPM} = 17.32 % - Natural soil : . γ_h = 1.71 t / m^3 . $W_{(N)}$ = 19.7 % . γ_s = 2.81 t / m^3	- Shear test : . Cuu = 48 kN /m^2 . ψ_{uu} = 22.05° - Chemical analysis : . pH = 6.64 . SO_4^{2} = 111 mg / L . Cl^- = 257.1 mg / L	Picks and shovels can be used.	

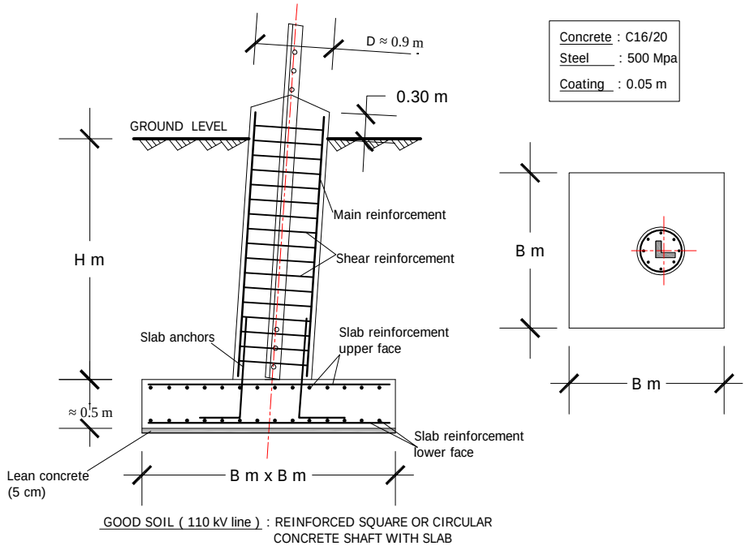
DESCRIPTION OF THE PIT	Depth (below existing ground level) cm	Soil Stratigraphy (observed in the well)	GEOTECHNICAL BEARING CAPACITIES			
			Allowable		ULS *	Ultimate
			(Mpa)	(Kpa)	(Mpa)	(Mpa)
Vegetable soil 0.00 - 0.30 m	0		0	0	0	0
	20		0.06	60	12	20
	40		0.06	60	12	20
	60		0.07	70	14	23
(-1.20 m)	80		0.09	90	18	25
	100		0.10	10	20	27
	120		0.09	90	18	27
	140		0.10	100	20	33
	160		0.12	120	25	35
	180		0.17	170	35	45
Clayey of intermediate plasticity 0.30 - 4.00 m	200		0.20	200	40	50
	220		0.25	250	50	60
	240		0.30	300	60	80
	260		0.35	350	70	80
	280		0.35	350	70	85
	300		0.35	350	70	90
	320		0.25	250	50	100
	340		0.27	270	55	110
	360		0.30	300	60	125
	380		0.35	350	70	145
	400		0.25	250	50	150
	420		0.20	200	40	110
	440		0.07	70	15	155
	460		0.10	100	20	165
	480		0.06	60	12	160
	500		0.07	70	15	120
	520		0.22	220	45	180
	540		0.25	250	50	190
	560		0.10	100	20	190
	580		0.15	150	30	200
	600		0.27	270	55	210
	620		0.40	400	80	280
	640		0.10	100	20	300
	660		0.50	500	100	350
	680		0.50	500	105	360
	700		0.60	600	120	380
	720		0.75	750	150	500
	740					
	760					
	780					
	800					
	820					

* ULS : Ultimate Limit State

EXCAVATION (test pit)

EXCAVATED SOIL

FOUNDATION TYPE



GOOD SOIL (110 kV line) : REINFORCED SQUARE OR CIRCULAR CONCRETE SHAFT WITH SLAB

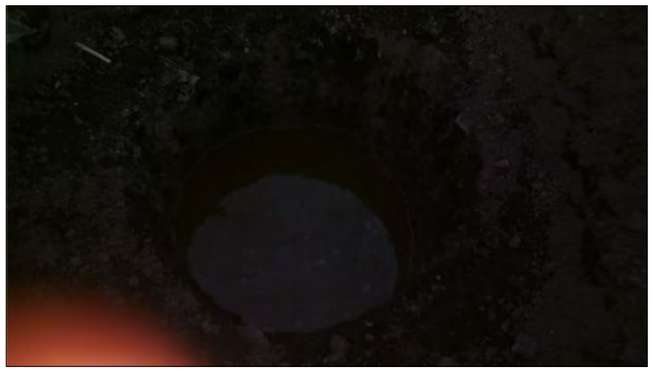
THE FOUNDATION DIMENSIONS COMPLY WITH THE STATIC BALANCE OF TOWER FIXING .

Soil investigation point	Extraction depth of the sample	Classification according USCS	Observation	ENGINEERING PROPERTIES		EXCAVATION CONDITION	GEOLOGICAL UNIT Light penetrometer (GeoMIL 50 kN SPT), test without soil coring for sample taking
SIP 177 (110 kV line Jabana - Birembo)	0.50 - 1.00 m	Clay of intermediate plasticity (CI)	Swampy area	- IP : 20.7 - Consistency Ic = 1.33 > 1 : very consistent ground - Compaction Backfill : . $\gamma_{d^{OPM}}$ = 1.81 t / m^3 . W_{OPM} = 18.98 % - Natural soil : . γ_h = 1.80 t / m^3 . $W_{(N)}$ = 15.7 % . γ_s = 2.82 t / m^3	- Shear test : . Cuu = 41 kN /m^2 . ψ_{uu} = 19.03° - Chemical analysis : . pH = 6.52 . SO_4^{2} = 125 mg / L . Cl^- = 283.6 mg / L	Picks and shovels can be used.	

DESCRIPTION OF THE PIT	Depth (below existing ground level) cm	Soil Stratigraphy (observed in the well)	GEOTECHNICAL BEARING CAPACITIES			
			Allowable		ULS *	Ultimate
			(Mpa)	(Kpa)	(Mpa)	(Mpa)
Vegetable soil 0.00 - 0.30 m	0		0	0	0	0
	20		0.10	100	20	35
	40		0.09	90	19	33
	60		0.09	90	18	35
(-1.20 m)	80		0.10	100	21	38
	100		0.10	100	20	38
	120		0.09	90	19	38
	140		0.10	100	21	39
	160		0.11	110	22	40
	180		0.11	110	22	42
Clayey of intermediate plasticity 0.30 - 4.00 m	200		0.12	120	25	42
	220		0.13	130	27	45
	240		0.16	160	32	50
	260		0.17	170	35	54
	280		0.18	180	37	55
	300		0.23	230	47	70
	320		0.24	240	49	68
	340		0.26	260	52	80
	360		0.28	280	57	92
	380		0.33	330	67	100
	400		0.28	280	57	100
	420		0.23	230	47	95
	440		0.26	260	52	80
	460		0.26	260	52	90
	480		0.25	250	50	90
	500		0.28	280	57	95
	520		0.31	310	62	100
	540		0.26	260	53	140
	560		0.30	300	60	150
	580		0.25	250	50	150
	600		0.35	350	70	200
	620		0.40	400	80	230
	640		0.42	420	85	255
	660		0.45	450	90	270
	680		0.40	400	80	290
	700		0.45	450	90	380
	720		0.50	500	100	420
	740		0.75	750	150	500
	760					
	780					
	800					
	820					

* ULS : Ultimate Limit State

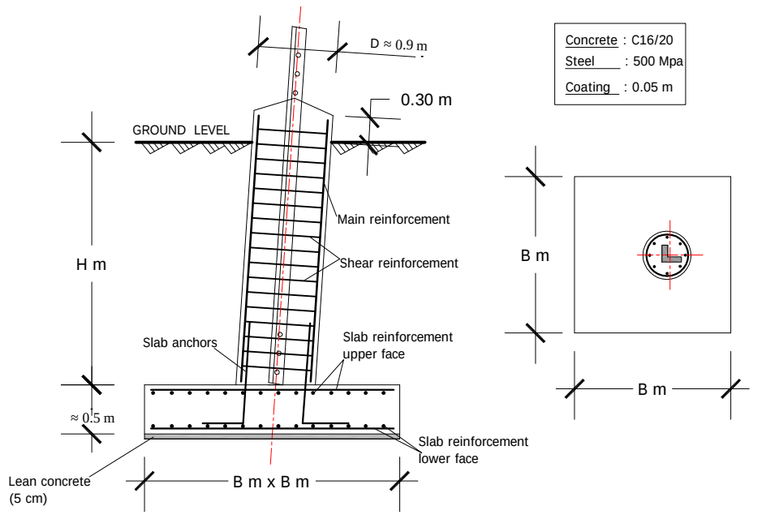
EXCAVATION (test pit)



EXCAVATED SOIL

55

FOUNDATION TYPE



GOOD SOIL (110 kV line) : REINFORCED SQUARE OR CIRCULAR CONCRETE SHAFT WITH SLAB

THE FOUNDATION DIMENSIONS COMPLY WITH THE STATIC BALANCE OF TOWER FIXING .

Soil investigation point	Extraction depth of the sample	Classification according USCS	Observation	ENGINEERING PROPERTIES		EXCAVATION CONDITION	GEOLOGICAL UNIT Light penetrometer (GeoMIL 50 kN SPT), test without soil coring for sample taking
SIP 178 (110 kV line Jabana - Birembo)	1.50 - 2.00 m	Silt of low plasticity (ML)	Swampy area	- IP : / - Consistency Ic < 1 : soft soil - Compaction Backfill : . $\gamma_{d^{OPM}}$ = 1.69 t / m^3 . W_{OPM} = 22.0 % - Natural soil : . γ_h = 1.62 t / m^3 . $W_{(N)}$ = 17.4 % . γ_s = 2.77 t / m^3	- Shear test : . Cuu = 10 kN /m^2 . ψ_{uu} = 26.79° - Chemical analysis : . pH = 7.04 . SO_4^{2} = 70 mg / L . Cl^- = 85 mg / L	Picks and shovels can be used.	

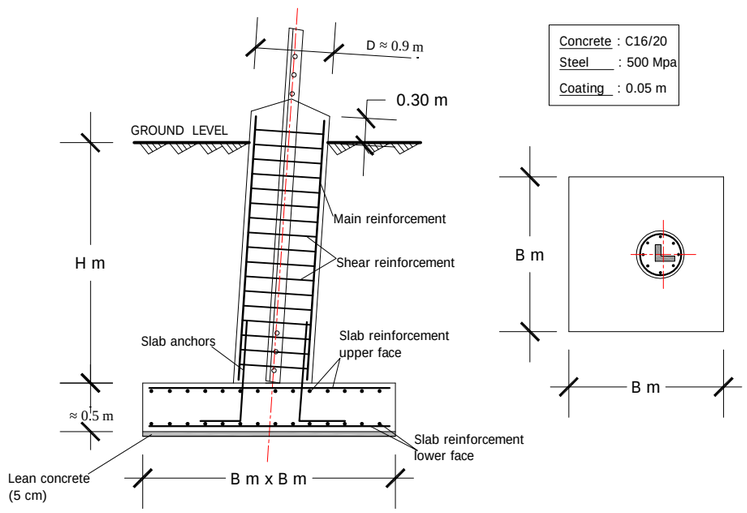
DESCRIPTION OF THE PIT	Depth (below existing ground level) cm	Soil Stratigraphy (observed in the well)	GEOTECHNICAL BEARING CAPACITIES			
			Allowable		ULS *	Ultimate
			(Mpa)	(Kpa)	(Mpa)	(Mpa)
Vegetable soil 0.00 - 0.30 m	0		0	0	0	0
	20		0.03	30	6	35
	40		0.05	50	10	39
	60		0.04	40	8	41
	80		0.07	70	15	41
	100		0.10	100	20	46
	120		0.12	120	25	51
Silt of low plasticity 0.30 - 4.00 m	140		0.07	70	15	49
	160		0.10	100	20	51
	180		0.12	120	25	59
	200		0.06	60	13	66
	220		0.10	100	20	63
	240		0.10	100	20	66
(-3.00 m) ▽	260		0.07	70	15	55
	280		0.10	100	20	61
	300		0.15	150	30	71
	320		0.20	200	40	81
	340		0.20	200	40	76
	360		0.20	200	40	71
	380		0.20	200	40	69
	400		0.14	140	38	51
	420		0.20	200	40	76
	440		0.24	240	48	81
	460		0.22	220	45	79
	480		0.25	250	50	86
	500		0.27	270	55	83
	520		0.30	300	60	91
	540		0.32	320	65	89
	560		0.30	300	60	85
	580		0.30	300	60	82
	600		0.35	350	70	80
	620		0.15	150	30	95
	640		0.05	50	10	90
	660		0.07	70	15	90
	680		0.10	100	20	100
	700		0.15	150	30	110
	720		0.15	150	30	115
	740		0.20	200	40	150
	760		0.50	500	100	250
	780		0.70	700	140	380
	800		0.75	750	150	500
	820					

* ULS : Ultimate Limit State

EXCAVATION (test pit)

EXCAVATED SOIL

FOUNDATION TYPE



THE FOUNDATION DIMENSIONS COMPLY WITH THE STATIC BALANCE OF TOWER FIXING .

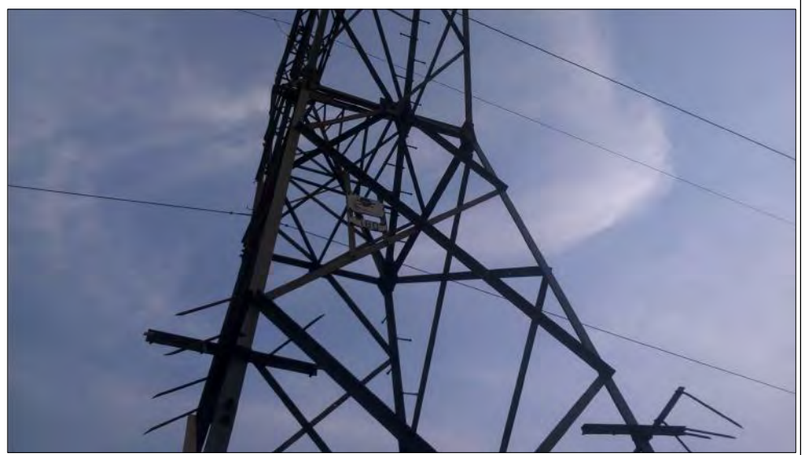
Soil investigation point	Extraction depth of the sample	Classification according USCS	Observation	ENGINEERING PROPERTIES		EXCAVATION CONDITION	GEOLOGICAL UNIT Light penetrometer (GeoMIL 50 kN SPT), test without soil coring for sample taking
SIP 180 (110 kV line Jabana - Birembo)	3.70 - 4.00 m	Silt of intermediate plasticity (MI)	Sandy soil	- IP : 17.3 - Consistency Ic = 1.51 > 1 : very consistent ground - Compaction Backfill : . $\gamma_{d^{OPM}}$ = 1.87 t / m^3 . W_{OPM} = 14.36 % - Natural soil : . γ_h = 1.80 t / m^3 . $W_{(N)}$ = 16 % . γ_S = 2.80 t / m^3	- Shear test : . Cuu = 20 kN /m^2 . ψ_{uu} = 24.23° - Chemical analysis : . pH = 6.2 . SO_4^{2} = 8.4 mg / L . Cl^- = 81 mg / L	Picks and shovels can be used.	

DESCRIPTION OF THE PIT	Depth (below existing ground level) cm	Soil Stratigraphy (observed in the well)	GEOTECHNICAL BEARING CAPACITIES			
			Allowable		ULS *	Ultimate
			(Mpa)	(Kpa)	(Mpa)	(Mpa)
Vegetable soil 0.00 - 0.40 m	0		0	0	0	0
	20		0.20	200	20	40
	40		0.65	650	65	80
Silt of intermediate plasticity 0.40 - 4.00 m	60		0.40	400	40	65
	80		1.00	1000	100	180
	100		1.20	1200	120	360
	120		1.30	1300	130	400
	140		1.50	1500	150	500
	160					
	180					
	200					
	220					
	240					
	260					
	280					
	300					
	320					
	340					
	360					
	380					
	400					
	420					
	440					
	460					
	480					
	500					
	520					
	540					
	560					
	580					
	600					
	620					
	640					
	660					
	680					
	700					
	720					
	740					
	760					
	780					
	800					
	820					

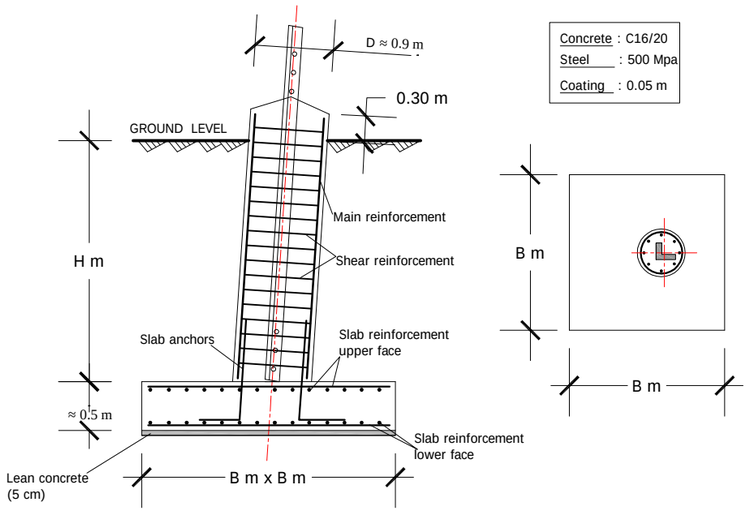
* ULS : Ultimate Limit State

EXCAVATION (test pit)

EXCAVATED SOIL



FOUNDATION TYPE



GOOD SOIL (110 kV line) : REINFORCED SQUARE OR CIRCULAR CONCRETE SHAFT WITH SLAB

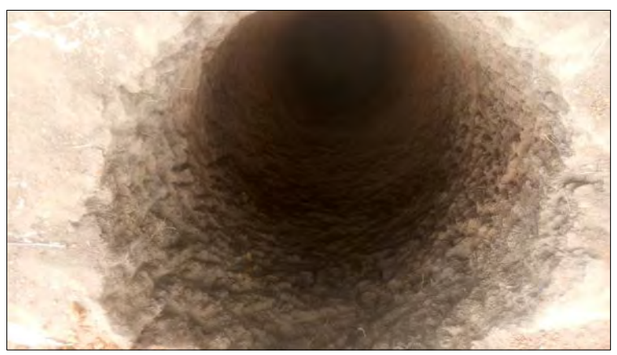
THE FOUNDATION DIMENSIONS COMPLY WITH THE STATIC BALANCE OF TOWER FIXING .

Soil investigation point	Extraction depth of the sample	Classification according USCS	Observation	ENGINEERING PROPERTIES		EXCAVATION CONDITION	GEOLOGICAL UNIT Light penetrometer (GeoMIL 50 kN SPT), test without soil coring for sample taking
SIP 181 (110 kV line Jabana - Birembo)	3.40 - 4.00 m	Clay of intermediate plasticity (CI)	Sandy soil	- IP : 21.1 - Consistency Ic = 1.33 > 1 : very consistent ground - Compaction Backfill : . $\gamma_{d^{OPM}}$ = 1.94 t / m^3 . W_{OPM} = 15.20 % - Natural soil : . γ_h = 1.68 t / m^3 . $W_{(N)}$ = 16 % . γ_s = 2.64 t / m^3	- Shear test : . Cuu = 31 kN /m^2 . ψ_{uu} = 23.75° - Chemical analysis : . pH = 6.55 . SO_4^{2} = 34 mg / L . Cl^- = 145 mg / L	Picks and shovels can be used.	

DESCRIPTION OF THE PIT	Depth (below existing ground level) /cm	Soil Stratigraphy (observed in the well)	GEOTECHNICAL BEARING CAPACITIES			
			Allowable		ULS *	Ultimate
			(Mpa)	(Kpa)	(Mpa)	(Mpa)
Vegetable soil 0.00 - 0.40 m	0		0	0	0	0
	20		0.25	250	25	40
	40		0.30	300	30	60
Clay of intermediate plasticity 0.40 - 4.00 m	60		0.80	800	80	140
	80		0.90	900	90	230
	100		1.00	1000	100	320
	120		1.20	1200	120	360
	140		1.40	1400	140	400
	160		1.50	1500	150	500
	180					
	200					
	220					
	240					
	260					
	280					
	300					
	320					
	340					
	360					
	380					
	400					
	420					
	440					
	460					
	480					
	500					
	520					
	540					
	560					
	580					
	600					
	620					
	640					
	660					
	680					
	700					
	720					
	740					
	760					
	780					
	800					
	820					

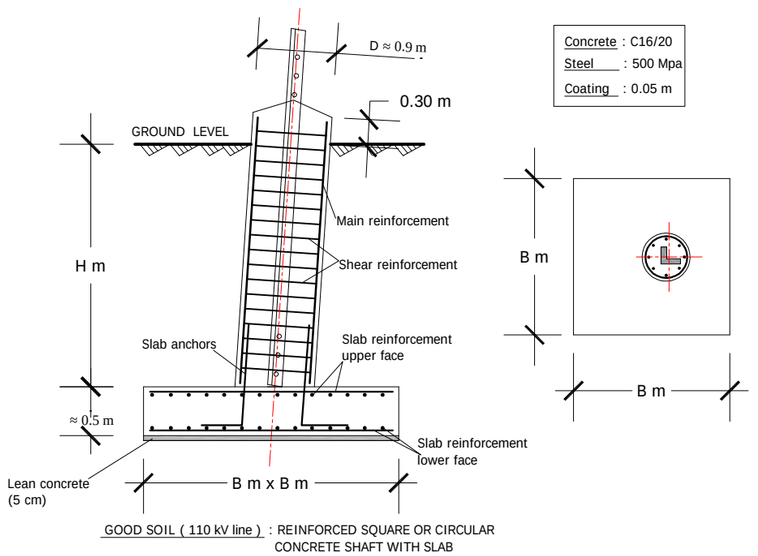
* ULS : Ultimate Limit State

EXCAVATION (test pit)



EXCAVATED SOIL

FOUNDATION TYPE



GOOD SOIL (110 kV line) : REINFORCED SQUARE OR CIRCULAR CONCRETE SHAFT WITH SLAB

THE FOUNDATION DIMENSIONS COMPLY WITH THE STATIC BALANCE OF TOWER FIXING .

Soil investigation point	Extraction depth of the sample	Classification according USCS	Observation	ENGINEERING PROPERTIES		EXCAVATION CONDITION	GEOLOGICAL UNIT Light penetrometer (GeoMIL 50 kN SPT), test without soil coring for sample taking
SIP 182 (110 kV line Jabana - Birembo)	3.80 - 4.00 m	Clay of intermediate plasticity (CI)	Sandy soil	- IP : 21.5 - Consistency Ic = 1.14 > 1 : very consistent ground - Compaction Backfill : . γ_{dOPM} = 1.79 t / m^3 . W_{OPM} = 16.87 % - Natural soil : . γ_h = 1.86 t / m^3 . $W_{(N)}$ = 20.7 % . γ_s = 2.67 t / m^3	- Shear test : . Cuu = 38 kN /m^2 . ψ_{uu} = 23.03° - Chemical analysis : . pH = 6.13 . SO_4^{2} = 13.7 mg / L . Cl^- = 101 mg / L	Picks and shovels can be used.	

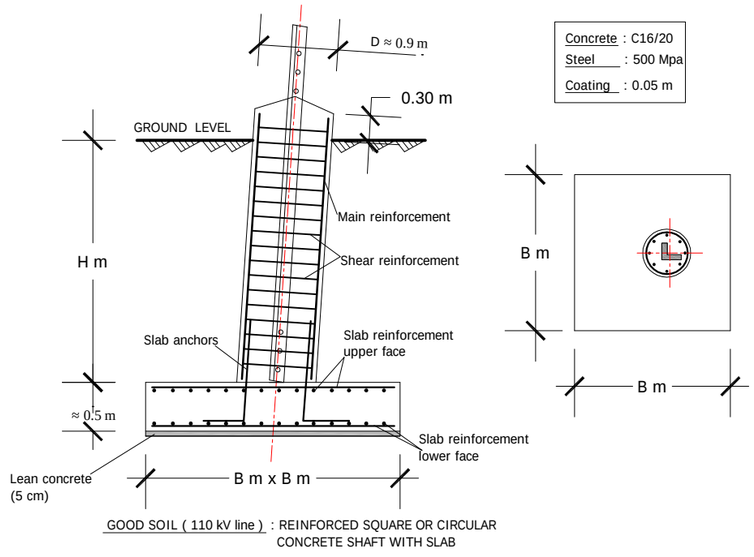
DESCRIPTION OF THE PIT	Depth (below existing ground level) cm	Soil Stratigraphy (observed in the well)	GEOTECHNICAL BEARING CAPACITIES			
			Allowable		ULS *	Ultimate
			(Mpa)	(Kpa)	(Mpa)	(Mpa)
	0		0	0	0	0
Vegetable soil 0.00 - 0.40 m	20		0.10	100	10	20
	40		0.35	350	35	65
	60		0.50	500	50	90
	80		0.45	450	45	70
	100		0.80	800	80	245
	120		0.90	900	90	290
	140		1.00	1000	100	350
	160		1.30	1300	130	420
Clay of intermediate plasticity 0.40 - 4.00 m	180		1.50	1500	150	500
	200					
	220					
	240					
	260					
	280					
	300					
	320					
	340					
	360					
	380					
	400					
	420					
	440					
	460					
	480					
	500					
	520					
	540					
	560					
	580					
	600					
	620					
	640					
	660					
	680					
	700					
	720					
	740					
	760					
	780					
	800					
	820					

* ULS : Ultimate Limit State

EXCAVATION (test pit)

EXCAVATED SOIL

FOUNDATION TYPE



GOOD SOIL (110 kV line) : REINFORCED SQUARE OR CIRCULAR CONCRETE SHAFT WITH SLAB

THE FOUNDATION DIMENSIONS COMPLY WITH THE STATIC BALANCE OF TOWER FIXING .

Soil investigation point	Extraction depth of the sample	Classification according USCS	Observation	ENGINEERING PROPERTIES		EXCAVATION CONDITION	GEOLOGICAL UNIT Light penetrometer (GeoMIL 50 kN SPT), test without soil coring for sample taking
SIP 184 (110 kV line Jabana - Birembo)	3.50 - 4.00 m	Clay of intermediate plasticity (CI)	Clayey soil	- IP : 19.1 - Consistency Ic = 0.97 < 1 : consistent ground - Compaction Backfill : . $\gamma_{d^{OPM}}$ = 1.79 t / m^3 . W_{OPM} = 19.0 % - Natural soil : . γ_h = 1.82 t / m^3 . $W_{(N)}$ = 21.5 % . γ_s = 2.79 t / m^3	- Shear test : . Cuu = 35 kN /m^2 . ψ_{uu} = 22.54° - Chemical analysis : . pH = 6.22 . SO_4^{2} = 28 mg / L . Cl^- = 151 mg / L	Picks and shovels can be used.	

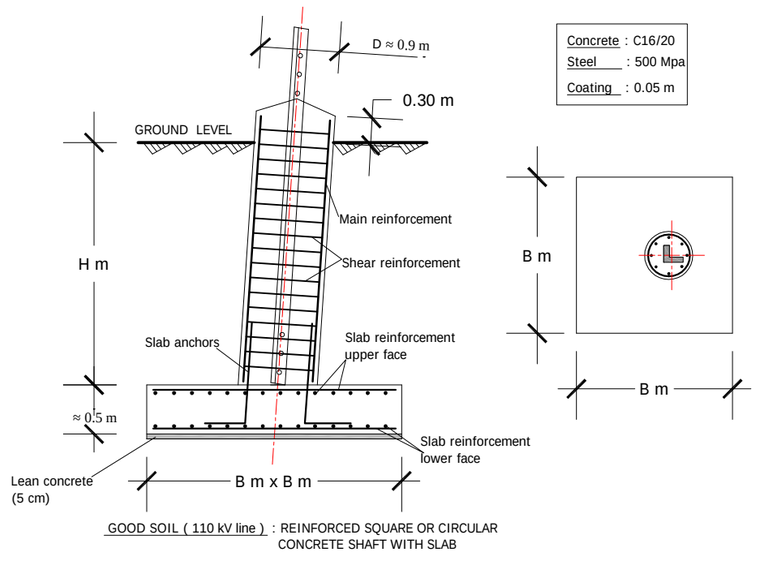
DESCRIPTION OF THE PIT	Depth (below existing ground level) cm	Soil Stratigraphy (observed in the well)	GEOTECHNICAL BEARING CAPACITIES			
			Allowable		ULS *	Ultimate
			(Mpa)	(Kpa)	(Mpa)	(Mpa)
Vegetable soil 0.00 - 0.30 m	0		0	0	0	0
	20		0.85	850	85	100
	40		0.90	900	90	125
	60		0.95	950	95	140
	80		1.00	1000	100	160
	100		0.30	300	30	60
	120		0.25	250	25	50
	140		0.20	200	20	45
	160		0.30	300	30	50
Clay of intermediate plasticity 0.30 - 4.00 m	180		0.30	300	30	45
	200		0.80	800	80	100
	220		0.80	800	80	123
	240		0.75	750	75	150
	260		0.85	850	85	180
	280		0.90	900	90	220
	300		1.00	1000	100	250
	320		0.95	950	95	280
	340		1.00	1000	100	320
	360		1.15	1150	115	380
	380		1.50	1500	150	500
	400					
	420					
	440					
	460					
	480					
	500					
	520					
	540					
	560					
	580					
	600					
	620					
	640					
	660					
	680					
	700					
	720					
	740					
	760					
	780					
	800					
	820					

* ULS : Ultimate Limit State

EXCAVATION (test pit)

EXCAVATED SOIL

FOUNDATION TYPE



GOOD SOIL (110 kV line) : REINFORCED SQUARE OR CIRCULAR CONCRETE SHAFT WITH SLAB

THE FOUNDATION DIMENSIONS COMPLY WITH THE STATIC BALANCE OF TOWER FIXING .

Soil investigation point	Extraction depth of the sample	Classification according USCS	Observation	ENGINEERING PROPERTIES		EXCAVATION CONDITION	GEOLOGICAL UNIT Light penetrometer (GeoMIL 50 kN SPT), test without soil coring for sample taking
SIP 186 (110 kV line Jabana - Birembo)	3.70 - 4.00 m	Clayey gravel poorly grded (GC)	Lateritic zone	- IP : 16.4 - Consistency Ic = 1.52 > 1 : very consistent ground - Compaction Backfill : . γ_{dOPM} = 1.93 t / m^3 . W_{OPM} = 15.88 % - Natural soil : . γ_h = 1.90 t / m^3 . $W_{(N)}$ = 18.4 % . γ_s = 2.90 t /m^3	- Shear test : . Cuu = 23 kN /m^2 . ψ_{uu} = 26.57° - Chemical analysis : . pH = 6.44 . SO_4^{2} = 68.4 mg / L . Cl^- = 113.4 mg / L	Picks and shovels can be used.	

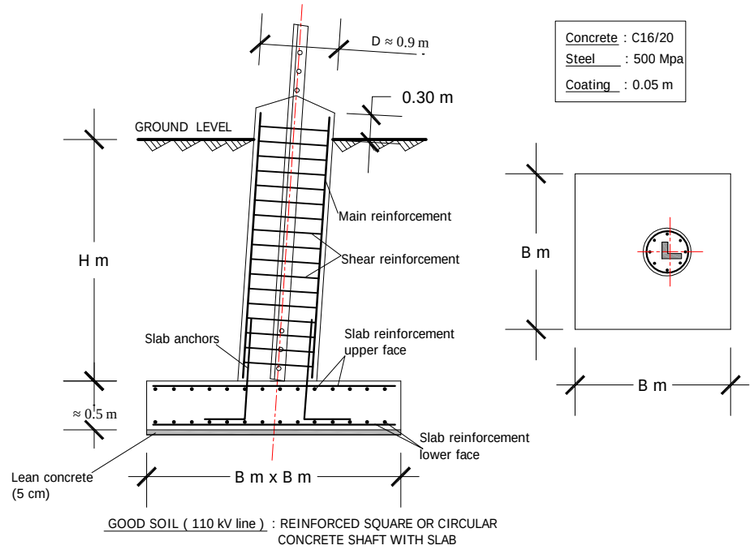
DESCRIPTION OF THE PIT	Depth (below existing ground level) cm	Soil Stratigraphy (observed in the well)	GEOTECHNICAL BEARING CAPACITIES			
			Allowable		ULS *	Ultimate
			(Mpa)	(Kpa)	(Mpa)	(Mpa)
	0		0	0	0	0
Vegetable soil 0.00 - 0.50 m	20		0.10	100	10	25
	40		0.20	200	20	35
	60		0.45	450	45	70
	80		0.30	300	30	55
	100		1.05	1050	105	290
	120		1.35	1350	135	420
	140		1.50	1500	150	500
	160					
	180					
Clayey gravel poorly grded 0.50 - 4.00 m	200					
	220					
	240					
	260					
	280					
	300					
	320					
	340					
	360					
	380					
	400					
	420					
	440					
	460					
	480					
	500					
	520					
	540					
	560					
	580					
	600					
	620					
	640					
	660					
	680					
	700					
	720					
	740					
	760					
	780					
	800					
	820					

* ULS : Ultimate Limit State

EXCAVATION (test pit)

EXCAVATED SOIL

FOUNDATION TYPE



GOOD SOIL (110 kV line) : REINFORCED SQUARE OR CIRCULAR CONCRETE SHAFT WITH SLAB

THE FOUNDATION DIMENSIONS COMPLY WITH THE STATIC BALANCE OF TOWER FIXING .

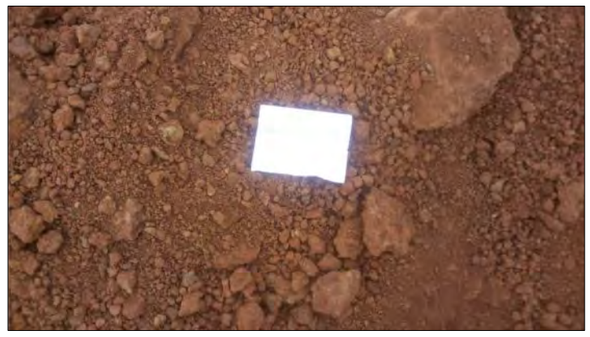
Soil investigation point	Extraction depth of the sample	Classification according USCS	Observation	ENGINEERING PROPERTIES		EXCAVATION CONDITION	GEOLOGICAL UNIT Light penetrometer (GeoMIL 50 kN SPT), test without soil coring for sample taking
SIP 187 (110 kV line Jabana - Birembo)	3.60 - 4.00 m	Clay of intermediate plasticity (CI)	Clayey soil	- IP : 19.6 - Consistency Ic = 1.28 > 1 : very consistent ground - Compaction Backfill : . γ_{dOPM} = 1.87 t / m^3 . W_{OPM} = 16.54 % - Natural soil : . γ_h = 1.72 t / m^3 . $W_{(N)}$ = 19.0 % . γ_s = 2.85 t / m^3	- Shear test : . Cuu = 39 kN / m^2 . ψ_{uu} = 20.56° - Chemical analysis : . pH = 5.42 . SO_4^{2} = 10.9 mg / L . Cl^- = 92.2 mg / L	Picks and shovels can be used.	

DESCRIPTION OF THE PIT	Depth (below existing ground level) cm	Soil Stratigraphy (observed in the well)	GEOTECHNICAL BEARING CAPACITIES			
			Allowable		ULS *	Ultimate
			(Mpa)	(Kpa)	(Mpa)	(Mpa)
Vegetable soil 0.00 - 0.20 m	0		0	0	0	0
	20		0.15	150	15	20
	40		0.25	250	25	45
	60		0.65	650	65	110
	80		1.00	1000	100	270
	100		1.05	1050	105	380
	120		1.30	1300	130	410
	140		1.50	1500	150	500
Clay of intermediate plasticity 0.20 - 4.00 m	160					
	180					
	200					
	220					
	240					
	260					
	280					
	300					
	320					
	340					
	360					
	380					
	400					
	420					
	440					
	460					
	480					
	500					
	520					
	540					
	560					
	580					
	600					
	620					
	640					
	660					
	680					
	700					
	720					
	740					
	760					
	780					
	800					
	820					

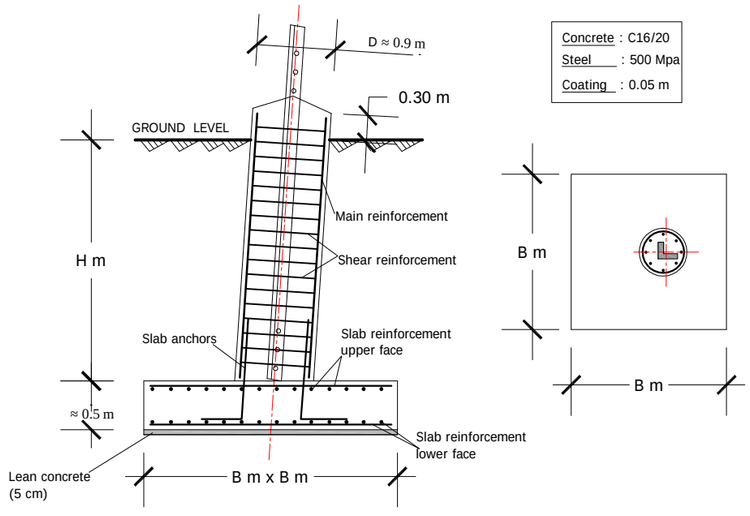
* ULS : Ultimate Limit State

EXCAVATION (test pit)

EXCAVATED SOIL

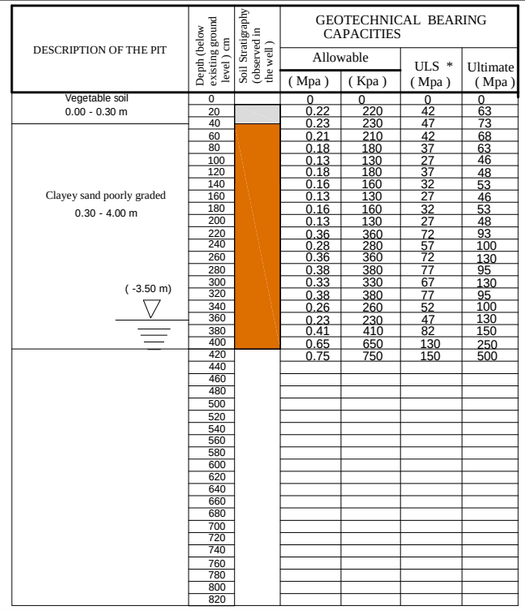


FOUNDATION TYPE



GOOD SOIL (110 kV line) : REINFORCED SQUARE OR CIRCULAR CONCRETE SHAFT WITH SLAB

THE FOUNDATION DIMENSIONS COMPLY WITH THE STATIC BALANCE OF TOWER FIXING .

Soil investigation point	Extraction depth of the sample	Classification according USCS	Observation	ENGINEERING PROPERTIES		EXCAVATION CONDITION	GEOLOGICAL UNIT Light penetrometer (GeoMIL 50 kN SPT), test without soil coring for sample taking
SIP 189 (110 kV line Jabana - Birembo)	3.50 - 4.00 m	Clayey sand poorly graded (SC)	Sandy soil & Swampy area	- IP : 17.2 - Consistency Ic = 1.28 > 1 : very consistent ground - Compaction Backfill : . γ_{d}^{OPM} = 1.97 t / m^3 . W_{OPM} = 14.40 % - Natural soil : . γ_h = 1.80 t / m^3 . $W_{(N)}$ = 16.0 % . γ_s = 2.85 t / m^3	- Shear test : . Cuu = 37 kN / m^2 . ψ_{uu} = 22.29° - Chemical analysis : . pH = 7.24 . SO_4^{2} = 65.9 mg / L . Cl^- = 70.9 mg / L	Picks and shovels can be used.	

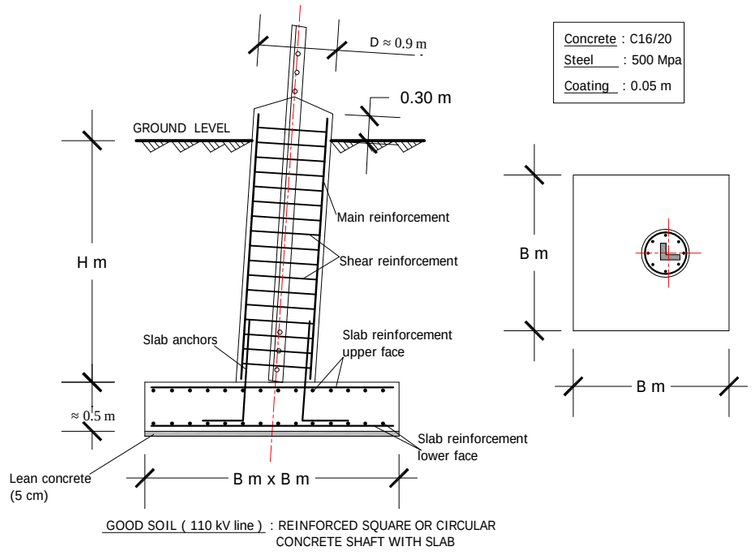
* ULS : Ultimate Limit State

EXCAVATION (test pit)

EXCAVATED SOIL

63

FOUNDATION TYPE



GOOD SOIL (110 kV line) : REINFORCED SQUARE OR CIRCULAR CONCRETE SHAFT WITH SLAB

THE FOUNDATION DIMENSIONS COMPLY WITH THE STATIC BALANCE OF TOWER FIXING .

Soil investigation point	Extraction depth of the sample	Classification according USCS	Observation	ENGINEERING PROPERTIES		EXCAVATION CONDITION	GEOLOGICAL UNIT Light penetrometer (GeoMIL 50 kN SPT), test without soil coring for sample taking
SIP 190 (110 kV line Jabana - Birembo)	3.00 - 3.50 m	Clayey sand poorly graded (SC)	Sandy soil & Swampy area	- IP : 18.2 - Consistency Ic = 1.30 > 1 : very consistent ground - Compaction Backfill : . $\gamma_{d^{OPM}}$ = 1.88 t / m^3 . W_{OPM} = 17.01 % - Natural soil : . γ_h = 2.01 t / m^3 . $W_{(N)}$ = 16.0 % . γ_s = 2.88 t / m^3	- Shear test : . Cuu = 22 kN / m^2 . ψ_{uu} = 25.64° - Chemical analysis : . pH = 4.81 . SO_4^{2} = 62.6 mg / L . Cl^- = 99.3 mg / L	Picks and shovels can be used.	

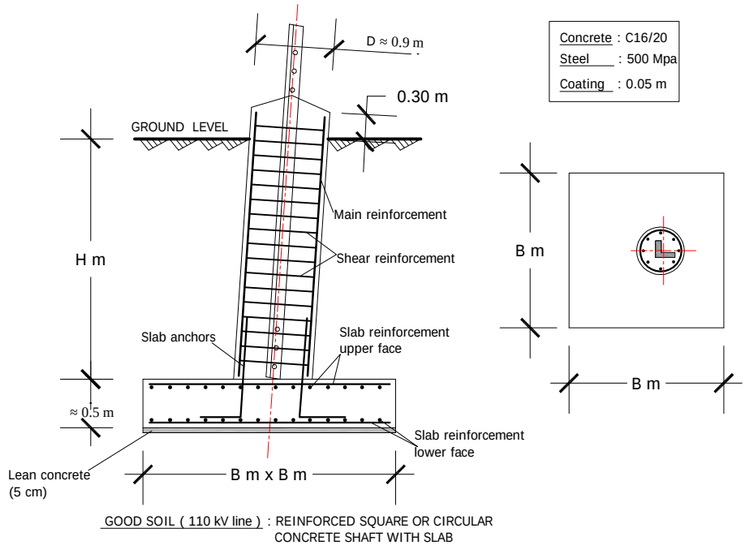
DESCRIPTION OF THE PIT	Depth (below existing ground level) cm	Soil Stratigraphy (observed in the well)	GEOTECHNICAL BEARING CAPACITIES			
			Allowable		ULS *	Ultimate
			(Mpa)	(Kpa)	(Mpa)	(Mpa)
Vegetable soil 0.00 - 0.30 m	0		0	0	0	0
	20		0.23	230	46	62
	40		0.19	190	39	52
	60		0.18	180	36	47
	80		0.13	130	26	45
	100		0.10	100	21	42
	120		0.21	210	43	62
	140		0.15	150	31	55
Clayey sand poorly graded 0.30 - 4.00 m	160		0.30	300	61	82
	180		0.30	300	71	97
	200		0.35	350	71	102
	220		0.40	400	81	110
	240		0.45	450	91	125
	260		0.50	500	101	180
	280		0.35	350	71	200
	300		0.45	450	91	220
(-3.50 m)	320		0.45	450	91	235
	340		0.47	470	95	260
	360		0.52	520	105	380
	380		0.75	750	150	500
	400					
	420					
	440					
	460					
	480					
	500					
	520					
	540					
	560					
	580					
	600					
	620					
	640					
	660					
	680					
	700					
	720					
	740					
	760					
	780					
	800					
	820					

* ULS : Ultimate Limit State

EXCAVATION (test pit)

EXCAVATED SOIL

FOUNDATION TYPE



GOOD SOIL (110 kV line) : REINFORCED SQUARE OR CIRCULAR CONCRETE SHAFT WITH SLAB

THE FOUNDATION DIMENSIONS COMPLY WITH THE STATIC BALANCE OF TOWER FIXING .

Soil investigation point	Extraction depth of the sample	Classification according USCS	Observation	ENGINEERING PROPERTIES		EXCAVATION CONDITION	GEOLOGICAL UNIT Light penetrometer (GeoMIL 50 kN SPT), test without soil coring for sample taking
SIP 195 (110 kV line Jabana - Birembo)	3.60 - 4.00 m	Clayey sand poorly graded (SC)	Sandy soil & Swampy area	- IP : 16.5 - Consistency Ic = 1.44 > 1 : very consistent ground - Compaction Backfill : . $\gamma_{d^{OPM}}$ = 1.91 t / m^3 . W_{OPM} = 16.40 % - Natural soil : . γ_h = 1.97 t / m^3 . $W_{(N)}$ = 16.6 % . γ_S = 2.88 t / m^3	- Shear test : . Cuu = 18 kN / m^2 . ψ_{uu} = 27.70° - Chemical analysis : . pH = 4.81 . SO_4^{2} = 62.6 mg / L . Cl^- = 99.3 mg / L	Picks and shovels can be used.	

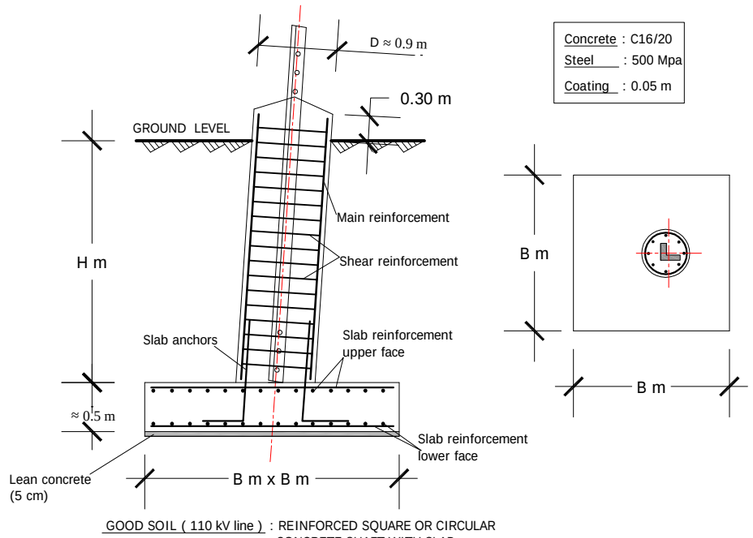
DESCRIPTION OF THE PIT	Depth (below existing ground level) cm	Soil Stratigraphy (observed in the well)	GEOTECHNICAL BEARING CAPACITIES			
			Allowable		ULS *	Ultimate
			(Mpa)	(Kpa)	(Mpa)	(Mpa)
Vegetable soil 0.00 - 0.30 m	0		0	0	0	0
	20		0.25	250	25	35
	40		0.20	200	20	45
	60		0.15	150	15	30
Clayey sand poorly graded 0.30 - 4.00 m	80		0.90	900	90	125
	100		1.00	1000	100	160
	120		1.20	1200	120	420
	140		1.50	1500	150	500
	160					
	180					
	200					
	220					
	240					
	260					
	280					
	300					
	320					
	340					
	360					
	380					
	400					
	420					
	440					
	460					
	480					
	500					
	520					
	540					
	560					
	580					
	600					
	620					
	640					
	660					
	680					
	700					
	720					
	740					
	760					
	780					
	800					
	820					

* ULS : Ultimate Limit State

EXCAVATION (test pit)

EXCAVATED SOIL

FOUNDATION TYPE



GOOD SOIL (110 kV line) : REINFORCED SQUARE OR CIRCULAR CONCRETE SHAFT WITH SLAB

THE FOUNDATION DIMENSIONS COMPLY WITH THE STATIC BALANCE OF TOWER FIXING .

Soil investigation point	Extraction depth of the sample	Classification according USCS	Observation	ENGINEERING PROPERTIES		EXCAVATION CONDITION	GEOLOGICAL UNIT Light penetrometer (GeoMIL 50 kN SPT), test without soil coring for sample taking
SIP 196 (110 kV line Jabana - Birembo)	3.70 - 4.00 m	Clay of intermediate plasticity (CI)	Sandy soil	- IP : 20.26 - Consistency Ic = 1.13 > 1 : very consistent ground - Compaction Backfill : . γ_{d}^{OPM} = 1.89 t / m^3 . W_{OPM} = 16.21 % - Natural soil : . γ_h = 1.89 t / m^3 . $W_{(N)}$ = 18.8 % . γ_S = 2.81 t / m^3	- Shear test : . Cuu = 30 kN / m^2 . ψ_{uu} = 25.41° - Chemical analysis : . pH = 6.11 . SO_4^{2} = 24 mg / L . Cl^- = 202.4 mg / L	Picks and shovels can be used.	

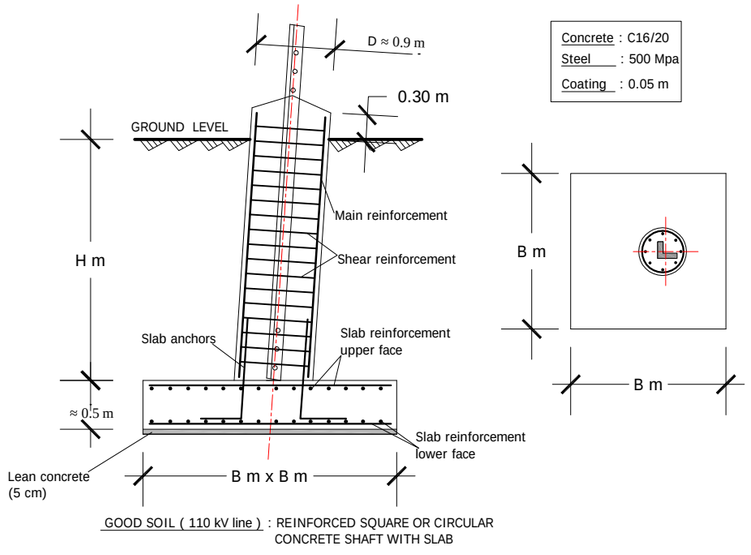
DESCRIPTION OF THE PIT	Depth (below existing ground level) cm	Soil Stratigraphy (observed in the well)	GEOTECHNICAL BEARING CAPACITIES			
			Allowable		ULS *	Ultimate
			(Mpa)	(Kpa)	(Mpa)	(Mpa)
Vegetable soil 0.00 - 0.50 m	0		0	0	0	0
	20		0.30	300	30	40
	40		0.40	400	40	65
	60		0.25	250	25	45
	80		0.75	750	75	120
	100		0.95	950	95	200
	120		1.00	1000	100	300
	140		1.10	1100	110	380
	160		1.50	1500	150	500
	180					
	200					
Clay of intermediate plasticity 0.50 - 4.00 m	220					
	240					
	260					
	280					
	300					
	320					
	340					
	360					
	380					
	400					
	420					
	440					
	460					
	480					
	500					
	520					
	540					
	560					
	580					
	600					
	620					
	640					
	660					
	680					
	700					
	720					
	740					
	760					
	780					
	800					
	820					

* ULS : Ultimate Limit State

EXCAVATION (test pit)

EXCAVATED SOIL

FOUNDATION TYPE



GOOD SOIL (110 kV line) : REINFORCED SQUARE OR CIRCULAR CONCRETE SHAFT WITH SLAB

THE FOUNDATION DIMENSIONS COMPLY WITH THE STATIC BALANCE OF TOWER FIXING .

V. GENERAL CONCLUSION

1) Soil as support structure.

The presence of clay being general in all the soil structures we have studied ; caution is importante in defining the bearing capacity of each lot.

Instead of the safety coefficient of 0.33 used by the laboratory ; we propose a coefficient of 0.01 which takes account of this harmful presence, in a tropical environment.

Indeed, if these studies were carried out during the dry season, the works will be carried out in all seasons and any earthwork will be confronted to a presence of water large enough in the rainy season.

It is strictly prudent to protect the works from any field sensitivity, as the index of plasticity varies from 14.8 % to 21.9 % , although the cohesion is acceptable (the internal friction angle sometimes exceeding 30°).

Apart a few cases requiring special treatment (as unconfined compressive strenght), from a depth of 100 cm, a bearing capacity of 200 kN / m2 can be , safety, envisaged for the entire project ; with the exception of flood areas where the bearing capacity is lower as indicated above.
This wouId be in the interest of the project whose foundations, for posts and for towers, are laid at more than 2.00 m depth.

(Nota / penetration test sheet :
Rt : total resistance, Rp : resistance to the tip and Qadm : bearing capacity).

2) Soil as building material.

Set up by backfill, soils must protect the works of all lifting and overturn.

The characteristics data from these studies attribute those qualities to examined soils ; indeed :

- The dry density $\gamma d_{OPM} \geq 1.67$ t /m^3
- The internal friction angle is greater than 20 ° for the majority of points (the shear strength is proportional to soil consolidation).
- The unconfined compressive strength gives good resistances (≥ 1.48 Mpa) to the compression pressure and good density (≥ 1.71 t / m3).
- No soil presents no aggression against cement (4.62 ≤ pH ≤ 7.3).

3) All the results of the tests imposed on soils allows to classify them into three categories :

a. Good soil, including :
- Clay of Intermediate plasticity ,
- Silty Sand ,
- Clayey Sand .

b. Soft rock, including :
- weathered rock,
- silty gravel,
- clayey gravel,
- semi rock soil.

c. Poor soils with water (or not) :
These soils are located in swampies areas or in any other areas which can be fllooded .

4) Remarque

Any anomalies observed in the performance of the results given above must be reported to an expert for advices and interpretation.

REPUBLIC OF RWANDA
MINISTRY OF INFRASTRUCTURE

Execution Agency :

Japan International Coorporation Agency

Buyer :

Consultant :

CONSULTING ENGINEERS & ARCHITECTS
YACHIYO ENGINEERING CO., LTD.

Project :

IMPROVEMENT OF SUBSTATIONS AND DISTRIBUTION NETWORK, PHASE 3, IN THE REPUBLIC OF RWANDA

SOIL INVESTIGATIONS

FILE 2 / 2

KIGALI, August 2017

IMPROVEMENT OF SUBSTATIONS AND DISTRIBUTION NETWORK, PHASE 3, JICA PROJECT.

SOIL INVESTIGATION (File 2 / 2 : Field & laboratory tests)

CONTENT

IMPROVEMENT OF SUBSTATIONS AND DISTRIBUTION NETWORK, PHASE 3, JICA PROJECT.

SOIL INVESTIGATION (File 2 / 2 : Field & laboratory tests)

I. LIGHT STATIC PENETRATION TESTS (on 46 points)

- New substation construction site & branch point line 110 kV at Gasogi (3 points) : Sip1 , Sip3, Sip5

- 15 kV Distribution line Gasogi substation - Nyagasambu (15 points) : Sip1 , Sip2, Sip3, Sip4, Sip5, Sip6, Sip Sip 9, Sip10, Sip11, Sip12, Sip13, Sip15, Sip16 & Sip17 .

- 15 kV Distribution line Gasogi substation - Masaka hospital (15 points) : Sip1 , Sip3, Sip4, Sip5, Sip6, Sip8, Sip 9, Sip10, Sip12, Sip13, Sip15, Sip16, Sip17, Sip18 & Sip19.

- Reconstruction of transmission 110 kV line Jabana - Birembo (13 points) : Sip176 , Sip177, Sip178, Sip180, Sip181, Sip182, Sip184, Sip186, Sip187, Sip189, Sip190, Sip195, Sip196 .

UNIVERSITY OF RWANDA - COLLEGE OF SCIENCE AND TECHNOLOGY (Huye Campus)
SCHOOL OF ENGINEERING
CIVIL ENGINEERING DEPARTMENT
LABORATORY OF GEOTECHNICS

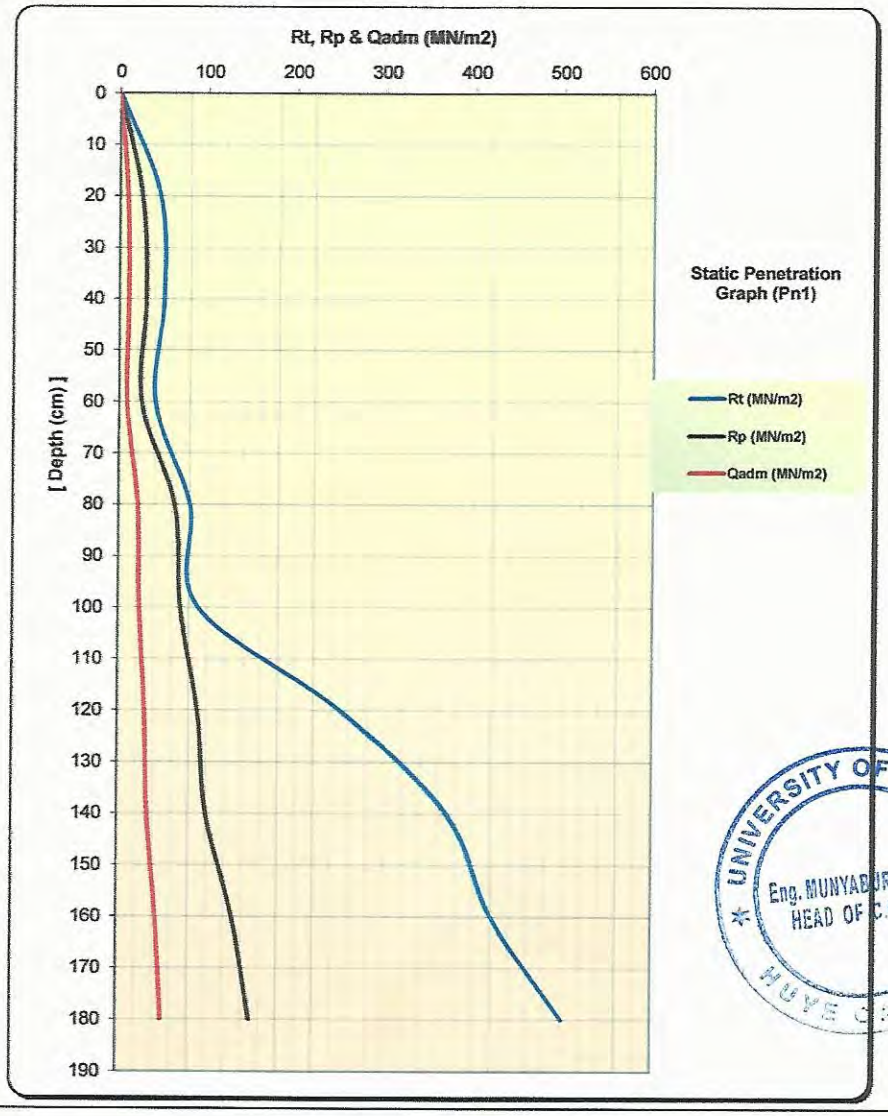
PROJECT: IMPROVEMENT OF SUBSTATION & DISTRIBUTION NETWORK - PHASE III

SUB PROJECT: New Substation Construction Site

Client: PITRAD IBAMBA LTD.
Operated by: Eng. Venerand GWIZA
Verified by: Eng. Vivien MUNYABURANGA (MSc)
Date: July, 2017

Penetration Test **N° S 1**

Depth (cm)	Rt (MN/m2)	Rp (MN/m2)	Qadm (MN/m2)	Qadm (kg/cm2)
0	0	0	0.00	0.00
20	45	25	8.33	84.98
40	50	30	10.00	101.97
60	40	25	8.33	84.98
80	80	63	21.00	214.14
100	90	70	23.33	237.93
120	250	90	30.00	305.92
140	370	100	33.33	339.91
160	420	130	43.33	441.88
180	500	150	50.00	509.86
200				



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CIVIL ENGINEERING DEPARTMENT
LABORATORY OF GEOTECHNICS

PROJECT: IMPROVEMENT OF SUBSTATION & DISTRIBUTION NETWORK - PHASE III

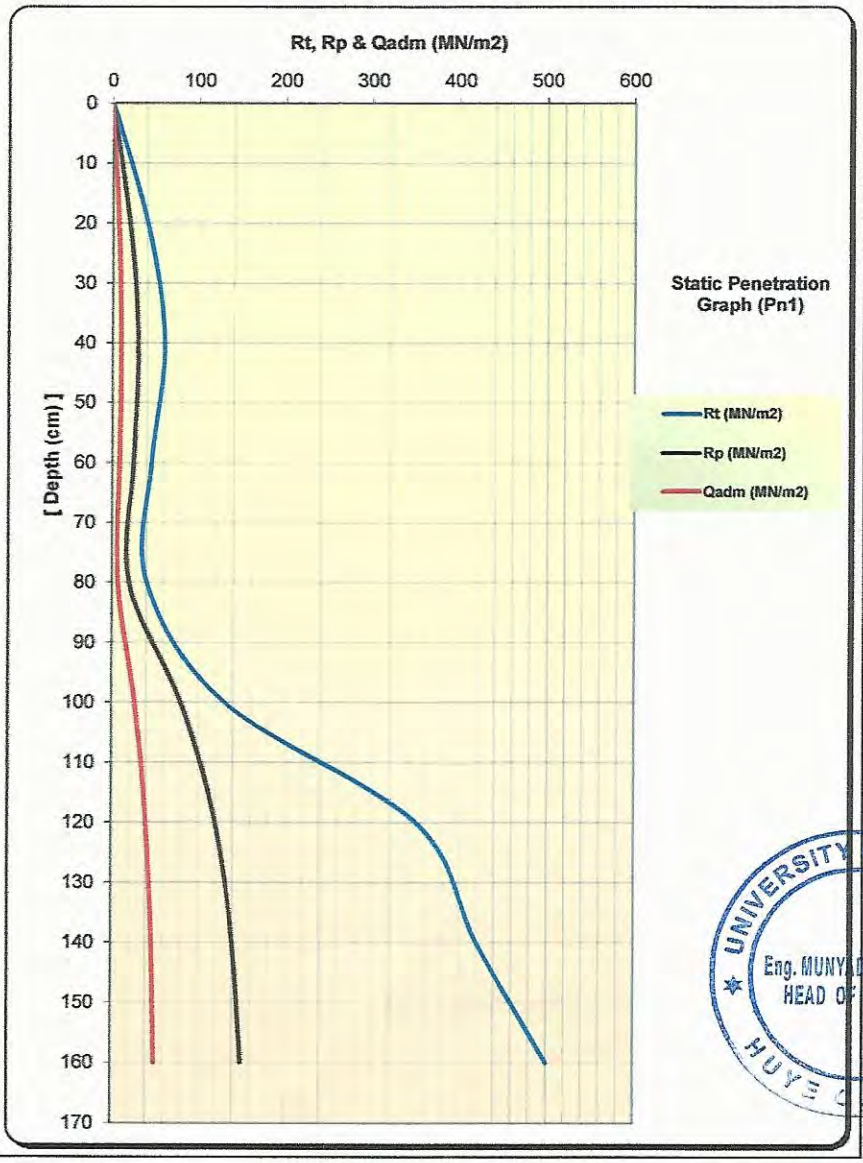
SUB PROJECT: New Substation Construction Site

Client: PITRAD IBAMBA LTD.

Operated by: Eng. Venerand GWIZA
Verified by: Eng. Vivien MUNYABURANGA (MSc)
Date: July, 2017

Penetration Test **N° S 3**

Depth (cm)	Rt (MN/m2)	Rp (MN/m2)	Qadm (MN/m2)	Qadm (kg/cm2)
0	0	0	0.00	0.00
20	40	20	6.67	67.98
40	60	30	10.00	101.97
60	45	25	8.33	84.98
80	40	20	6.67	67.98
100	130	80	26.67	271.93
120	350	120	40.00	407.89
140	420	140	46.67	475.87
160	500	150	50.00	509.86
180				



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SCHOOL OF ENGINEERING
CIVIL ENGINEERING DEPARTMENT
LABORATORY OF GEOTECHNICS

PROJECT: **IMPROVEMENT OF SUBSTATION & DISTRIBUTION NETWORK - PHASE III**

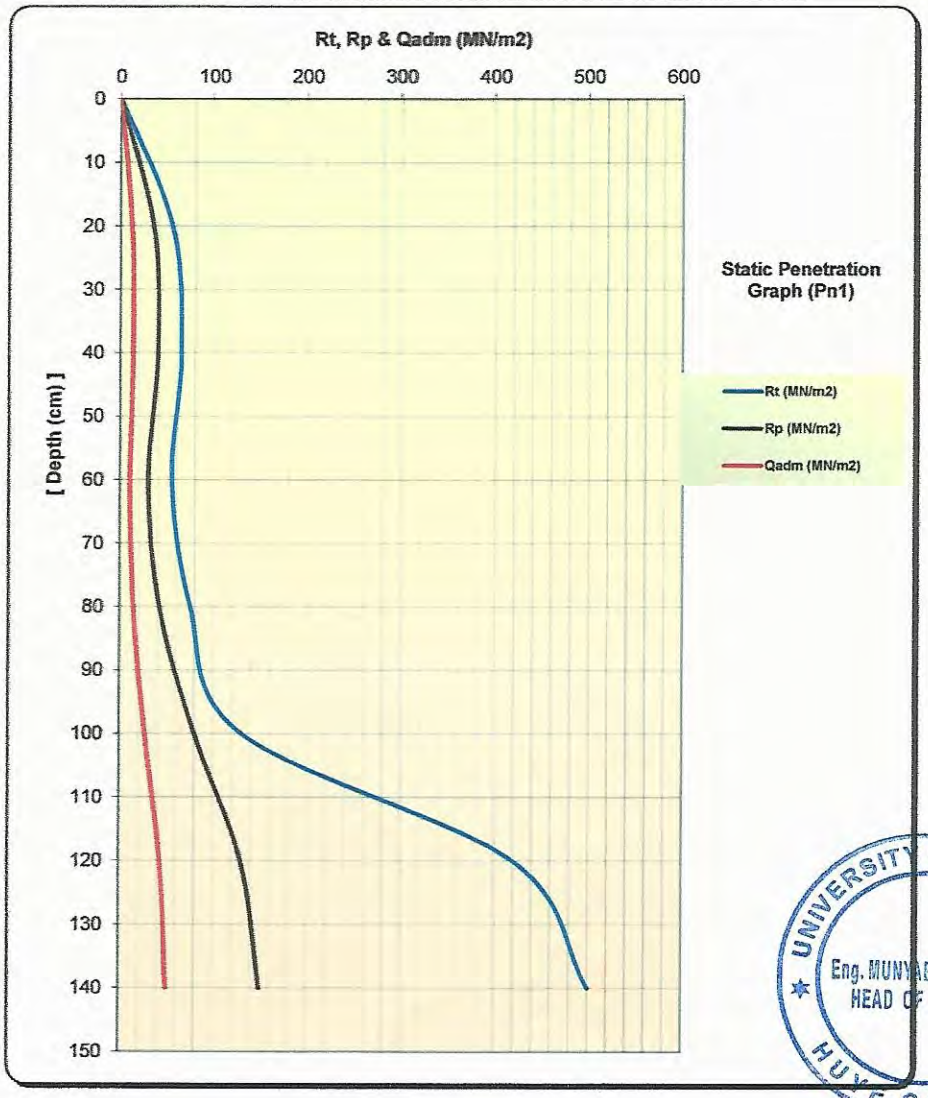
SUB PROJECT: New Substation Construction Site

Client: PITRAD IBAMBA LTD.

Operated by: Eng. Venerand GWIZA
Verified by: Eng. Vivien MUNYABURANGA (MSc)

Date: July, 2017 : S5

Depth (cm)	Rt (MN/m2)	Rp (MN/m2)	Qadm (MN/m2)	Qadm (kg/cm2)
0	0	0	0.00	0.00
20	55	35	11.67	118.97
40	65	40	13.33	135.96
60	55	30	10.00	101.97
80	75	42	14.00	142.76
100	130	80	26.67	271.93
120	420	130	43.33	441.88
140	500	150	50.00	509.86
160				



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SCHOOL OF ENGINEERING
CIVIL ENGINEERING DEPARTMENT
LABORATORY OF GEOTECHNICS

PROJECT: **IMPROVEMENT OF SUBSTATION & DISTRIBUTION NETWORK - PHASE III**

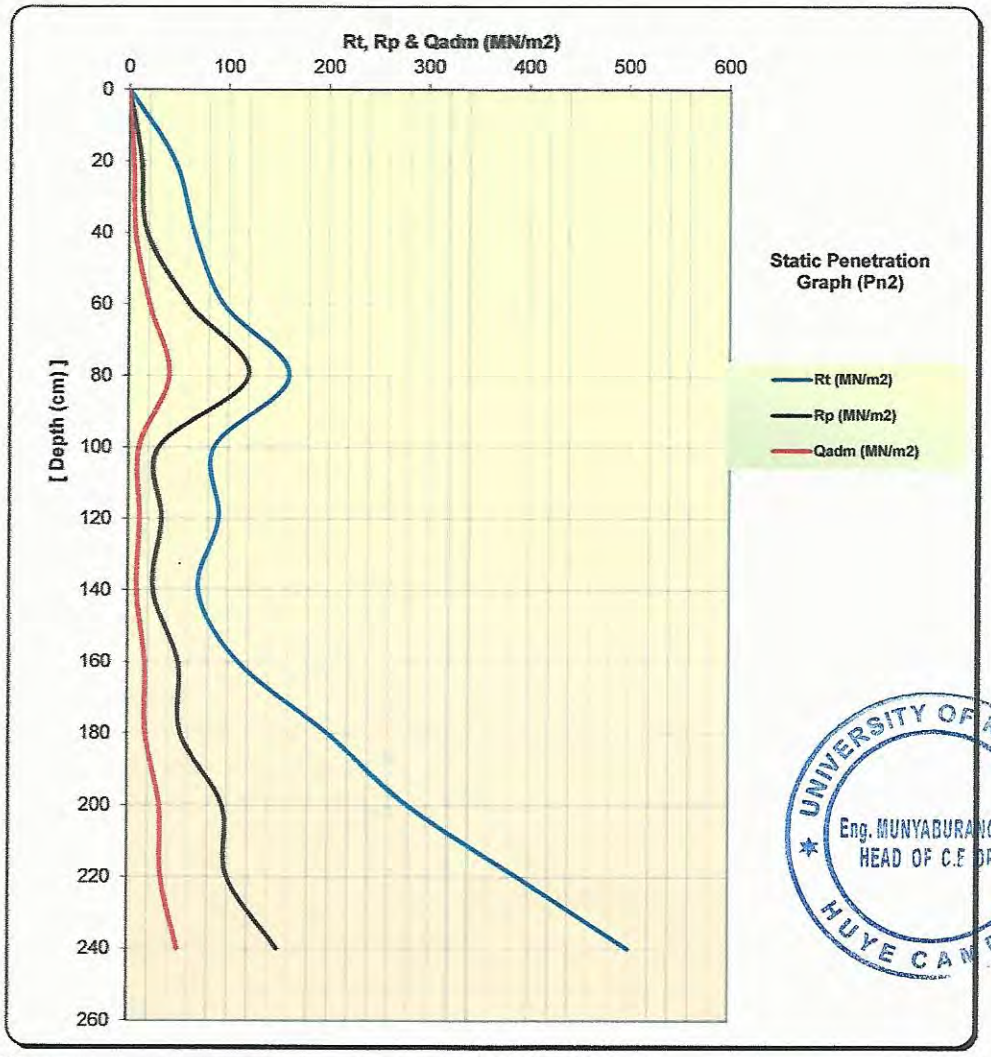
SUB PROJECT: **15 KV Distribution line Gasogi Substation - Nyagasambu**

Client: PITRAD IBAMBA LTD.

Operated by: Eng. Venerand GWIZA
Verified by: Eng. Vivien MUNYABURANGA (MSc)
Date: July, 2017

Penetration Test **N° AP 1**

Depth (cm)	Rt (MN/m2)	Rp (MN/m2)	Qadm (MN/m2)	Qadm (kg/cm2)
0	0	0	0.00	0.00
20	45	12	4.00	40.79
40	65	18	6.00	61.18
60	94	60	20.00	203.94
80	160	120	40.00	407.89
100	85	30	10.00	101.97
120	90	33	11.00	112.17
140	70	25	8.33	84.98
160	110	50	16.67	169.95
180	200	53	17.67	180.15
200	280	95	31.67	322.91
220	390	100	33.33	339.91
240	500	150	50.00	509.86
260				



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PROJECT: IMPROVEMENT OF SUBSTATION & DISTRIBUTION NETWORK - PHASE III

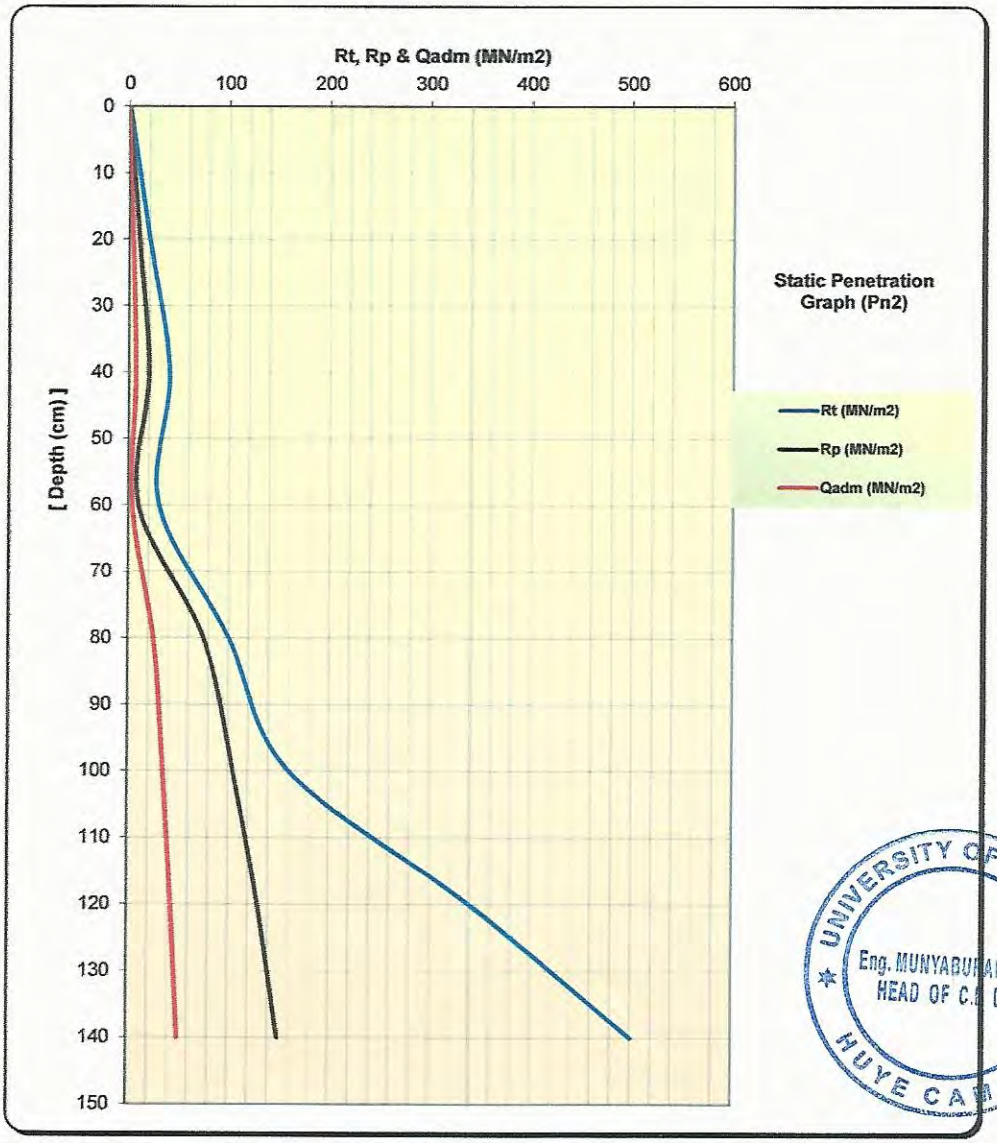
SUB PROJECT: 15 KV Distribution line Gasogi Substation - Nyagasambu

Client: PITRAD IBAMBA LTD.

Operated by: Eng. Venerand GWIZA
Verified by: Eng. Vivien MUNYABURANGA (MSc)
Date: July, 2017

Penetration Test **N° AP 2**

Depth (cm)	Rt (MN/m2)	Rp (MN/m2)	Qadm (MN/m2)	Qadm (kg/cm2)
0	0	0	0.00	0.00
20	20	10	3.33	33.99
40	40	20	6.67	67.98
60	30	10	3.33	33.99
80	100	75	25.00	254.93
100	160	105	35.00	356.90
120	340	130	43.33	441.88
140	500	150	50.00	509.86
160				



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PROJECT: **IMPROVEMENT OF SUBSTATION & DISTRIBUTION NETWORK - PHASE III**

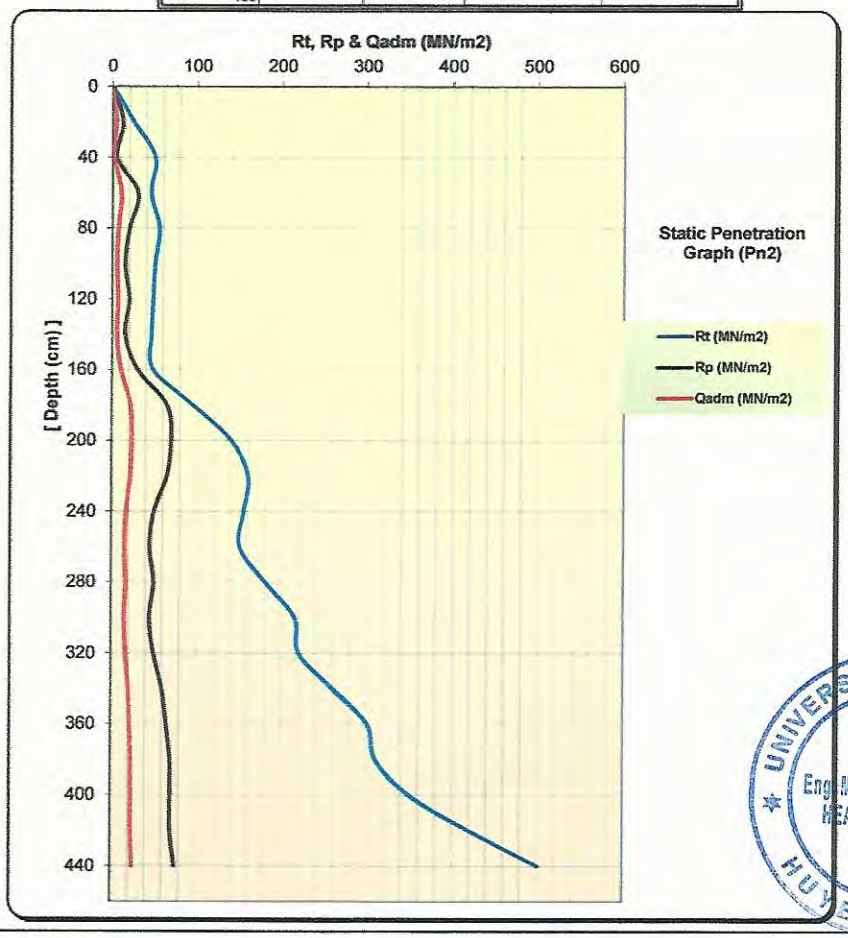
SUB PROJECT: **15 KV Distribution line Gasogi Substation - Nyagasambu**

Client: PITRAD IBAMBA LTD.

Operated by: Eng. Venerand GWIZA
Verified by: Eng. Vivien MUNYABURANGA (MSc)
Date: July, 2017

Penetration Test **N° AP 3**

Depth (cm)	Rt (MN/m2)	Rp (MN/m2)	Qadm (MN/m2)	Qadm (kg/cm2)
0	0	0	0.00	0.00
20	25	12	4.00	40.79
40	50	5	1.67	17.00
60	45	30	10.00	101.97
80	55	20	6.67	67.98
100	50	15	5.00	50.99
120	48	20	6.67	67.98
140	46	15	5.00	50.99
160	48	30	10.00	101.97
180	95	65	21.67	220.94
200	140	70	23.33	237.93
220	160	65	21.67	220.94
240	155	50	16.67	169.95
260	150	45	15.00	152.96
280	180	50	16.67	169.95
300	215	45	15.00	152.96
320	220	50	16.67	169.95
340	260	60	20.00	203.94
360	300	65	21.67	220.94
380	310	70	23.33	237.93
400	350	70	23.33	237.93
420	420	70	23.33	237.93
440	500	75	25.00	254.93
460				



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PROJECT: IMPROVEMENT OF SUBSTATION & DISTRIBUTION NETWORK - PHASE III

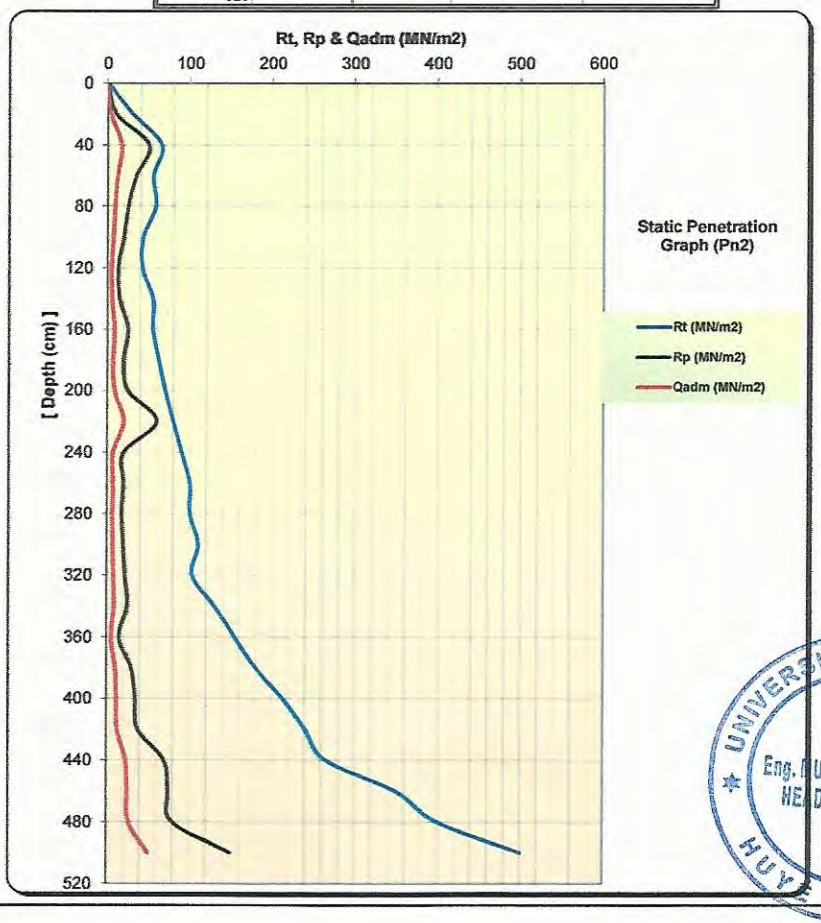
SUB PROJECT: 15 KV Distribution line Gasogi Substation - Nyagasambu

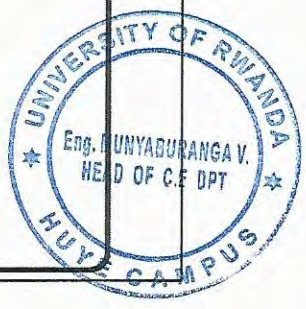
Client: PITRAD IBAMBA LTD.

Operated by: Eng. Venerand GWIZA
Verified by: Eng. Vivien MUNYABURANGA (MSc)
Date: July, 2017

Penetration Test N° AP 4

Depth (cm)	Rt (MN/m2)	Rp (MN/m2)	Qadm (MN/m2)	Qadm (kg/cm2)
0	0	0	0.00	0.00
20	30	10	3.33	33.99
40	65	50	16.67	169.95
60	55	35	11.67	118.97
80	58	25	8.33	84.98
100	43	20	6.67	67.98
120	42	13	4.33	44.19
140	55	15	5.00	50.99
160	55	25	8.33	84.98
180	62	20	6.67	67.98
200	70	25	8.33	84.98
220	80	60	20.00	203.94
240	90	20	6.67	67.98
260	100	20	6.67	67.98
280	100	18	6.00	61.18
300	110	20	6.67	67.98
320	103	22	7.33	74.78
340	130	25	8.33	84.98
360	155	15	5.00	50.99
380	180	30	10.00	101.97
400	213	35	11.67	118.97
420	240	38	12.67	129.16
440	265	70	23.33	237.93
460	350	75	25.00	254.93
480	400	80	26.67	271.93
500	500	150	50.00	509.86
520				





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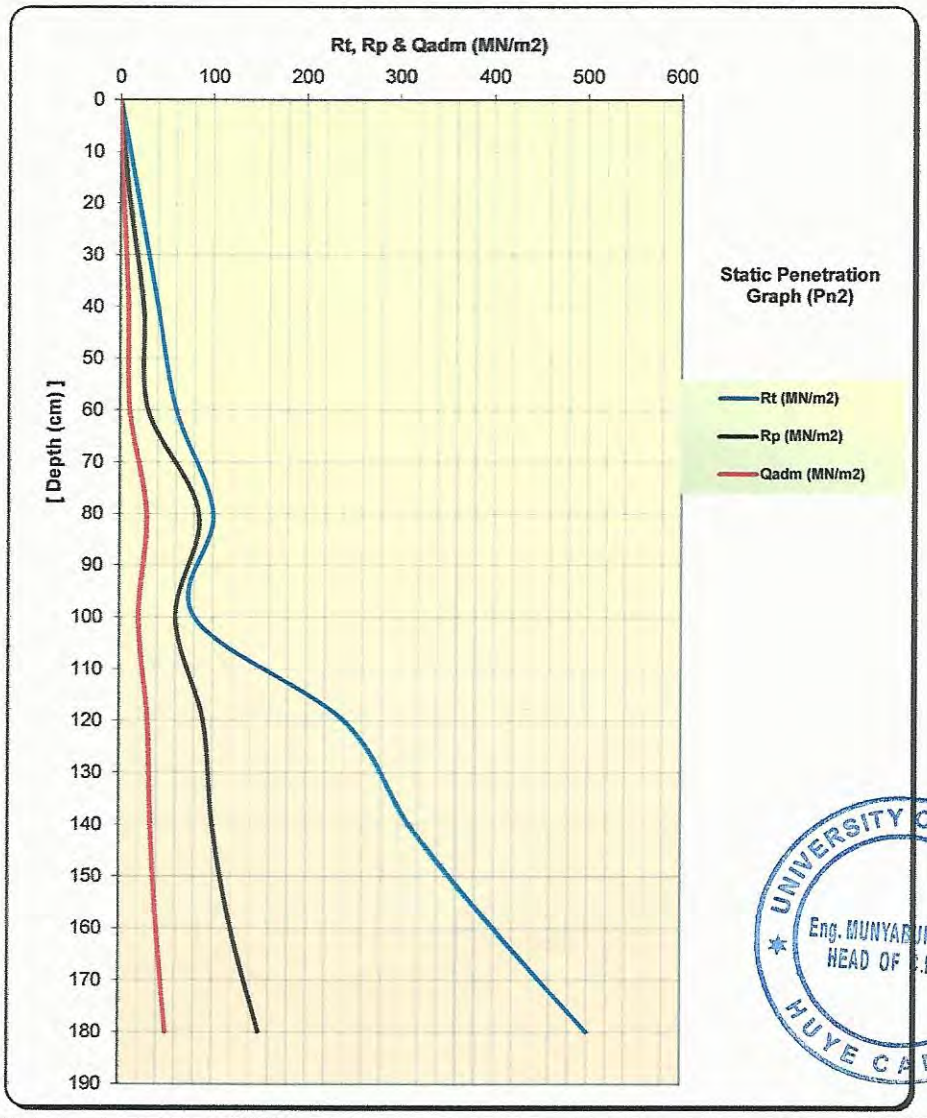
PROJECT: **IMPROVEMENT OF SUBSTATION & DISTRIBUTION NETWORK - PHASE III**

SUB PROJECT: **15 KV Distribution line Gasogi Substation - Nyagasambu**
Client: PITRAD IBAMBA LTD.

Operated by: Eng. Venerand GWIZA
Verified by: Eng. Vivien MUNYABURANGA (MSc)
Date: July, 2017

Penetration Test **N° AP 5**

Depth (cm)	Rt (MN/m2)	Rp (MN/m2)	Qadm (MN/m2)	Qadm (kg/cm2)
0	0	0	0.00	0.00
20	20	10	3.33	33.99
40	40	25	8.33	84.98
60	60	30	10.00	101.97
80	100	85	28.33	288.92
100	80	60	20.00	203.94
120	240	90	30.00	305.92
140	310	100	33.33	339.91
160	400	120	40.00	407.89
180	500	150	50.00	509.86
200				



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PROJECT: **IMPROVEMENT OF SUBSTATION & DISTRIBUTION NETWORK - PHASE III**

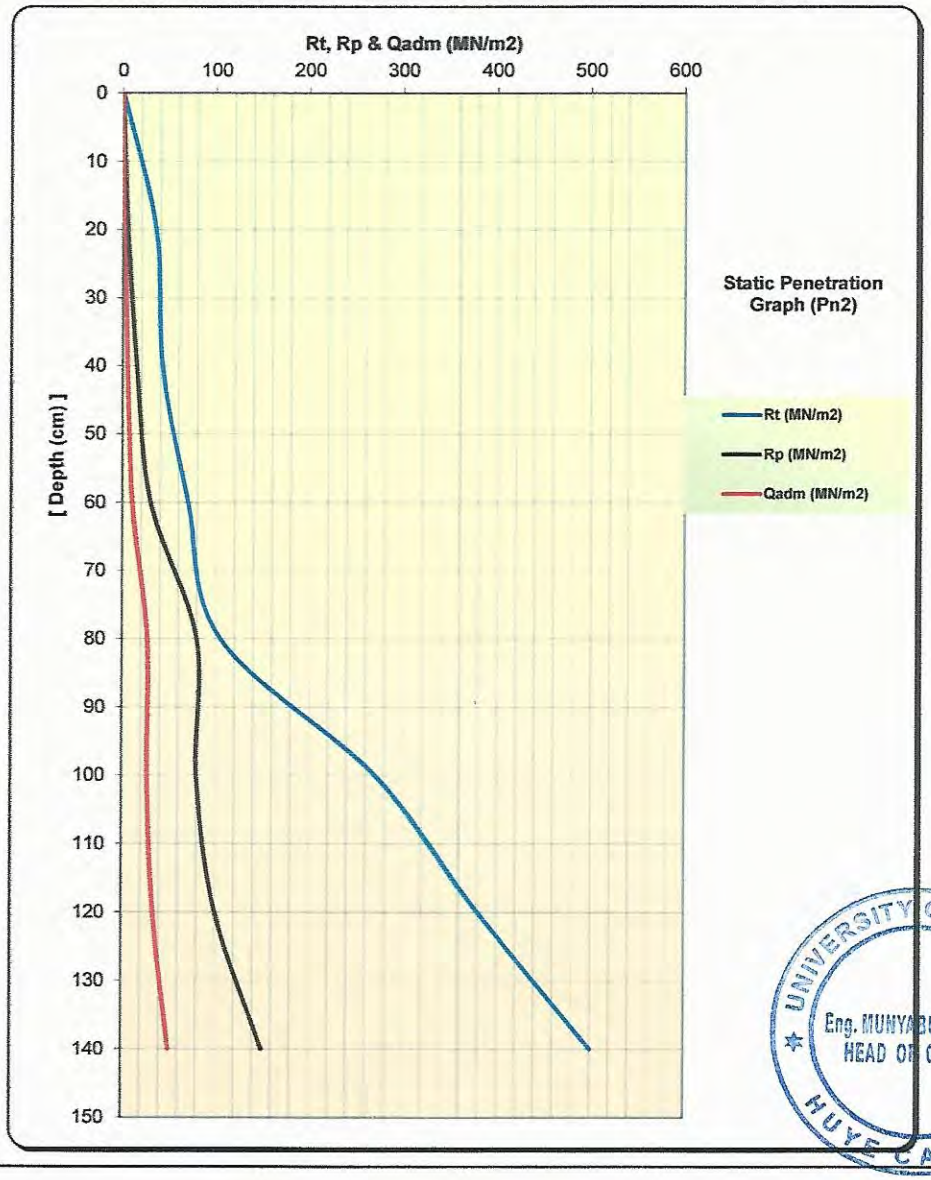
SUB PROJECT: **15 KV Distribution line Gasogi Substation - Nyagasambu**

Client: PITRAD IBAMBA LTD.

Operated by: Eng. Venerand GWIZA
Verified by: Eng. Vivien MUNYABURANGA (MSc)
Date: July, 2017

Penetration Test **N° AP 6**

Depth (cm)	Rt (MN/m2)	Rp (MN/m2)	Qadm (MN/m2)	Qadm (kg/cm2)
0	0	0	0.00	0.00
20	35	5	1.67	17.00
40	42	15	5.00	50.99
60	70	30	10.00	101.97
80	105	80	26.67	271.93
100	270	80	26.67	271.93
120	380	100	33.33	339.91
140	500	150	50.00	509.86
160				



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PROJECT: **IMPROVEMENT OF SUBSTATION & DISTRIBUTION NETWORK - PHASE III**

SUB PROJECT: **15 KV Distribution line Gasogi Substation - Nyagasambu**

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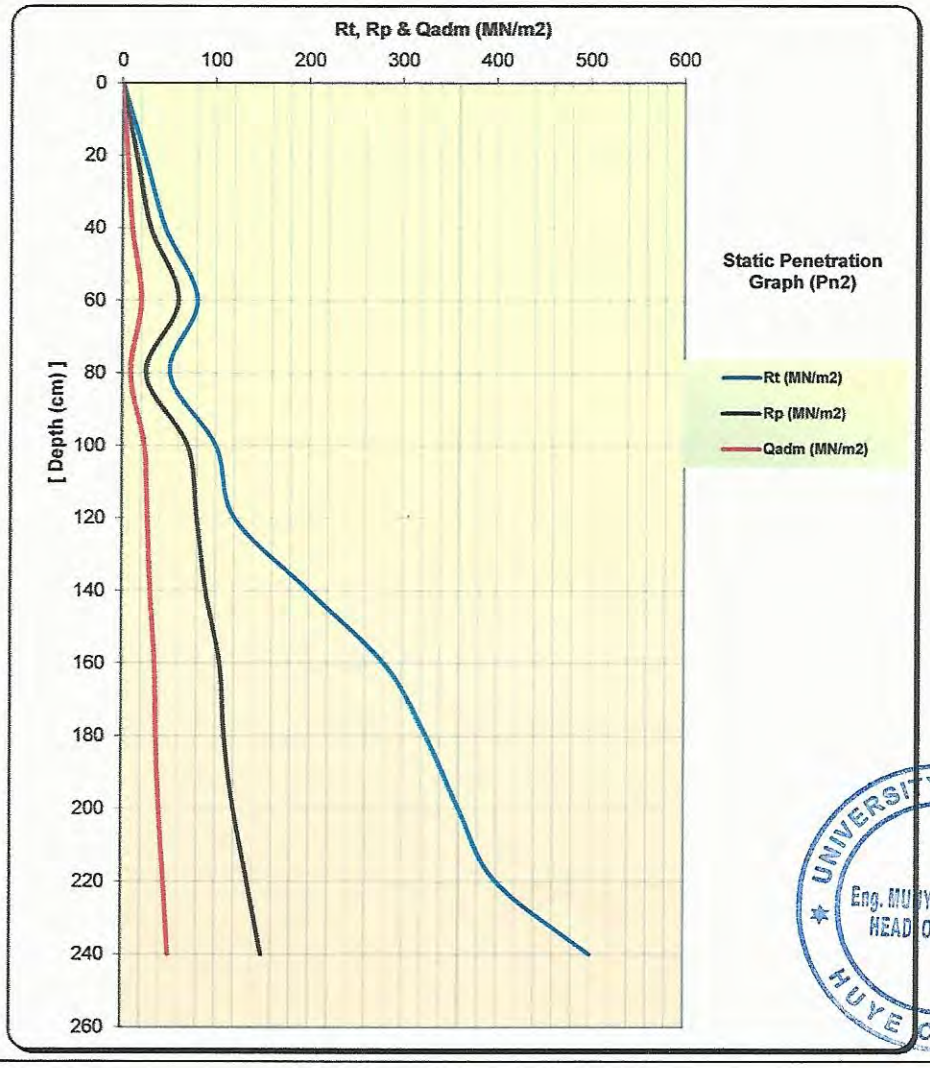
Date: July, 2017

Penetration Test **N° AP 7**

Depth (cm)	Rt (MN/m2)	Rp (MN/m2)	Qadm (MN/m2)	Qadm (kg/cm2)
0	0	0	0.00	0.00
20	23	15	5.00	50.99
40	45	30	10.00	101.97
60	80	60	20.00	203.94
80	50	25	8.33	84.98
100	100	70	23.33	237.93
120	120	80	26.67	271.93
140	200	90	30.00	305.92
160	280	105	35.00	356.90
180	325	110	36.67	373.90
200	360	120	40.00	407.89
220	400	135	45.00	458.87
240	500	150	50.00	509.86
260				



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PROJECT: **IMPROVEMENT OF SUBSTATION & DISTRIBUTION NETWORK - PHASE III**

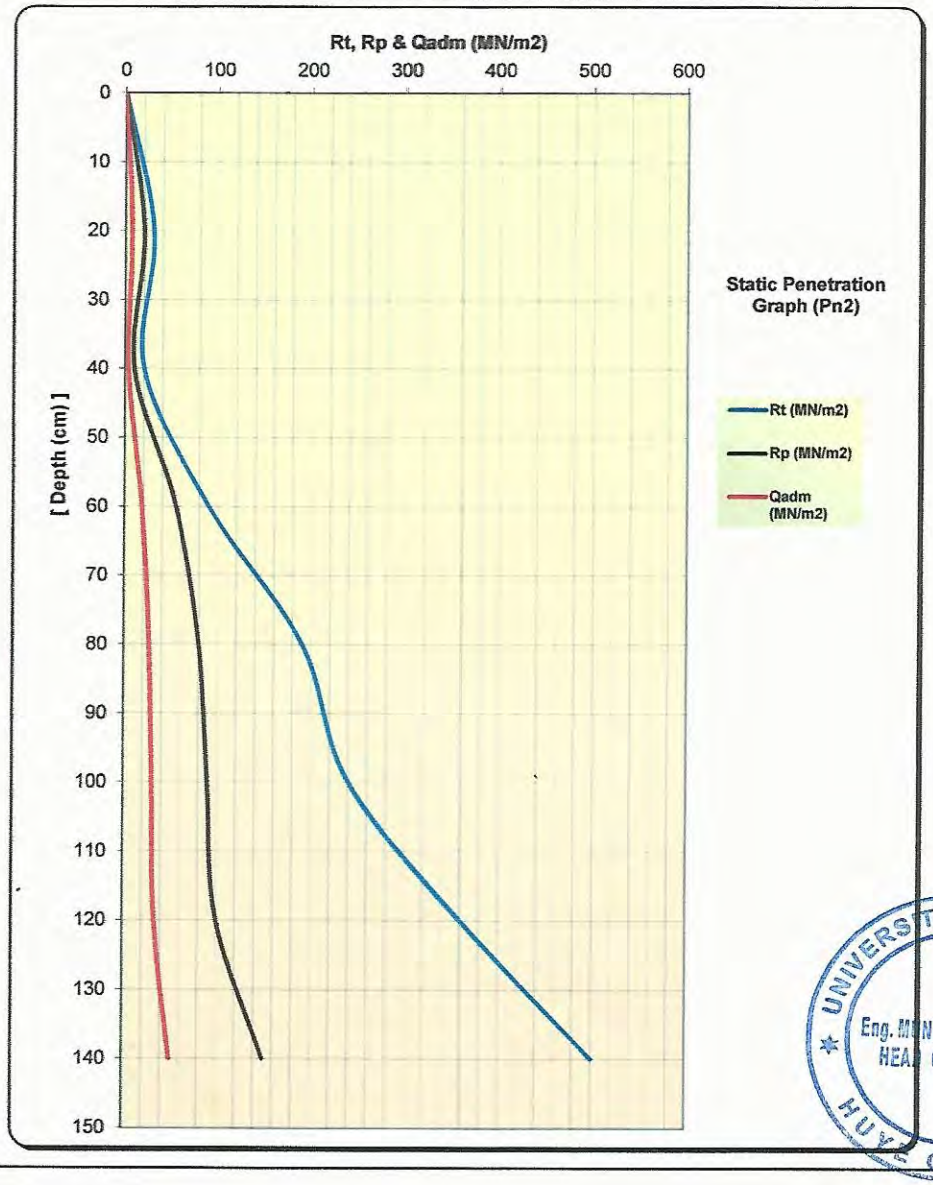
SUB PROJECT: **15 KV Distribution line Gasogi Substation - Nyagasambu**

Client: PITRAD IBAMBA LTD.

Operated by: Eng. Venerand GWIZA
Verified by: Eng. Vivien MUNYABURANGA (MSc)
Date: July, 2017

Penetration Test **N° AP 9**

Depth (cm)	Rt (MN/m2)	Rp (MN/m2)	Qadm (MN/m2)	Qadm (kg/cm2)
0	0	0	0.00	0.00
20	30	20	6.67	67.98
40	20	10	3.33	33.99
60	90	55	18.33	186.95
80	190	80	26.67	271.93
100	240	90	30.00	305.92
120	360	100	33.33	339.91
140	500	150	50.00	509.86
160				



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PROJECT: **IMPROVEMENT OF SUBSTATION & DISTRIBUTION NETWORK - PHASE III**

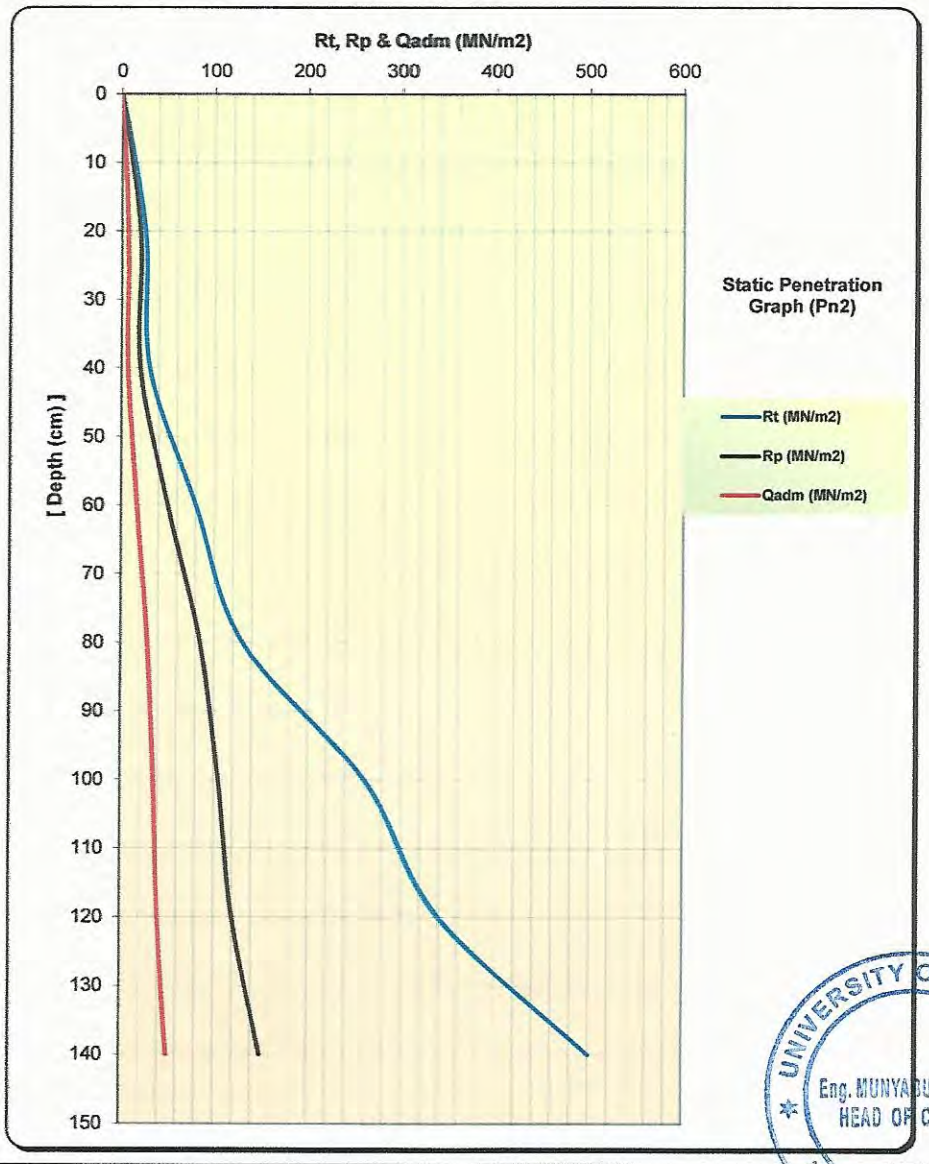
SUB PROJECT: **15 KV Distribution line Gasogi Substation - Nyagasambu**

Client: PITRAD IBAMBA LTD.

Operated by: Eng. Venerand GWIZA
Verified by: Eng. Vivien MUNYABURANGA (MSc)
Date: July, 2017

Penetration Test **N° AP 10**

Depth (cm)	Rt (MN/m2)	Rp (MN/m2)	Qadm (MN/m2)	Qadm (kg/cm2)
0	0	0	0.00	0.00
20	25	20	6.67	67.98
40	30	20	6.67	67.98
60	80	50	16.67	169.95
80	130	85	28.33	288.92
100	260	105	35.00	356.90
120	340	120	40.00	407.89
140	500	150	50.00	509.86
160				



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PROJECT: IMPROVEMENT OF SUBSTATION & DISTRIBUTION NETWORK - PHASE III

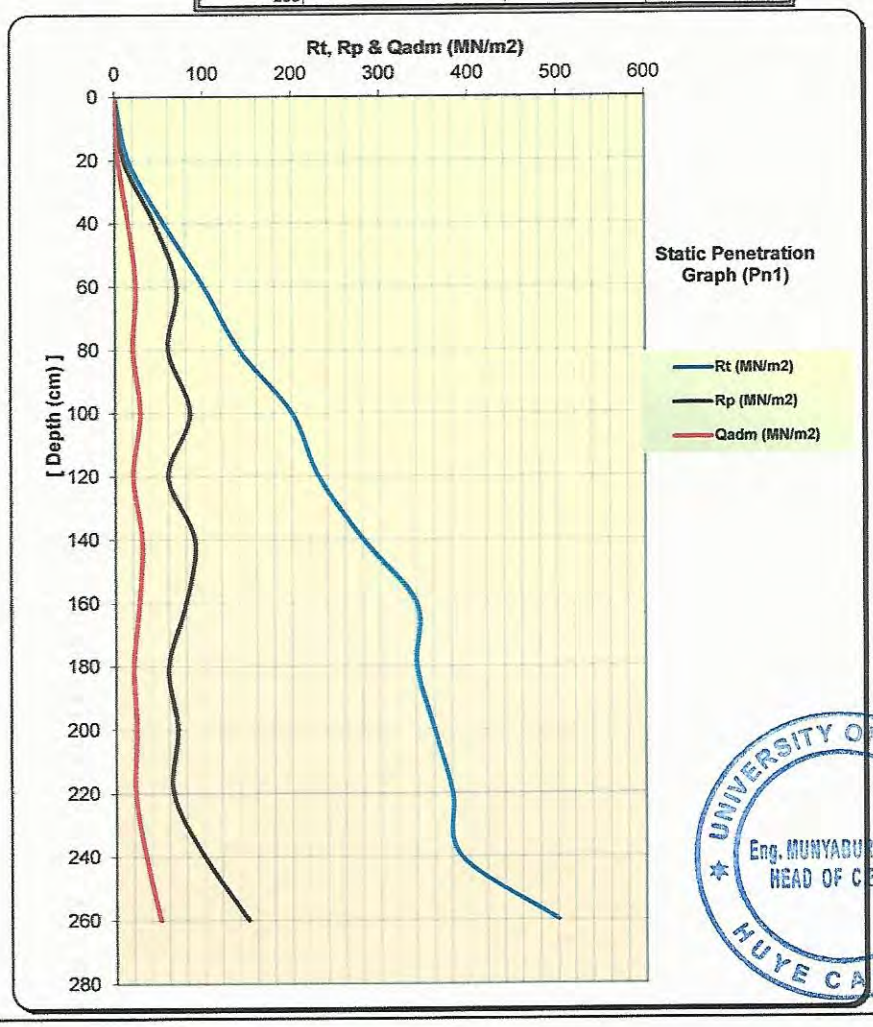
SUB PROJECT: 15 KV Distribution line Gasogi Substation - Nyagasambu

Client: PITRAD IBAMBA LTD.

Operated by: Eng. Venerand GWIZA
Verified by: Eng. Vivien MUNYABURANGA (MSc)
Date: July, 2017

Penetration Test **N° AP 11**

Depth (cm)	Rt (MN/m2)	Rp (MN/m2	Qadm (MN/m2)	Qadm (kg/cm2)
0	0	0	0.00	0.00
20	15	10	3.33	33.99
40	55	45	15.00	152.96
60	100	70	23.33	237.93
80	140	60	20.00	203.94
100	200	85	28.33	288.92
120	230	60	20.00	203.94
140	280	90	30.00	305.92
160	340	80	26.67	271.93
180	340	60	20.00	203.94
200	360	70	23.33	237.93
220	380	65	21.67	220.94
240	390	100	33.33	339.91
260	500	150	50.00	509.86
280				



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PROJECT: IMPROVEMENT OF SUBSTATION & DISTRIBUTION NETWORK - PHASE III

SUB PROJECT: 15 KV Distribution line Gasogi Substation - Nyagasambu

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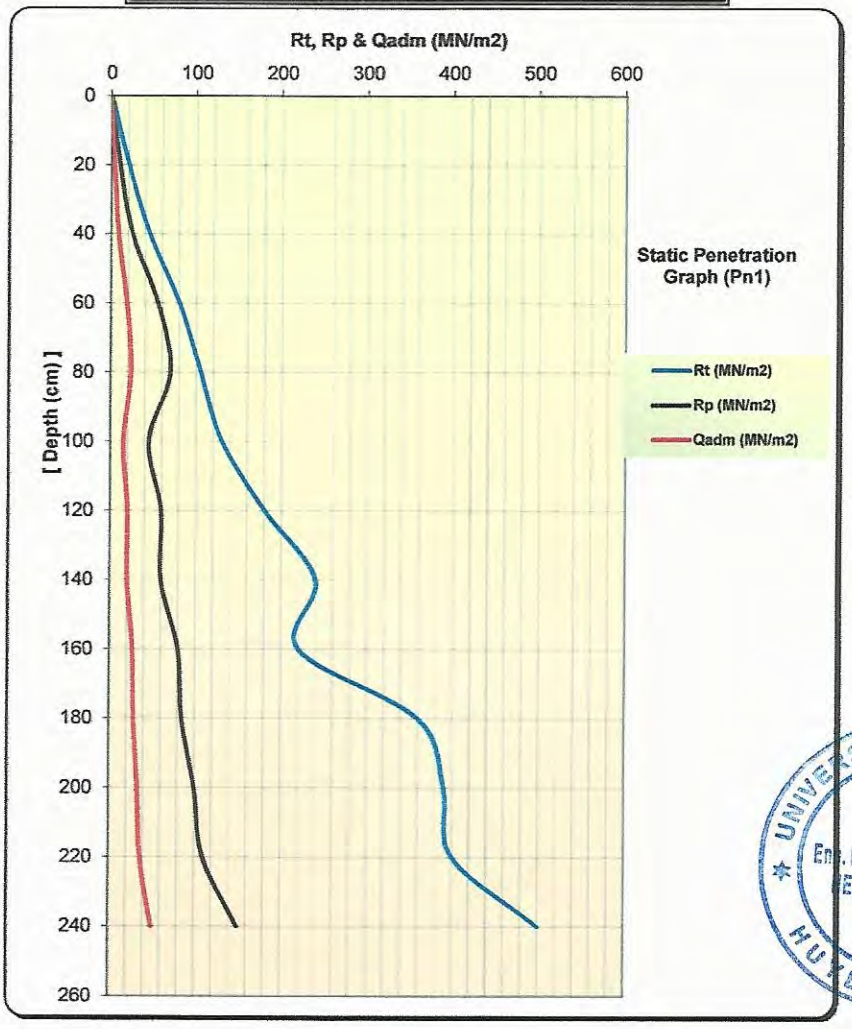
Operated by: Eng. Venerand GWIZA
Verified by: Eng. Vivien MUNYABURANGA (MSc)
Date: July, 2017

Penetration Test **N° AP 12**

Depth (cm)	Rt (MN/m2)	Rp (MN/m2)	Qadm (MN/m2)	Qadm (kg/cm2)
0	0	0	0.00	0.00
20	20	10	3.33	33.99
40	45	25	8.33	84.98
60	80	55	18.33	186.95
80	105	70	23.33	237.93
100	130	45	15.00	152.96
120	180	60	20.00	203.94
140	240	60	20.00	203.94
160	220	80	26.67	271.93
180	360	85	28.33	288.92
200	390	100	33.33	339.91
220	400	110	36.67	373.90
240	500	150	50.00	509.86
260				



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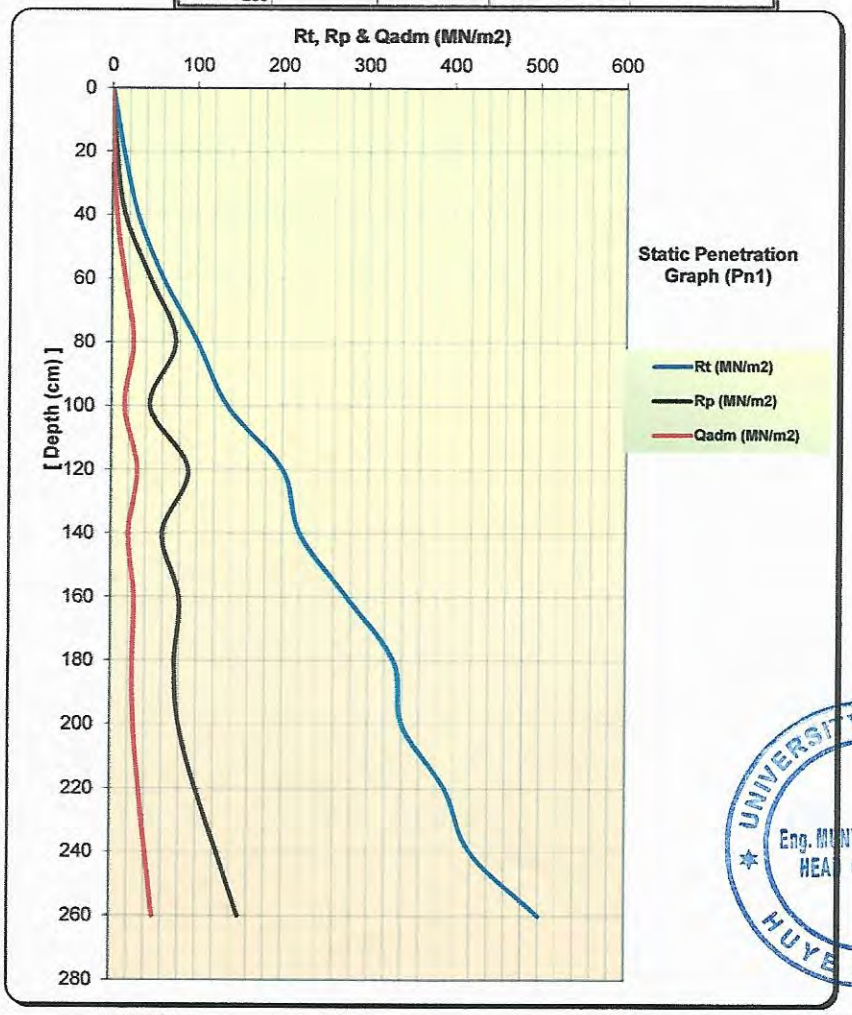
Date: July, 2017

Penetration Test **N° AP 13**

Depth (cm)	Rt (MN/m2)	Rp (MN/m2)	Qadm (MN/m2)	Qadm (kg/cm2)
0	0	0	0.00	0.00
20	13	5	1.67	17.00
40	30	15	5.00	50.99
60	60	45	15.00	152.96
80	100	75	25.00	254.93
100	135	45	15.00	152.96
120	200	90	30.00	305.92
140	220	60	20.00	203.94
160	275	80	26.67	271.93
180	330	75	25.00	254.93
200	340	80	26.67	271.93
220	390	100	33.33	339.91
240	420	125	41.67	424.88
260	500	150	50.00	509.86
280				



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PROJECT: IMPROVEMENT OF SUBSTATION & DISTRIBUTION NETWORK - PHASE III

SUB PROJECT: 15 KV Distribution line Gasogi Substation - Nyagasambu
Client: PITRAD IBAMBA LTD.
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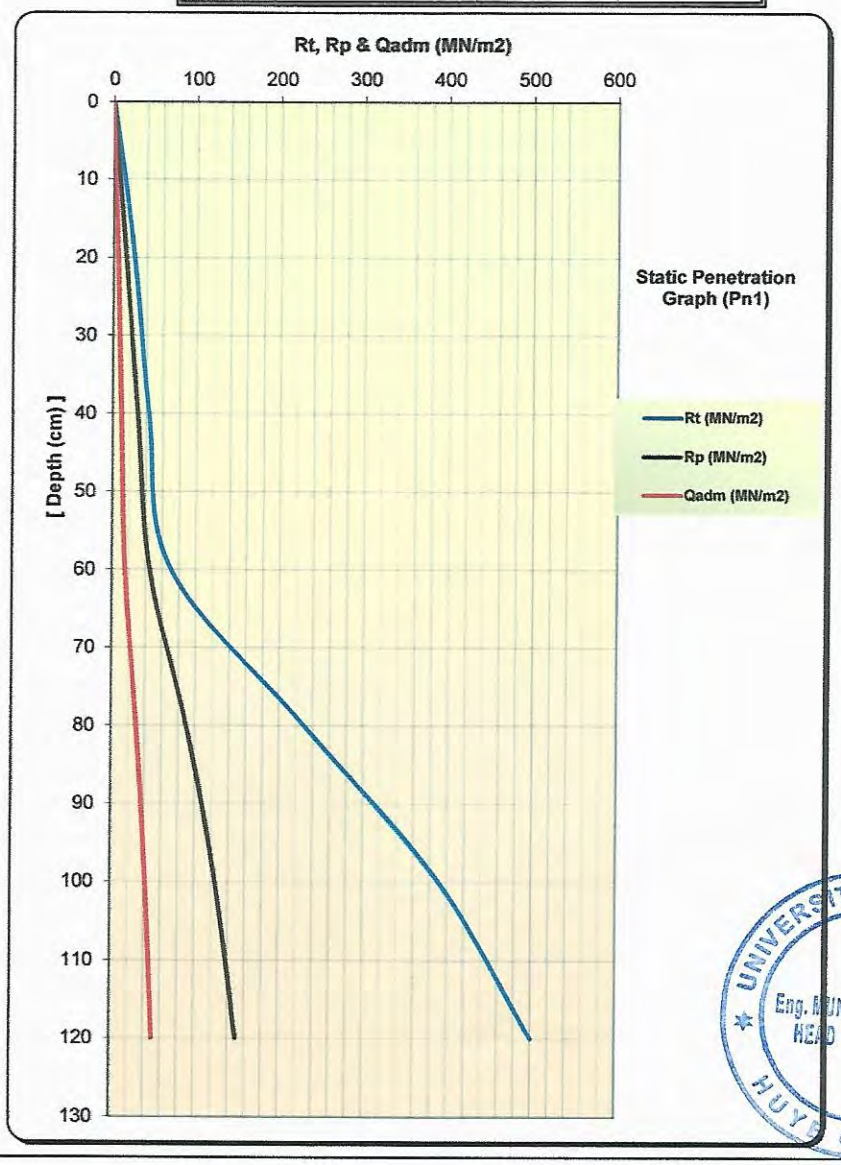
Date: July, 2017

Penetration Test **N° AP 15**

Depth (cm)	Rt (MN/m2)	Rp (MN/m2	Qadm (MN/m2)	Qadm (kg/cm2)
0	0	0	0.00	0.00
20	25	15	5.00	50.99
40	43	30	10.00	101.97
60	70	45	15.00	152.96
80	230	90	30.00	305.92
100	390	125	41.67	424.88
120	500	150	50.00	509.86
140				



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PROJECT: IMPROVEMENT OF SUBSTATION & DISTRIBUTION NETWORK - PHASE III

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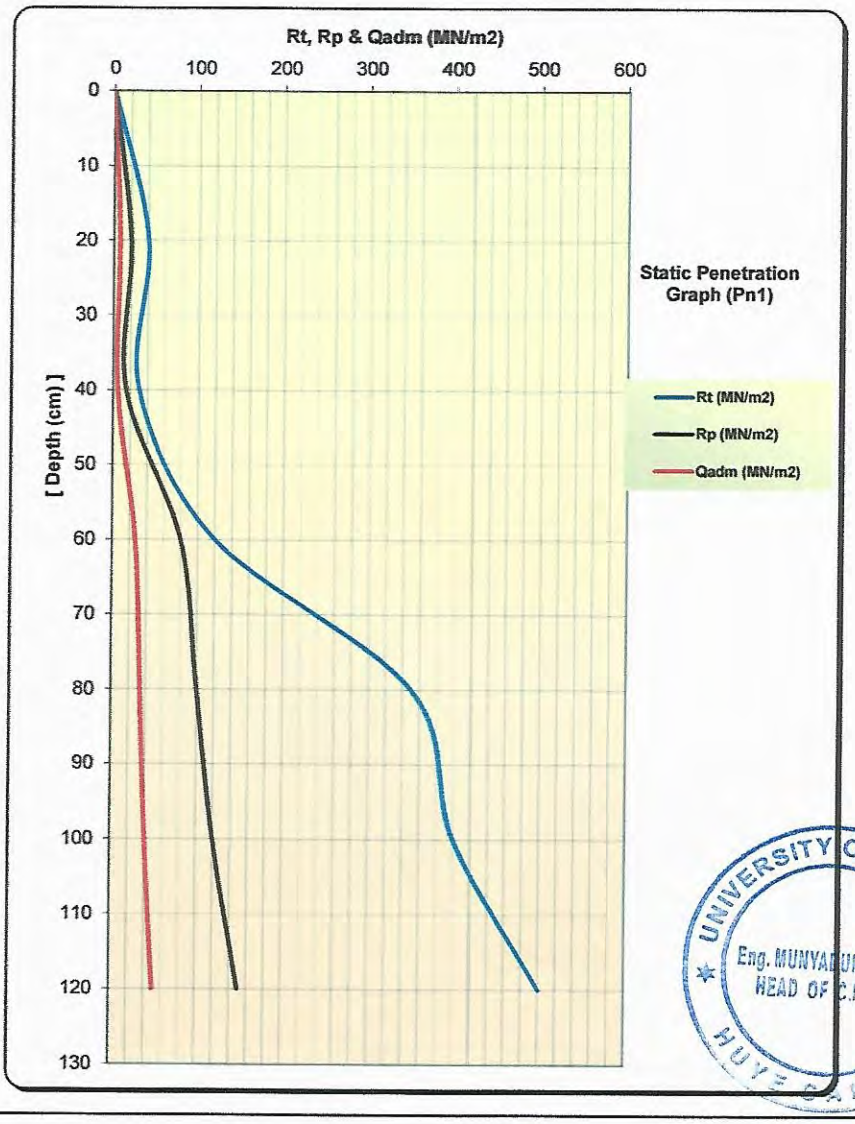
Date: July, 2017

Penetration Test **N° AP 16**

Depth (cm)	Rt (MN/m2)	Rp (MN/m2)	Qadm (MN/m2)	Qadm (kg/cm2)
0	0	0	0.00	0.00
20	40	20	6.67	67.98
40	30	15	5.00	50.99
60	120	80	26.67	271.93
80	350	100	33.33	339.91
100	400	120	40.00	407.89
120	500	150	50.00	509.86
140				



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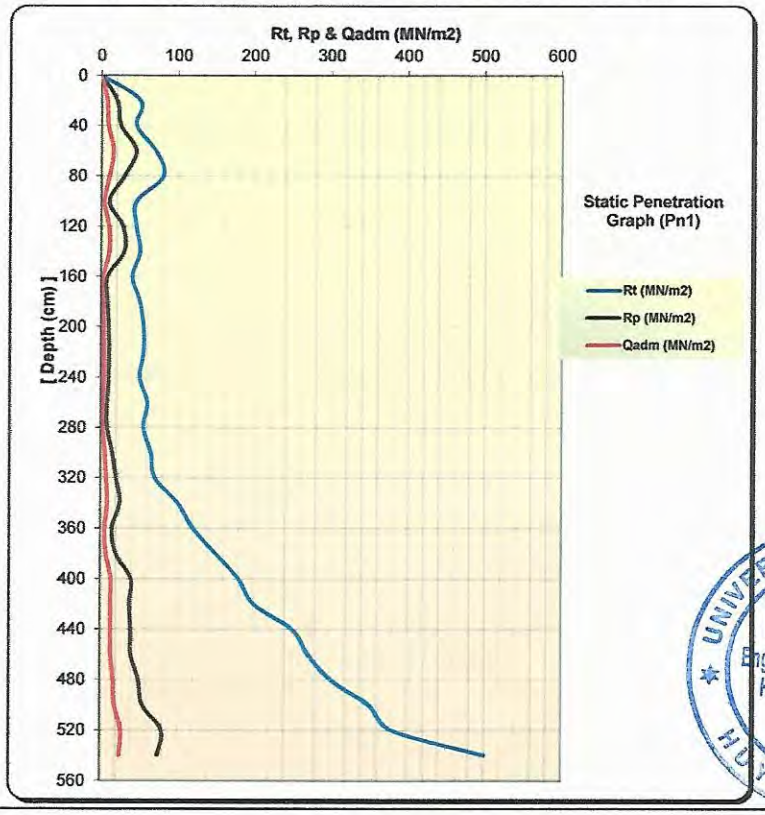
PROJECT: IMPROVEMENT OF SUBSTATION & DISTRIBUTION NETWORK - PHASE III

SUB PROJECT: 15 KV Distribution line Gasogi Substation - Nyagasambu
Client: PITRAD IBAMBA LTD.
Operated by: Eng. Venerand GWIZA
Verified by: Eng. Vivien MUNYABURANGA (MSc)
Date: July, 2017

Penetration Test **N° AP 17**

Depth (cm)	Rt (MN/m2)	Rp (MN/m2)	Qadm (MN/m2)	Qadm (kg/cm2)
0	0	0	0.00	0.00
20	50	20	6.67	67.98
40	45	25	8.33	84.98
60	70	45	15.00	152.96
80	80	30	10.00	101.97
100	45	10	3.33	33.99
120	45	28	9.33	95.17
140	50	30	10.00	101.97
160	40	8	2.67	27.19
180	50	8	2.67	27.19
200	55	10	3.33	33.99
220	55	10	3.33	33.99
240	50	10	3.33	33.99
260	60	8	2.67	27.19
280	55	8	2.67	27.19
300	65	15	5.00	50.99
320	70	20	6.67	67.98
340	100	25	8.33	84.98
360	120	15	5.00	50.99
380	150	20	6.67	67.98
400	180	40	13.33	135.96
420	200	38	12.67	129.16
440	250	40	13.33	135.96
460	270	40	13.33	135.96
480	300	50	16.67	169.95
500	350	55	18.33	186.95
520	380	80	26.67	271.93
540	500	75	25.00	254.93
560				



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LABORATORY OF GEOTECHNICS

PROJECT: IMPROVEMENT OF SUBSTATION & DISTRIBUTION NETWORK - PHASE III

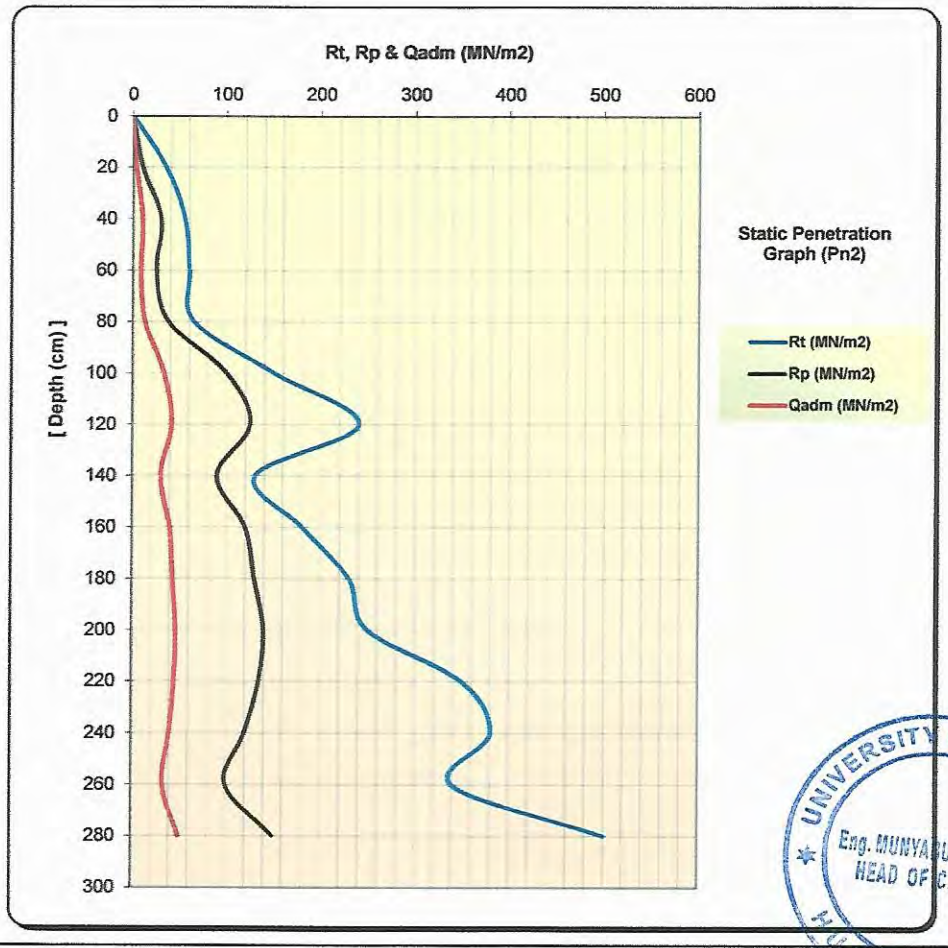
SUB PROJECT: 15 KV Distribution line Gasogi Substation - Masaka Hospital

Client: PITRAD IBAMBA LTD.

Operated by: Eng. Venerand GWIZA
Verified by: Eng. Vivien MUNYABURANGA (MSc)
Date: July, 2017

Penetration Test **N° AP 1**

Depth (cm)	Rt (MN/m2)	Rp (MN/m2)	Qadm (MN/m2)	Qadm (kg/cm2)
0	0	0	0.00	0.00
20	35	10	3.33	33.99
40	55	30	10.00	101.97
60	60	25	8.33	84.98
80	65	38	12.67	129.16
100	150	100	33.33	339.91
120	240	125	41.67	424.88
140	130	90	30.00	305.92
160	180	120	40.00	407.89
180	230	130	43.33	441.88
200	250	140	46.67	475.87
220	350	135	45.00	458.87
240	380	120	40.00	407.89
260	340	100	33.33	339.91
280	500	150	50.00	509.86
300				



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PROJECT: **IMPROVEMENT OF SUBSTATION & DISTRIBUTION NETWORK - PHASE III**

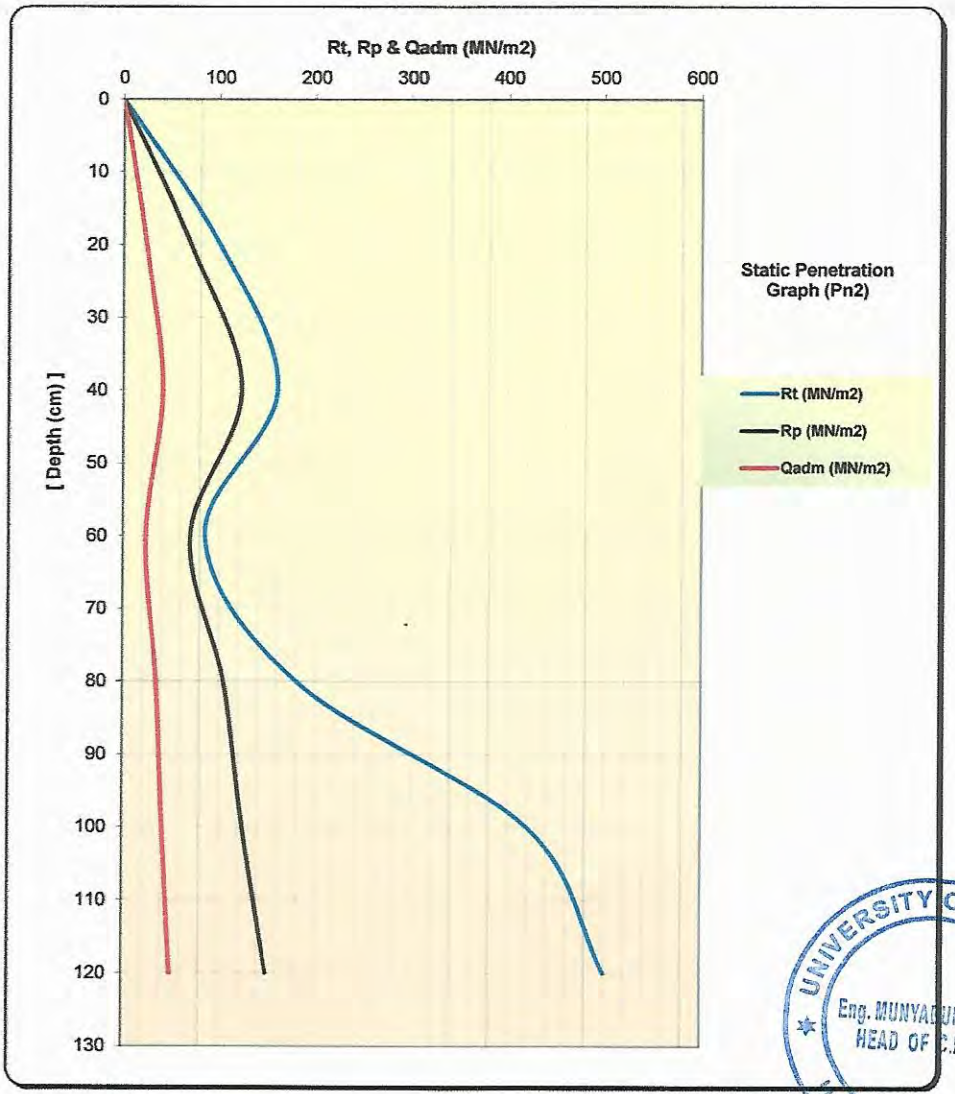
SUB PROJECT: **15 KV Distribution line Gasogi Substation - Masaka Hospital**

Client: PITRAD IBAMBA LTD.

Operated by: Eng. Venerand GWIZA
Verified by: Eng. Vivien MUNYABURANGA (MSc)
Date: July, 2017

Penetration Test **N° AP 3**

Depth (cm)	Rt (MN/m2)	Rp (MN/m2)	Qadm (MN/m2)	Qadm (kg/cm2)
0	0	0	0.00	0.00
20	100	70	23.33	237.93
40	160	123	41.00	418.09
60	85	70	23.33	237.93
80	180	105	35.00	356.90
100	420	125	41.67	424.88
120	500	150	50.00	509.86
140				



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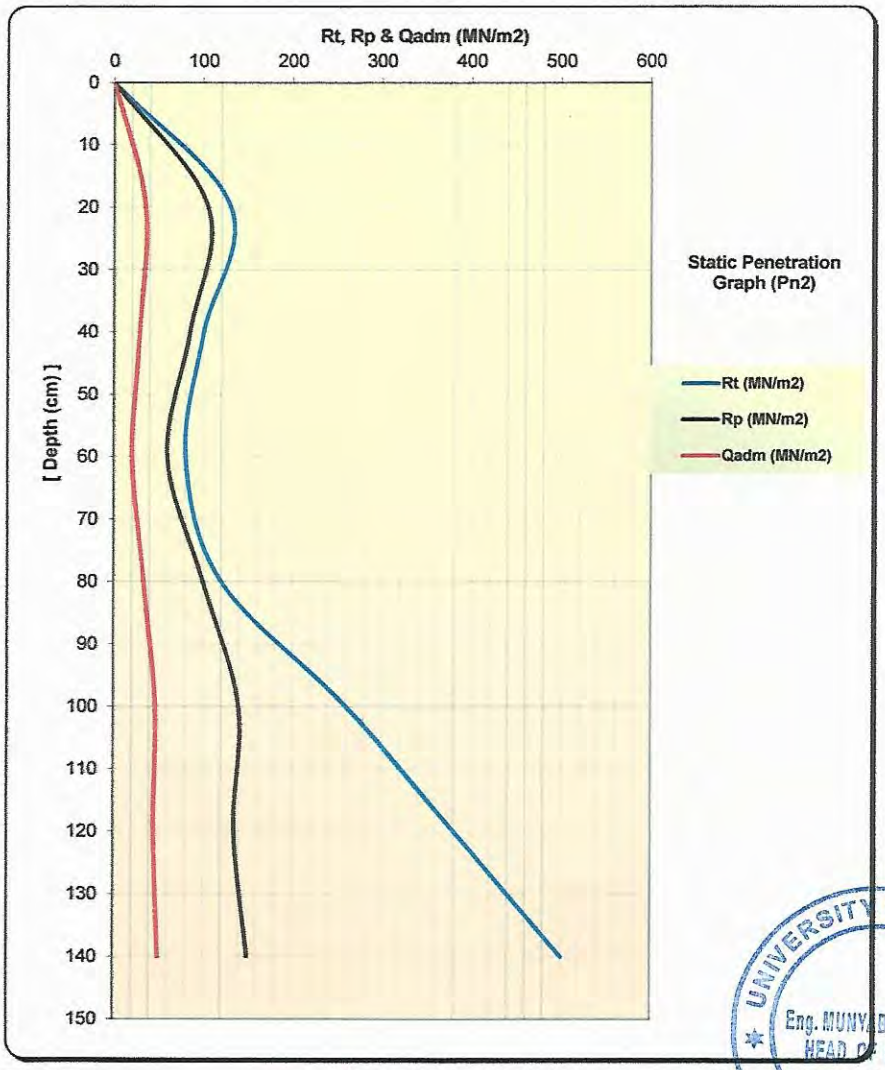
PROJECT: **IMPROVEMENT OF SUBSTATION & DISTRIBUTION NETWORK - PHASE III**
SUB PROJECT: **15 KV Distribution line Gasogi Substation - Masaka Hospital**
Client: PITRAD IBAMBA LTD.
Operated by: Eng. Venerand GWIZA
Verified by: Eng. Vivien MUNYABURANGA (MSc)
Date: July, 2017

Penetration Test **N° AP 4**

Depth (cm)	Rt (MN/m2)	Rp (MN/m2)	Qadm (MN/m2)	Qadm (kg/cm2)
0	0	0	0.00	0.00
20	130	105	35.00	356.90
40	100	85	28.33	288.92
60	80	60	20.00	203.94
80	120	100	33.33	339.91
100	260	140	46.67	475.87
120	380	135	45.00	458.87
140	500	150	50.00	509.86
160				



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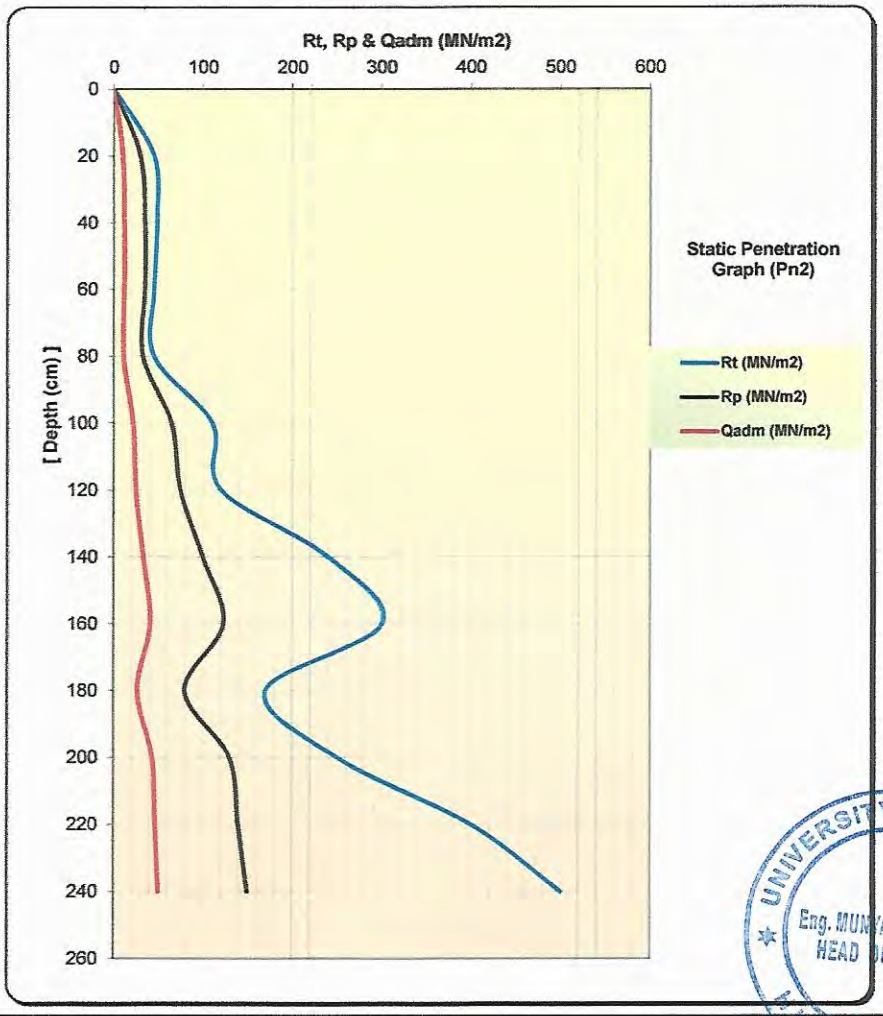
PROJECT: **IMPROVEMENT OF SUBSTATION & DISTRIBUTION NETWORK - PHASE III**
SUB PROJECT: **15 KV Distribution line Gasogi Substation - Masaka Hospital**

Client: PITRAD IBAMBA LTD.
Operated by: Eng. Venerand GWIZA
Verified by: Eng. Vivien MUNYABURANGA (MSc)
Date: July, 2017

Penetration Test **N° AP 5**

Depth (cm)	Rt (MN/m2)	Rp (MN/m2)	Qadm (MN/m2)	Qadm (kg/cm2)
0	0	0	0.00	0.00
20	45	30	10.00	101.97
40	48	35	11.67	118.97
60	45	35	11.67	118.97
80	45	33	11.00	112.17
100	110	65	21.67	220.94
120	120	75	25.00	254.93
140	240	100	33.33	339.91
160	300	123	41.00	418.09
180	170	80	26.67	271.93
200	250	130	43.33	441.88
220	400	140	46.67	475.87
240	500	150	50.00	509.86
320				



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PROJECT: **IMPROVEMENT OF SUBSTATION & DISTRIBUTION NETWORK - PHASE III**

SUB PROJECT: **15 KV Distribution line Gasogi Substation - Masaka Hospital**

Client: PITRAD IBAMBA LTD.

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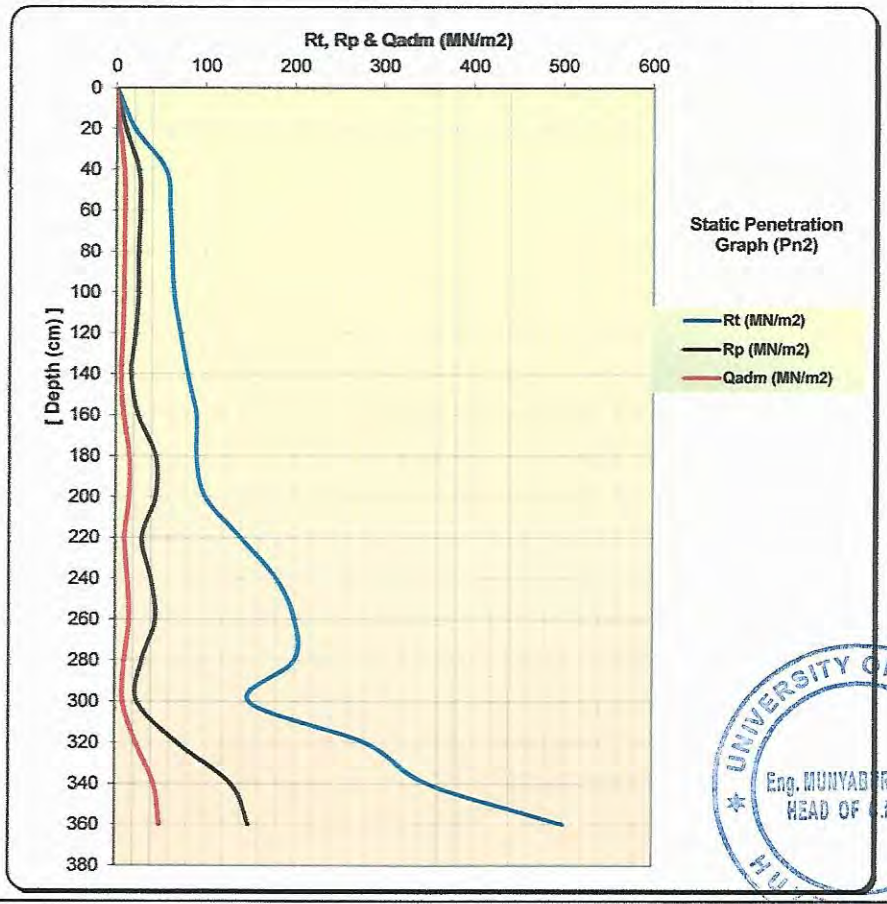
Date: July, 2017

Penetration Test **N° AP 6**

Depth (cm)	Rt (MN/m2)	Rp (MN/m2)	Qadm (MN/m2)	Qadm (kg/cm2)
0	0	0	0.00	0.00
20	20	10	3.33	33.99
40	55	25	8.33	84.98
60	60	27	9.00	91.77
80	62	25	8.33	84.98
100	64	25	8.33	84.98
120	72	22	7.33	74.78
140	80	17	5.67	57.78
160	90	25	8.33	84.98
180	90	45	15.00	152.96
200	100	45	15.00	152.96
220	140	30	10.00	101.97
240	180	40	13.33	135.96
260	200	45	15.00	152.96
280	200	30	10.00	101.97
300	150	25	8.33	84.98
320	280	70	23.33	237.93
340	350	130	43.33	441.88
360	500	150	50.00	509.86
380				



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PROJECT: IMPROVEMENT OF SUBSTATION & DISTRIBUTION NETWORK - PHASE III

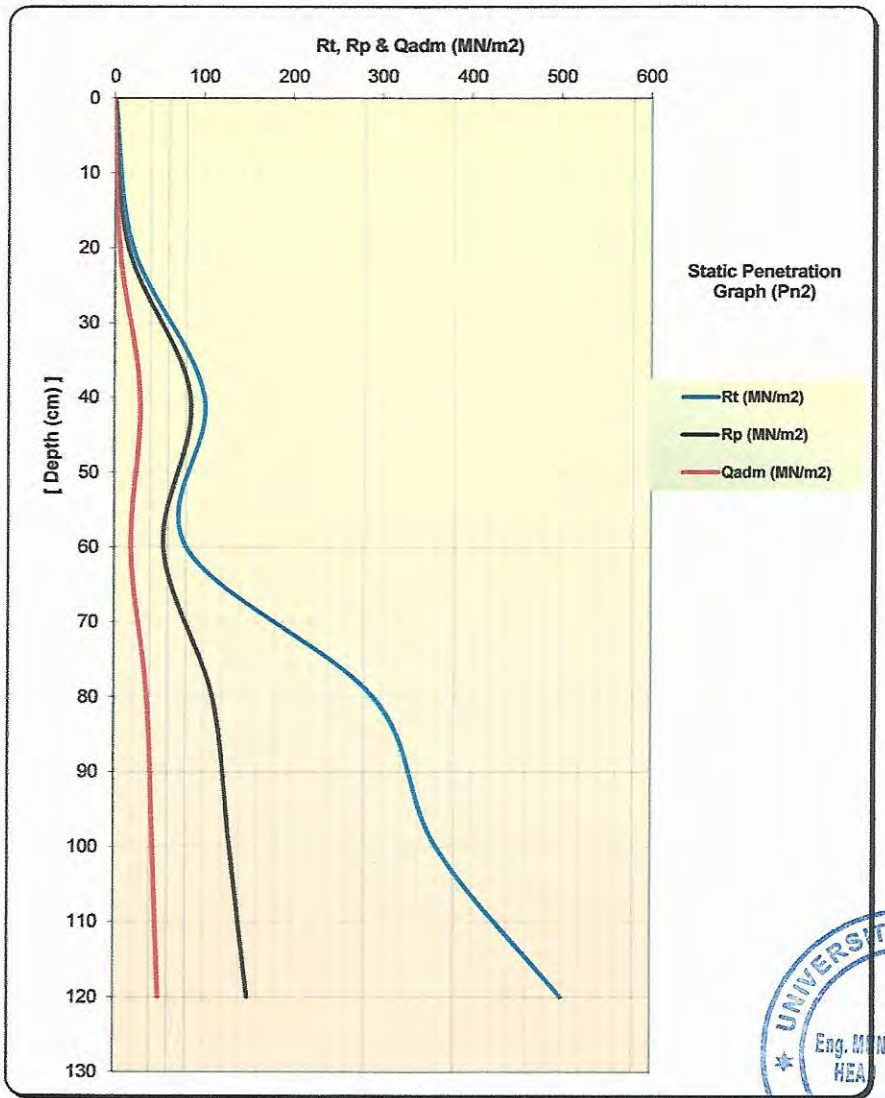
SUB PROJECT: 15 KV Distribution line Gasogi Substation - Masaka Hospital

Client: PITRAD IBAMBA LTD.

Operated by: Eng. Venerand GWIZA
Verified by: Eng. Vivien MUNYABURANGA (MSc)
Date: July, 2017

Penetration Test N°8 - Pump Station

Depth (cm)	Rt (MN/m2)	Rp (MN/m2)	Qadm (MN/m2)	Qadm (kg/cm2)
0	0	0	0.00	0.00
20	20	15	5.00	50.99
40	100	85	28.33	288.92
60	80	55	18.33	186.95
80	290	110	36.67	373.90
100	360	130	43.33	441.88
120	500	150	50.00	509.86
140				



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PROJECT: **IMPROVEMENT OF SUBSTATION & DISTRIBUTION NETWORK - PHASE III**

SUB PROJECT: **15 KV Distribution line Gasogi Substation - Masaka Hospital**

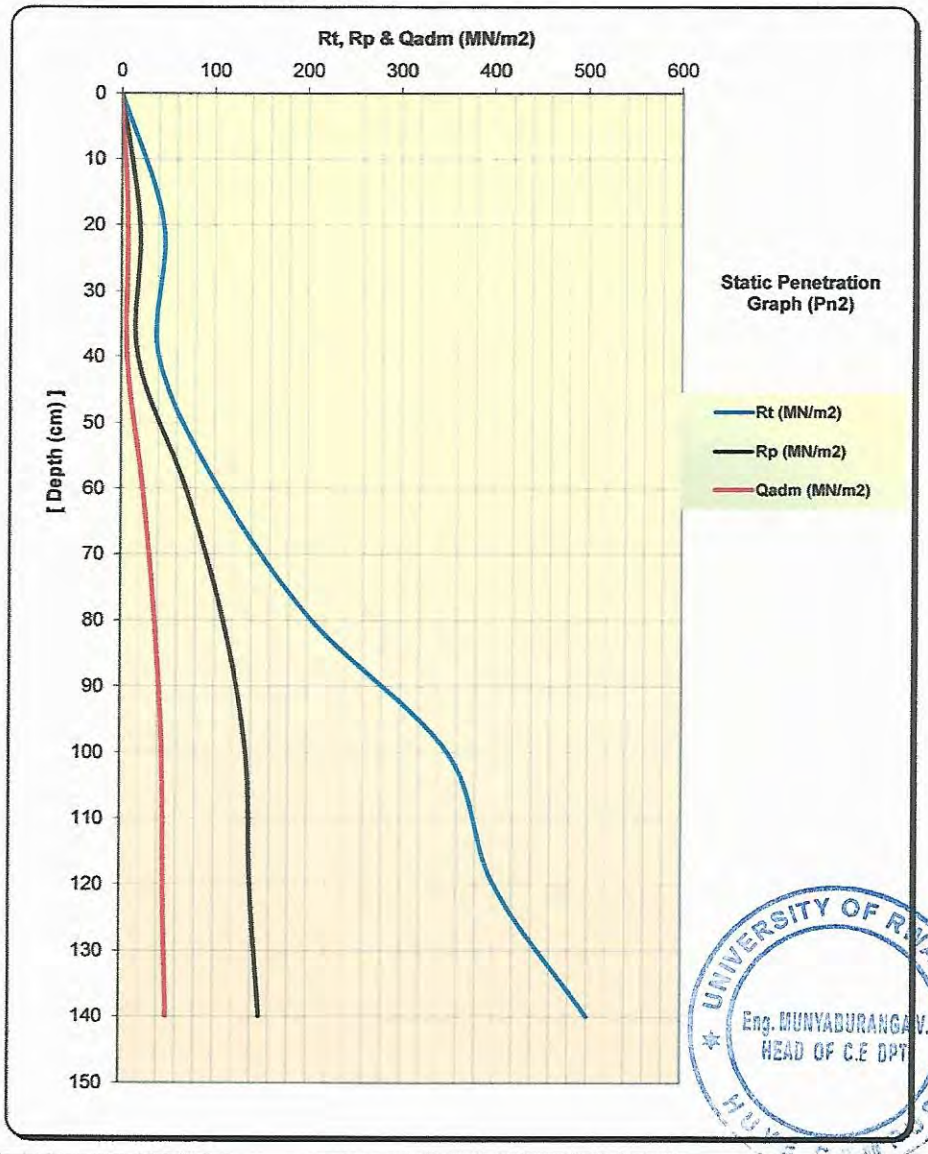
Client: PITRAD IBAMBA LTD.

Operated by: Eng. Venerand GWIZA
Verified by: Eng. Vivien MUNYABURANGA (MSc)
Date: July, 2017

Penetration Test **N° AP 9**

Date: 29-08 to 25-09-2013

Depth (cm)	Rt (MN/m2)	Rp (MN/m2)	Qadm (MN/m2)	Qadm (kg/cm2)
0	0	0	0.00	0.00
20	45	20	6.67	67.98
40	40	18	6.00	61.18
60	105	70	23.33	237.93
80	205	110	36.67	373.90
100	350	135	45.00	458.87
120	400	140	46.67	475.87
140	500	150	50.00	509.86
160				



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PROJECT: **IMPROVEMENT OF SUBSTATION & DISTRIBUTION NETWORK - PHASE III**

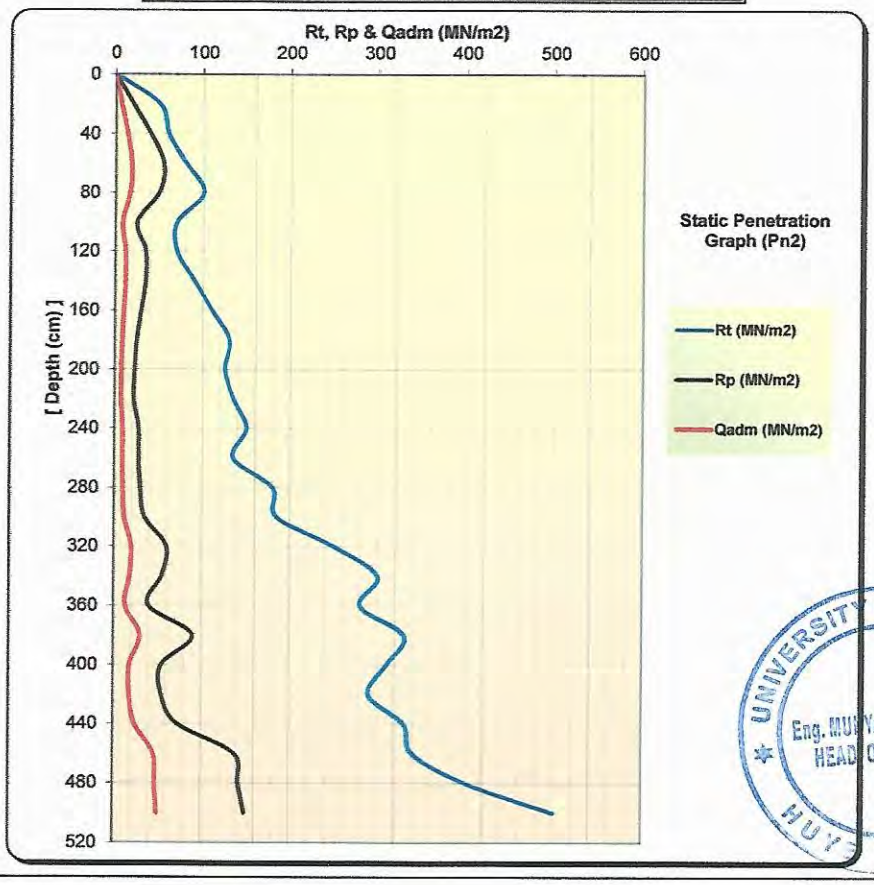
SUB PROJECT: **15 KV Distribution line Gasogi Substation - Masaka Hospital**

Client: PITRAD IBAMBA LTD.

Operated by: Eng. Venerand GWIZA
Verified by: Eng. Vivien MUNYABURANGA (MSc)
Date: July, 2017

Penetration Test **N° AP 10**

Depth (cm)	Rt (MN/m2)	Rp (MN/m2)	Qadm (MN/m2)	Qadm (kg/cm2)
0	0	0	0.00	0.00
20	50	20	6.67	67.98
40	60	40	13.33	135.96
60	80	55	18.33	186.95
80	100	50	16.67	169.95
100	70	25	8.33	84.98
120	70	35	11.67	118.97
140	90	35	11.67	118.97
160	110	30	10.00	101.97
180	130	25	8.33	84.98
200	125	23	7.67	78.18
220	135	22	7.33	74.78
240	150	28	9.33	95.17
260	135	28	9.33	95.17
280	180	30	10.00	101.97
300	185	35	11.67	118.97
320	250	60	20.00	203.94
340	300	55	18.33	186.95
360	280	40	13.33	135.96
380	330	90	30.00	305.92
400	310	55	18.33	186.95
420	290	55	18.33	186.95
440	330	73	24.33	248.13
460	340	138	46.00	469.07
480	400	143	47.67	486.07
500	500	150	50.00	509.86
520				



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PROJECT: **IMPROVEMENT OF SUBSTATION & DISTRIBUTION NETWORK - PHASE III**

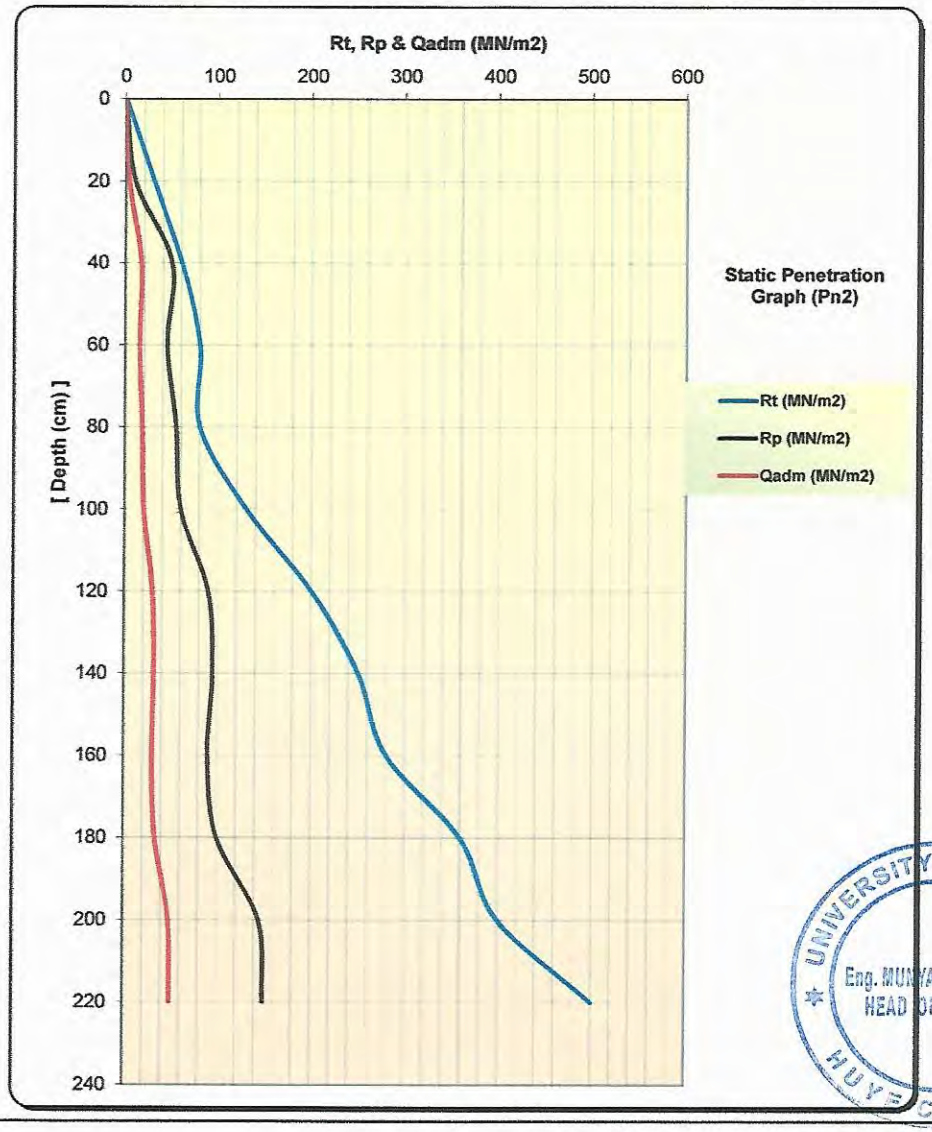
SUB PROJECT: **15 KV Distribution line Gasogi Substation - Masaka Hospital**

Client: PITRAD IBAMBA LTD.

Operated by: Eng. Venerand GWIZA
Verified by: Eng. Vivien MUNYABURANGA (MSc)
Date: July, 2017

Penetration Test **N°AP 12**

Depth (cm)	Rt (MN/m2)	Rp (MN/m2)	Qadm (MN/m2)	Qadm (kg/cm2)
0	0	0	0.00	0.00
20	30	10	3.33	33.99
40	60	50	16.67	169.95
60	80	45	15.00	152.96
80	80	55	18.33	186.95
100	130	60	20.00	203.94
120	200	90	30.00	305.92
140	250	95	31.67	322.91
160	280	90	30.00	305.92
180	360	100	33.33	339.91
200	400	145	48.33	492.86
220	500	150	50.00	509.86
240				



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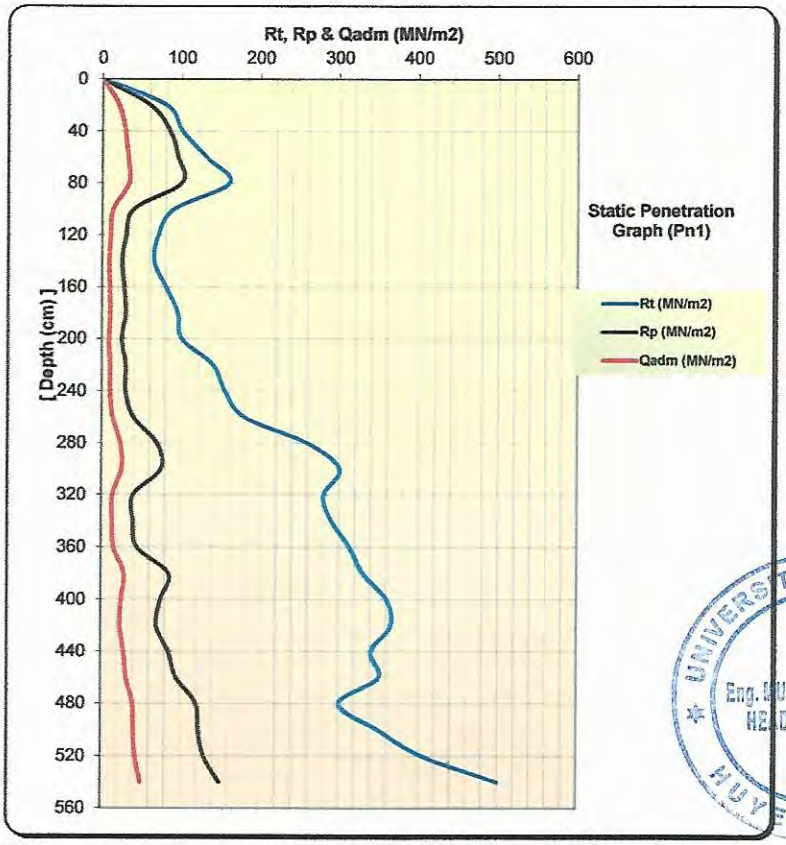
PROJECT: IMPROVEMENT OF SUBSTATION & DISTRIBUTION NETWORK - PHASE III
SUB PROJECT: 15 KV Distribution line Gasogi Substation - Masaka Hospital

Client: PITRAD IBAMBA LTD.

Operated by: Eng. Venerand GWIZA
Verified by: Eng. Vivien MUNYABURANGA (MSc)
Date: July, 2017
Penetration Test **N° AP 13**

Depth (cm)	Rt (MN/m2)	Rp (MN/m2)	Qadm (MN/m2)	Qadm (kg/cm2)
0	0	0	0.00	0.00
20	80	60	20.00	203.94
40	100	85	28.33	288.92
60	130	95	31.67	322.91
80	160	100	33.33	339.91
100	90	40	13.33	135.96
120	70	30	10.00	101.97
140	65	25	8.33	84.98
160	80	28	9.33	95.17
180	95	30	10.00	101.97
200	100	25	8.33	84.98
220	140	30	10.00	101.97
240	155	30	10.00	101.97
260	180	40	13.33	135.96
280	260	70	23.33	237.93
300	300	75	25.00	254.93
320	280	40	13.33	135.96
340	290	40	13.33	135.96
360	313	45	15.00	152.96
380	330	85	28.33	288.92
400	360	75	25.00	254.93
420	365	70	23.33	237.93
440	340	85	28.33	288.92
460	350	95	31.67	322.91
480	300	120	40.00	407.89
500	350	123	41.00	418.09
520	405	130	43.33	441.88
540	500	150	50.00	509.86
560				



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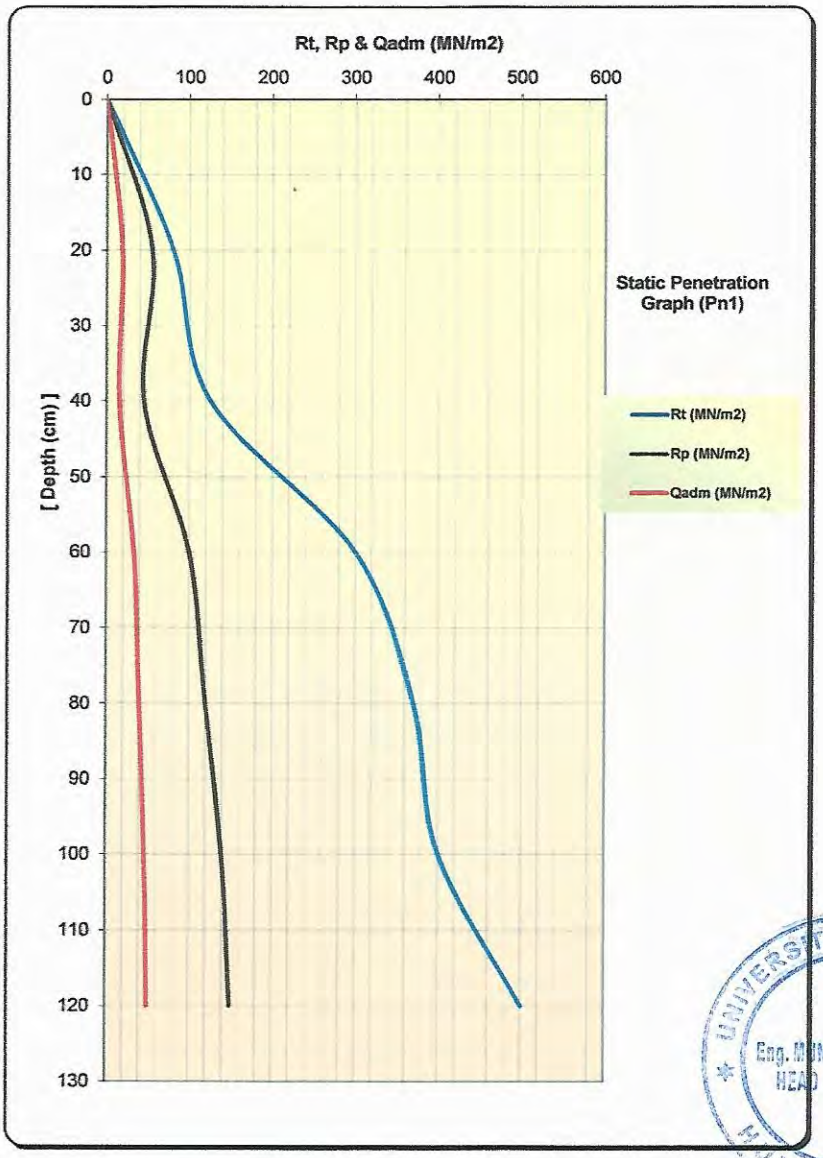
SUB PROJECT: 15 KV Distribution line Gasogi Substation - Masaka Hospital

Client: PITRAD IBAMBA LTD.

Operated by: Eng. Venerand GWIZA
Verified by: Eng. Vivien MUNYABURANGA (MSc)
Date: July, 2017
Penetration Test **N° AP 15**

Depth (cm)	Rt (MN/m2)	Rp (MN/m2)	Qadm (MN/m2)	Qadm (kg/cm2)
0	0	0	0.00	0.00
20	80	55	18.33	186.95
40	125	45	15.00	152.96
60	300	100	33.33	339.91
80	370	120	40.00	407.89
100	400	140	46.67	475.87
120	500	150	50.00	509.86
140				



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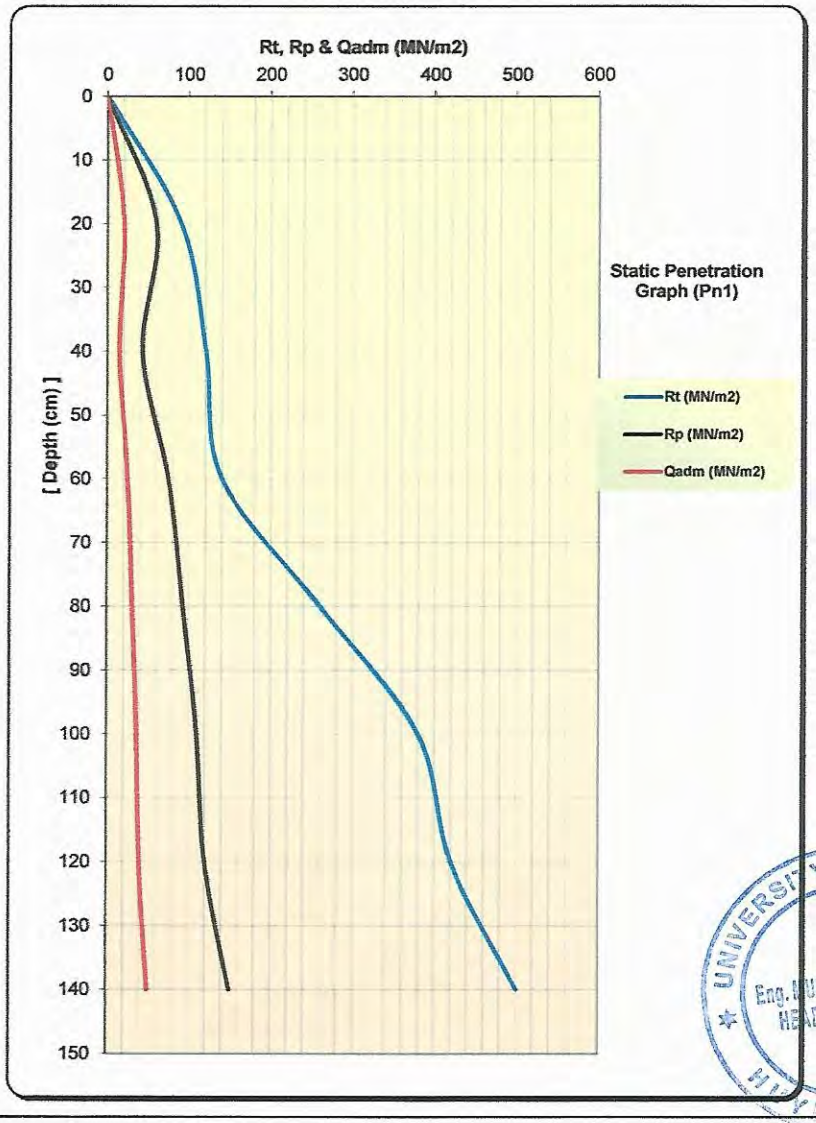
Client: PITRAD IBAMBA LTD.
Operated by: Eng. Venerand GWIZA
Verified by: Eng. Vivien MUNYABURANGA (MSc)
Date: July, 2017
Penetration Test **N° AP 16**

Depth (cm)	Rt (MN/m2)	Rp (MN/m2)	Qadm (MN/m2)	Qadm (kg/cm2)
0	0	0	0.00	0.00
20	90	60	20.00	203.94
40	120	43	14.33	146.16
60	140	75	25.00	254.93
80	260	93	31.00	316.11
100	380	110	36.67	373.90
120	420	120	40.00	407.89
140	500	150	50.00	509.86
160				



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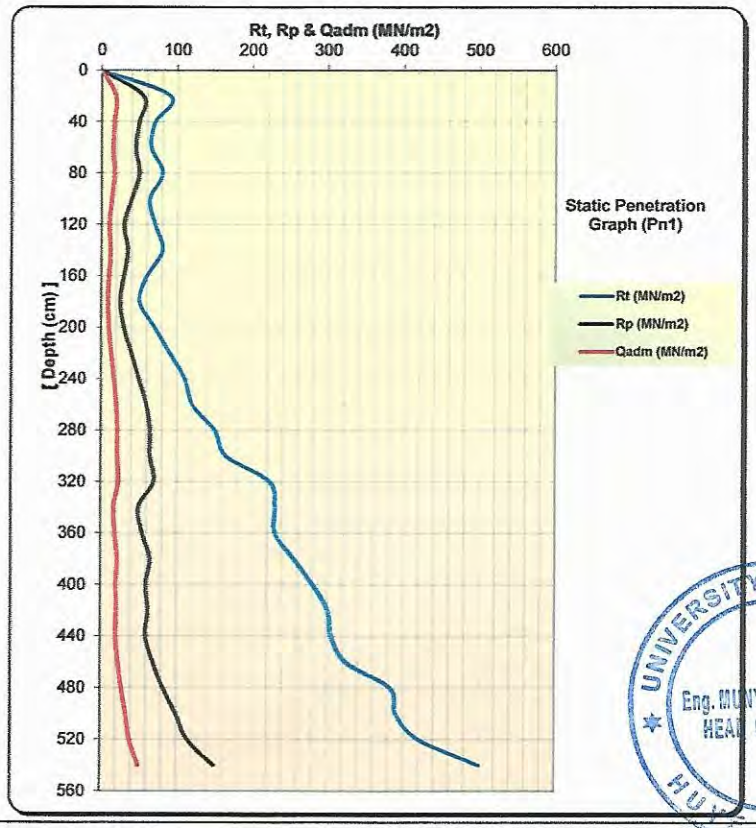
Client: PITRAD IBAMBA LTD.
Operated by: Eng. Venerand GWIZA
Verified by: Eng. Vivien MUNYABURANGA (MSc)
Date: July, 2017
Penetration Test **N° AP 17**

Depth (cm)	Rt (MN/m2)	Rp (MN/m2)	Qadm (MN/m2)	Qadm (kg/cm2)
0	0	0	0.00	0.00
20	90	55	18.33	186.95
40	70	50	16.67	169.95
60	65	45	15.00	152.96
80	80	50	16.67	169.95
100	63	40	13.33	135.96
120	70	30	10.00	101.97
140	80	35	11.67	118.97
160	60	30	10.00	101.97
180	50	25	8.33	84.98
200	70	30	10.00	101.97
220	90	40	13.33	135.96
240	110	50	16.67	169.95
260	120	60	20.00	203.94
280	150	65	21.67	220.94
300	165	65	21.67	220.94
320	223	70	23.33	237.93
340	230	50	16.67	169.95
360	230	55	18.33	186.95
380	255	65	21.67	220.94
400	280	60	20.00	203.94
420	300	63	21.00	214.14
440	305	60	20.00	203.94
460	325	70	23.33	237.93
480	383	83	27.67	282.12
500	390	100	33.33	339.91
520	420	115	38.33	390.89
540	500	150	50.00	509.86
560				



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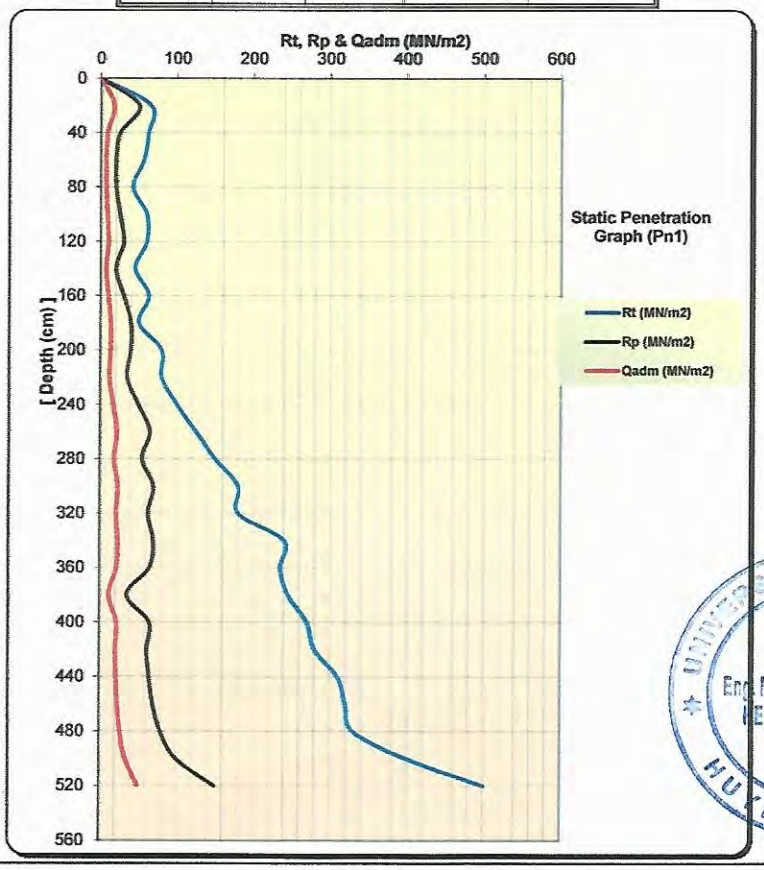
LABORATORY OF GEOTECHNICS

PROJECT: IMPROVEMENT OF SUBSTATION & DISTRIBUTION NETWORK - PHASE III
SUB PROJECT: 15 KV Distribution line Gasogi Substation - Masaka Hospital

Client: PITRAD IBAMBA LTD.

Operated by: Eng. Venerand GWIZA
Verified by: Eng. Vivien MUNYABURANGA (MSc)
Date: July, 2017
Penetration Test **N° AP 18**

Depth (cm)	Rt (MN/m2)	Rp (MN/m2)	Qadm (MN/m2)	Qadm (kg/cm2)
0	0	0	0.00	0.00
20	65	50	16.67	169.95
40	62	25	8.33	84.98
60	56	20	6.67	67.98
80	42	20	6.67	67.98
100	60	25	8.33	84.98
120	60	30	10.00	101.97
140	45	20	6.67	67.98
160	63	30	10.00	101.97
180	50	40	13.33	135.96
200	80	40	13.33	135.96
220	80	35	11.67	118.97
240	100	50	16.67	169.95
260	125	65	21.67	220.94
280	150	55	18.33	186.95
300	180	70	23.33	237.93
320	180	63	21.00	214.14
340	240	70	23.33	237.93
360	235	65	21.67	220.94
380	245	35	11.67	118.97
400	270	65	21.67	220.94
420	280	62	20.67	210.74
440	310	65	21.67	220.94
460	320	70	23.33	237.93
480	330	80	26.67	271.93
500	400	100	33.33	339.91
520	500	150	50.00	509.86
540				



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SCHOOL OF ENGINEERING
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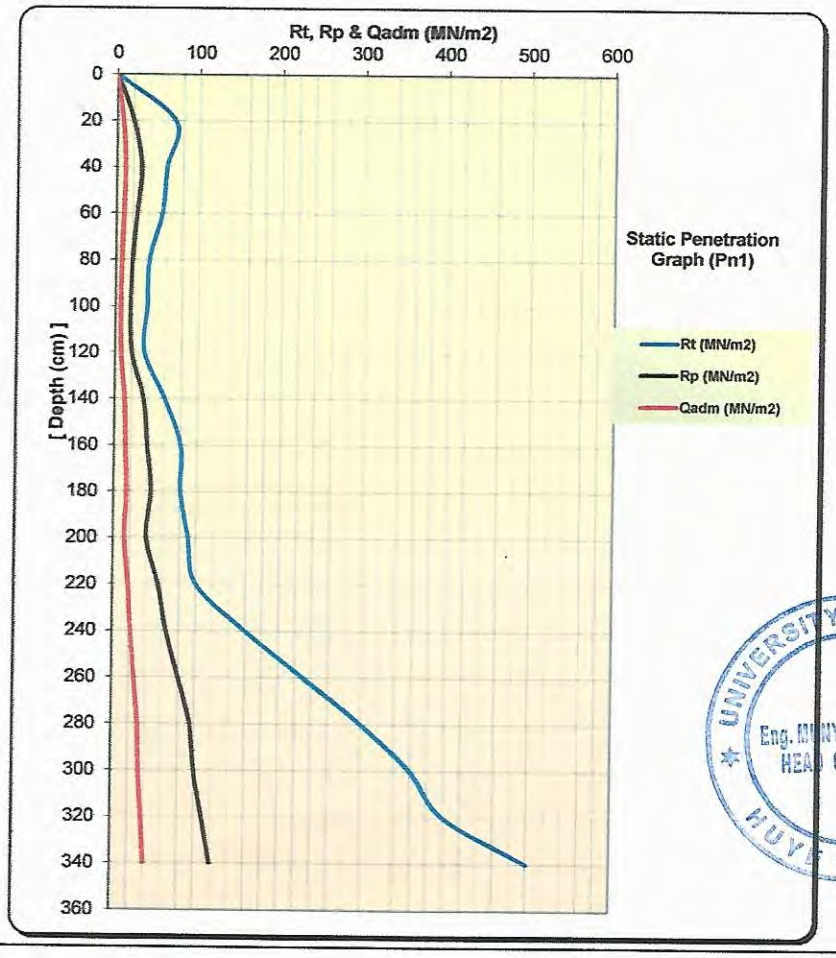
LABORATORY OF GEOTECHNICS

PROJECT: **IMPROVEMENT OF SUBSTATION & DISTRIBUTION NETWORK - PHASE III**
SUB PROJECT: **15 KV Distribution line Gasogi Substation - Masaka Hospital .**

Client: PITRAD IBAMBA LTD.
Operated by: Eng. Venerand GWIZA
Verified by: Eng. Vivien MUNYABURANGA (MSc)
Date: July, 2017

Penetration Test **N° AP 19**

Depth (cm)	Rt (MN/m2)	Rp (MN/m2)	Qadm (MN/m2)	Qadm (kg/cm2)
0	0	0	0.00	0.00
20	70	20	6.67	67.98
40	60	30	10.00	101.97
60	55	25	8.33	84.98
80	40	20	6.67	67.98
100	38	18	6.00	61.18
120	35	20	6.67	67.98
140	60	35	11.67	118.97
160	80	40	13.33	135.96
180	80	45	15.00	152.96
200	90	40	13.33	135.96
220	100	55	18.33	186.95
240	160	65	21.67	220.94
260	230	80	26.67	271.93
280	300	95	31.67	322.91
300	360	100	33.33	339.91
320	400	110	36.67	373.90
340	500	120	40.00	407.89
360				



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LABORATORY OF GEOTECHNICS

PROJECT: IMPROVEMENT OF SUBSTATION & DISTRIBUTION NETWORK - PHASE III

SUB PROJECT: Reconstruction of transmission 110 KV Line Jabana - Birembo

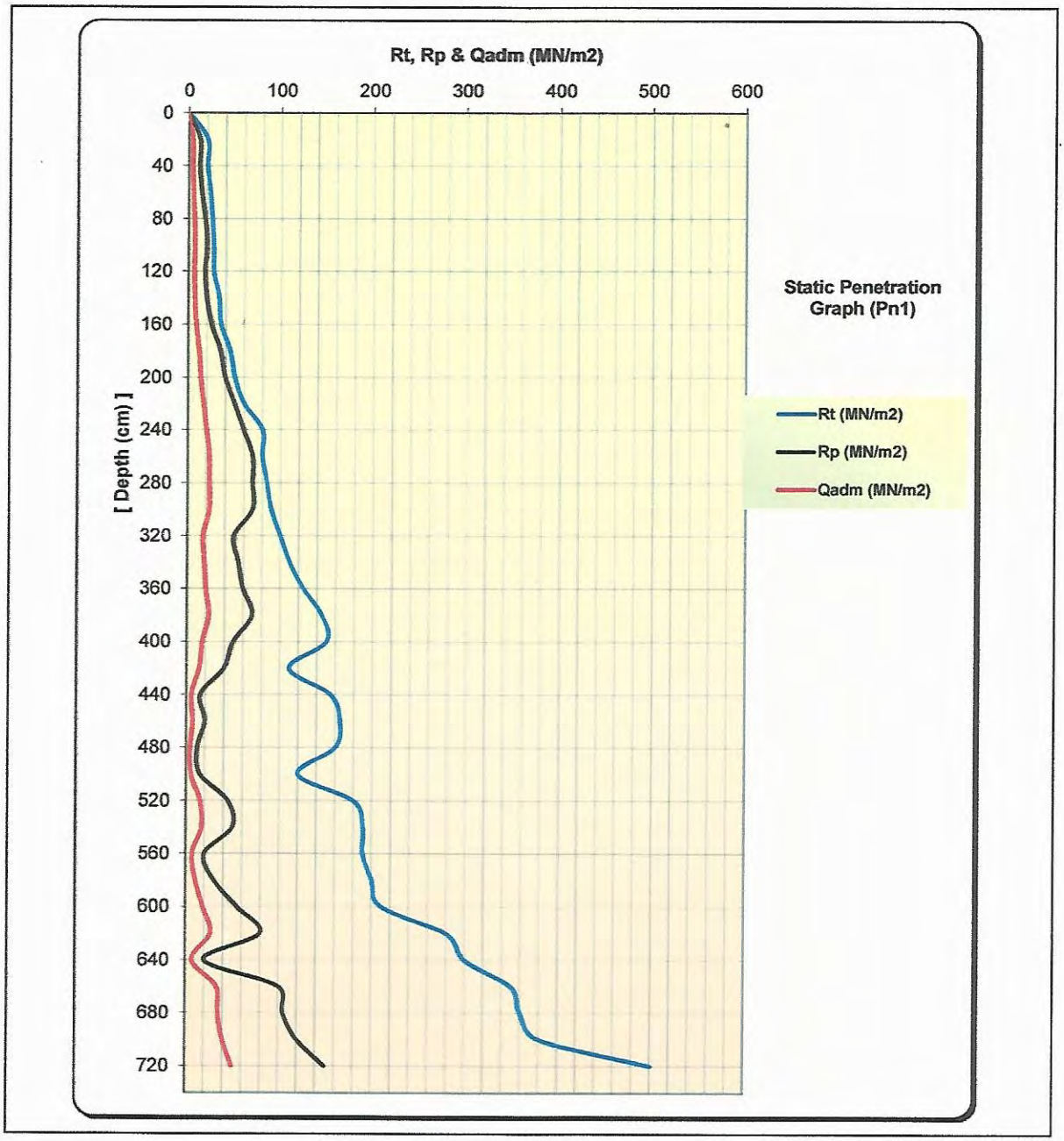
Client: PITRAD IBAMBA LTD.

Operated by: Eng. Venerand GWIZA
Verified by: Eng. Vivien MUNYABURANGA (MSc)

Date: July, 2017

Penetration Test **N° 176**

Depth (cm)	Rt (MN/m2)	Rp (MN/m2)	Qadm (MN/m2)	Qadm (kg/cm2)
0	0	0	0.00	0.00
20	20	12	4.00	40.79
40	20	12	4.00	40.79
60	23	14	4.67	47.59
80	25	18	6.00	61.18
100	27	20	6.67	67.98
120	27	18	6.00	61.18
140	33	20	6.67	67.98
160	35	25	8.33	84.98
180	45	35	11.67	118.97
200	50	40	13.33	135.96
220	60	50	16.67	169.95
240	80	60	20.00	203.94
260	80	70	23.33	237.93
280	85	70	23.33	237.93
300	90	70	23.33	237.93
320	100	50	16.67	169.95
340	110	55	18.33	186.95
360	125	60	20.00	203.94
380	145	70	23.33	237.93
400	150	50	16.67	169.95
420	110	40	13.33	135.96
440	155	15	5.00	50.99
460	165	20	6.67	67.98
480	160	12	4.00	40.79
500	120	15	5.00	50.99
520	180	45	15.00	152.96
540	190	50	16.67	169.95
560	190	20	6.67	67.98
580	200	30	10.00	101.97
600	210	55	18.33	186.95
620	280	80	26.67	271.93
640	300	20	6.67	67.98
660	350	100	33.33	339.91
680	360	105	35.00	356.90
700	380	120	40.00	407.89
720	500	150	50.00	509.86
740				



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LABORATORY OF GEOTECHNICS

PROJECT: IMPROVEMENT OF SUBSTATION & DISTRIBUTION NETWORK - PHASE III

SUB PROJECT: Reconstruction of transmission 110 KV Line Jabana - Birembo

Client: PITRAD IBAMBA LTD.

Operated by: Eng. Venerand GWIZA
Verified by: Eng. Vivien MUNYABURANGA (MSc)

Date: July, 2017

Penetration Test **N° 177**

Depth (cm)	Rt (MN/m2)	Rp (MN/m2)	Qadm (MN/	Qadm (kg/cm2)
0	0	0	0.00	0.00
20	35	20	6.67	67.98
40	33	19	6.33	64.58
60	35	18	6.00	61.18
80	38	21	7.00	71.38
100	38	20	6.67	67.98
120	38	19	6.33	64.58
140	39	21	7.00	71.38
160	40	22	7.33	74.78
180	42	22	7.33	74.78
200	42	25	8.33	84.98
220	45	27	9.00	91.77
240	50	32	10.67	108.77
260	54	35	11.67	118.97
280	55	37	12.33	125.77
300	70	47	15.67	159.76
320	68	49	16.33	166.55
340	80	52	17.33	176.75
360	92	57	19.00	193.75
380	100	67	22.33	227.74
400	100	57	19.00	193.75
420	95	47	15.67	159.76
440	80	52	17.33	176.75
460	90	52	17.33	176.75
480	90	50	16.67	169.95
500	95	57	19.00	193.75
520	100	62	20.67	210.74
540	140	53	17.67	180.15
560	150	60	20.00	203.94
580	150	50	16.67	169.95
600	200	70	23.33	237.93
620	230	80	26.67	271.93
640	255	85	28.33	288.92
660	270	90	30.00	305.92
680	290	80	26.67	271.93
700	380	90	30.00	305.92
720	420	100	33.33	339.91
740	500	150	50.00	509.86
760				

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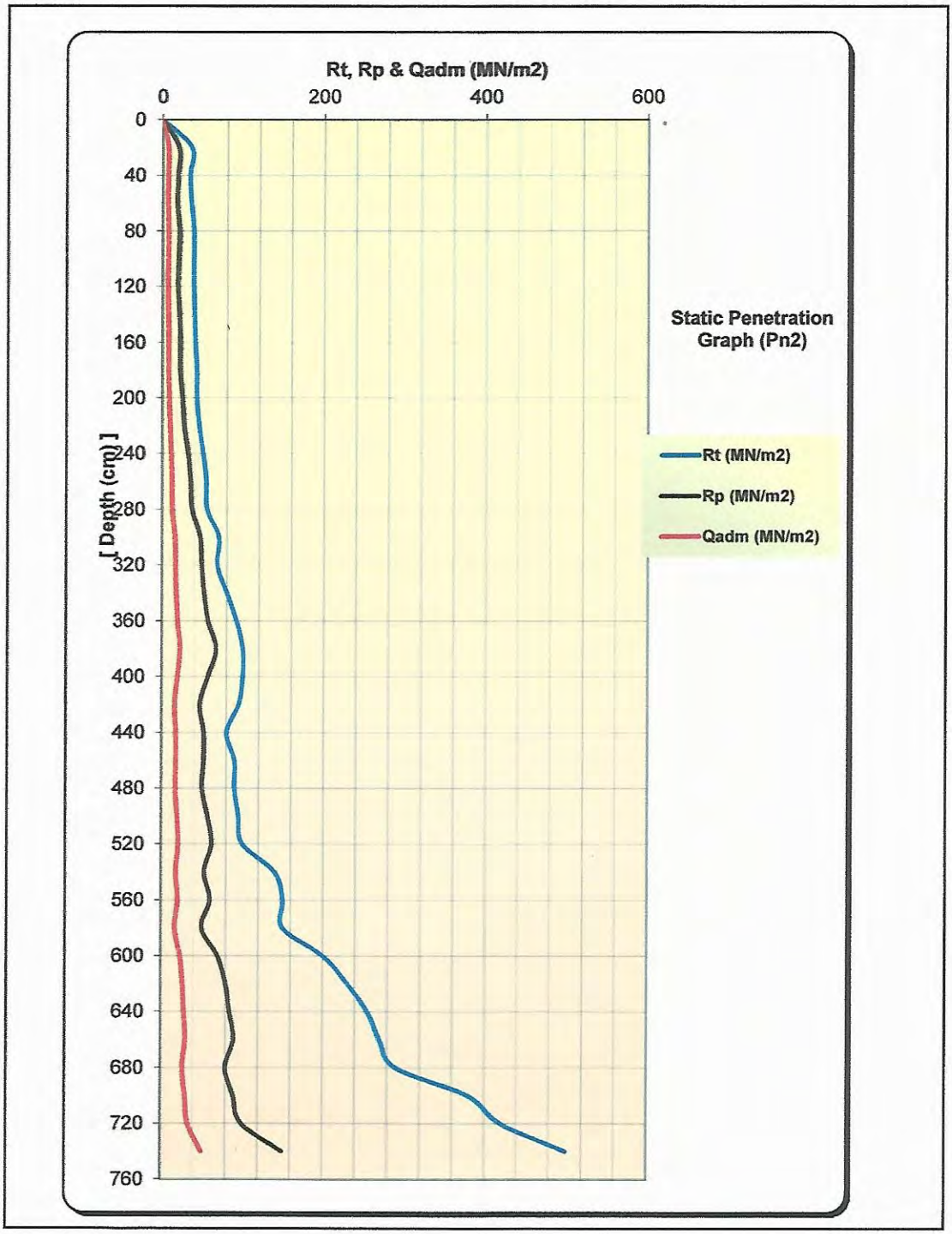

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PROJECT: IMPROVEMENT OF SUBSTATION & DISTRIBUTION NETWORK - PHASE III

SUB PROJECT: Reconstruction of transmission 110 KV Line Jabana - Birembo

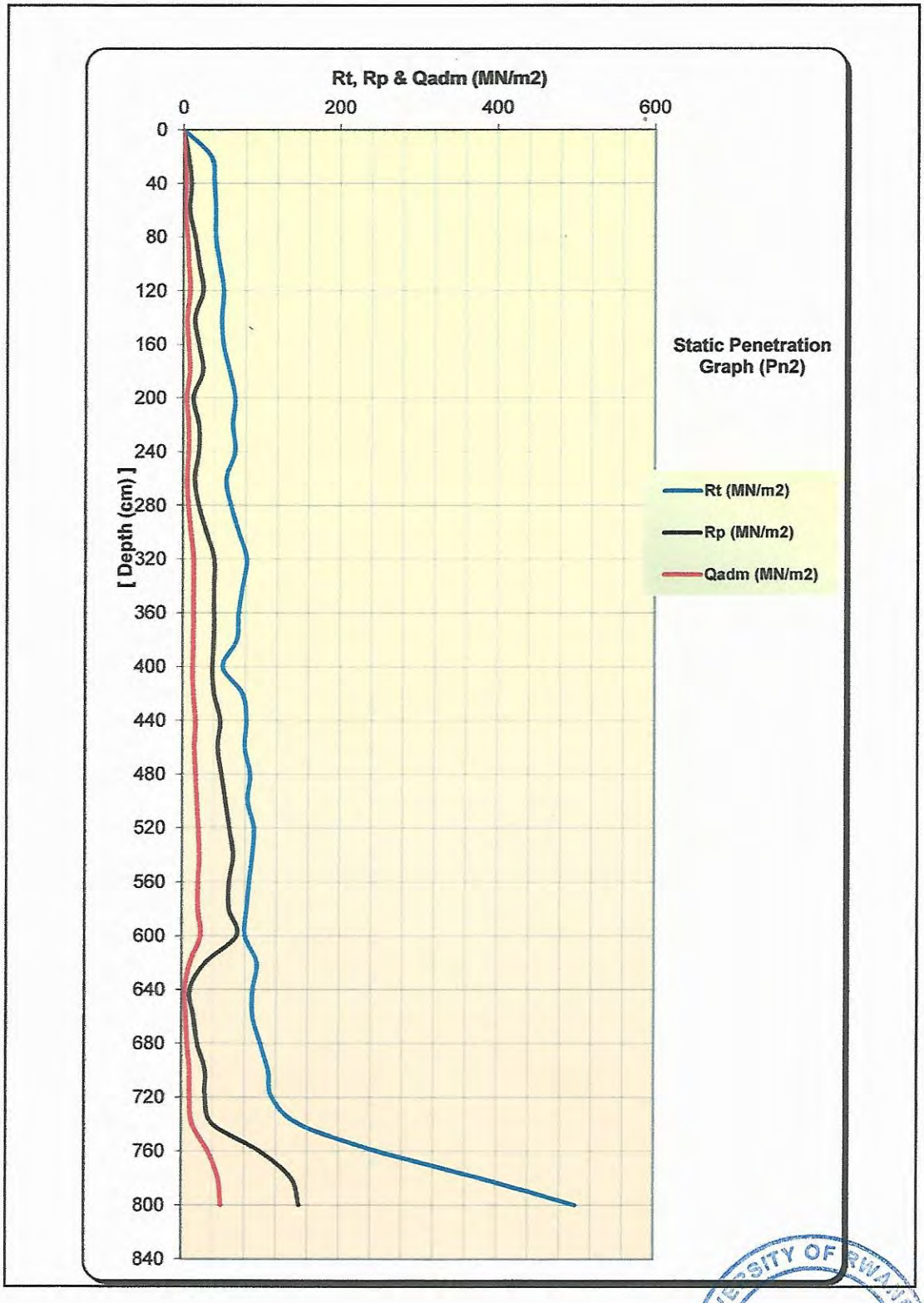
Client: PITRAD IBAMBA LTD.

Operated by: Eng. Venerand GWIZA
Verified by: Eng. Vivien MUNYABURANGA (MSc)

Date: July, 2017

Penetration Test **N° 178**

Depth (cm)	Rt (MN/m2)	Rp (MN/m2)	Qadm (MN/	Qadm (kg/cm2)
0	0	0	0.00	0.00
20	35	6	2.00	20.39
40	39	10	3.33	33.99
60	41	8	2.67	27.19
80	41	15	5.00	50.99
100	46	20	6.67	67.98
120	51	25	8.33	84.98
140	49	15	5.00	50.99
160	51	20	6.67	67.98
180	59	25	8.33	84.98
200	66	13	4.33	44.19
220	63	20	6.67	67.98
240	66	20	6.67	67.98
260	55	15	5.00	50.99
280	61	20	6.67	67.98
300	71	30	10.00	101.97
320	81	40	13.33	135.96
340	76	40	13.33	135.96
360	71	40	13.33	135.96
380	69	40	13.33	135.96
400	51	38	12.67	129.16
420	76	40	13.33	135.96
440	81	48	16.00	163.16
460	79	45	15.00	152.96
480	86	50	16.67	169.95
500	83	55	18.33	186.95
520	91	60	20.00	203.94
540	89	65	21.67	220.94
560	85	60	20.00	203.94
580	82	60	20.00	203.94
600	80	70	23.33	237.93
620	95	30	10.00	101.97
640	90	10	3.33	33.99
660	90	15	5.00	50.99
680	100	20	6.67	67.98
700	110	30	10.00	101.97
720	115	30	10.00	101.97
740	150	40	13.33	135.96
760	250	100	33.33	339.91
780	380	140	46.67	475.87
800	500	150	50.00	509.86
820				



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LABORATORY OF GEOTECHNICS

PROJECT: IMPROVEMENT OF SUBSTATION & DISTRIBUTION NETWORK - PHASE III

SUB PROJECT: Reconstruction of transmission 110 KV Line Jabana - Birembo

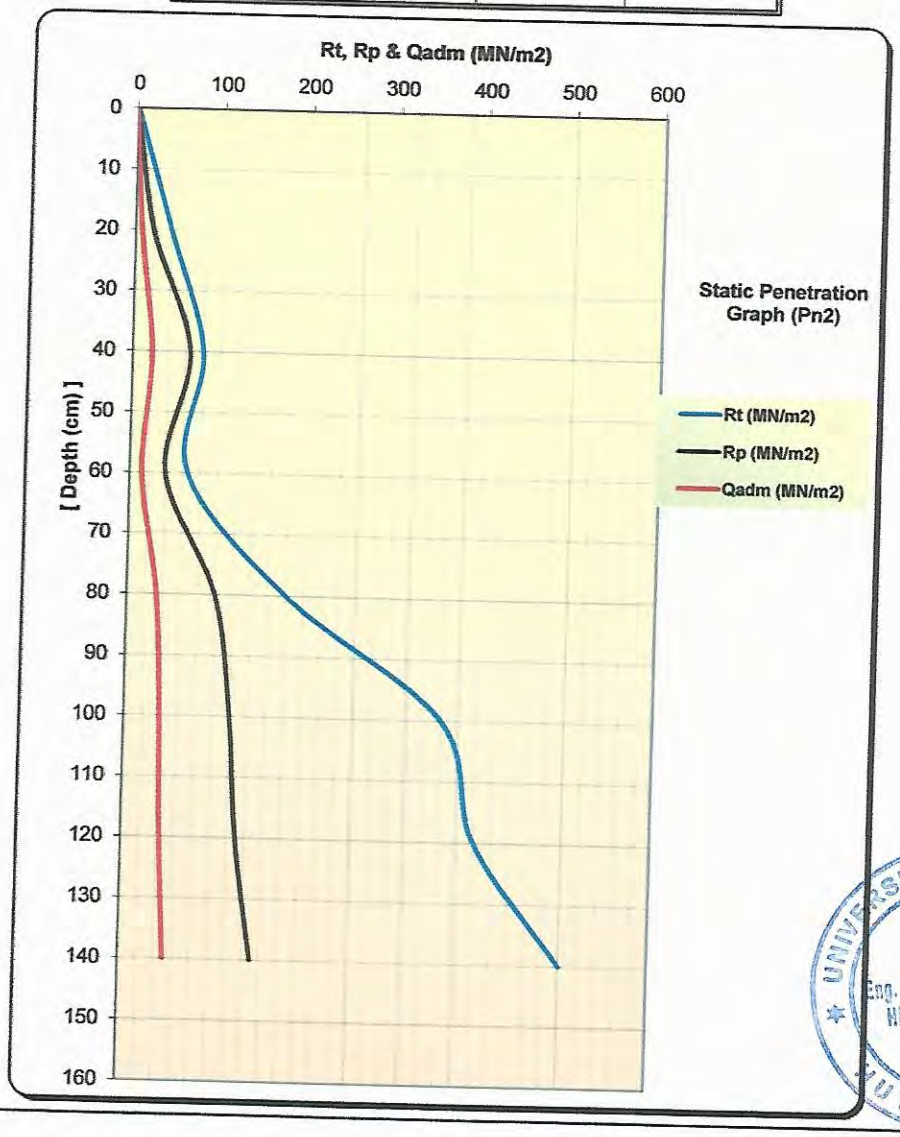
Client: PITRAD IBAMBA LTD.

Operated by: Eng. Venerand GWIZA
Verified by: Eng. Vivien MUNYABURANGA (MSc)

Date: July, 2017

Penetration Test **N° 180**

Depth (cm)	Rt (MN/m2)	Rp (MN/m2)	Qadm (MN/m2)	Qadm (kg/cm2)
0	0	0	0.00	0.00
20	40	20	6.67	67.98
40	80	65	21.67	220.94
60	65	40	13.33	135.96
80	180	100	33.33	339.91
100	360	120	40.00	407.89
120	400	130	43.33	441.88
140	500	150	50.00	509.86
160				



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UNIVERSITY OF RWANDA - COLLEGE OF SCIENCE AND TECHNOLOGY (Huye Campus)
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PROJECT: IMPROVEMENT OF SUBSTATION & DISTRIBUTION NETWORK - PHASE III

SUB PROJECT: Reconstruction of transmission 110 KV Line Jabana - Birembo

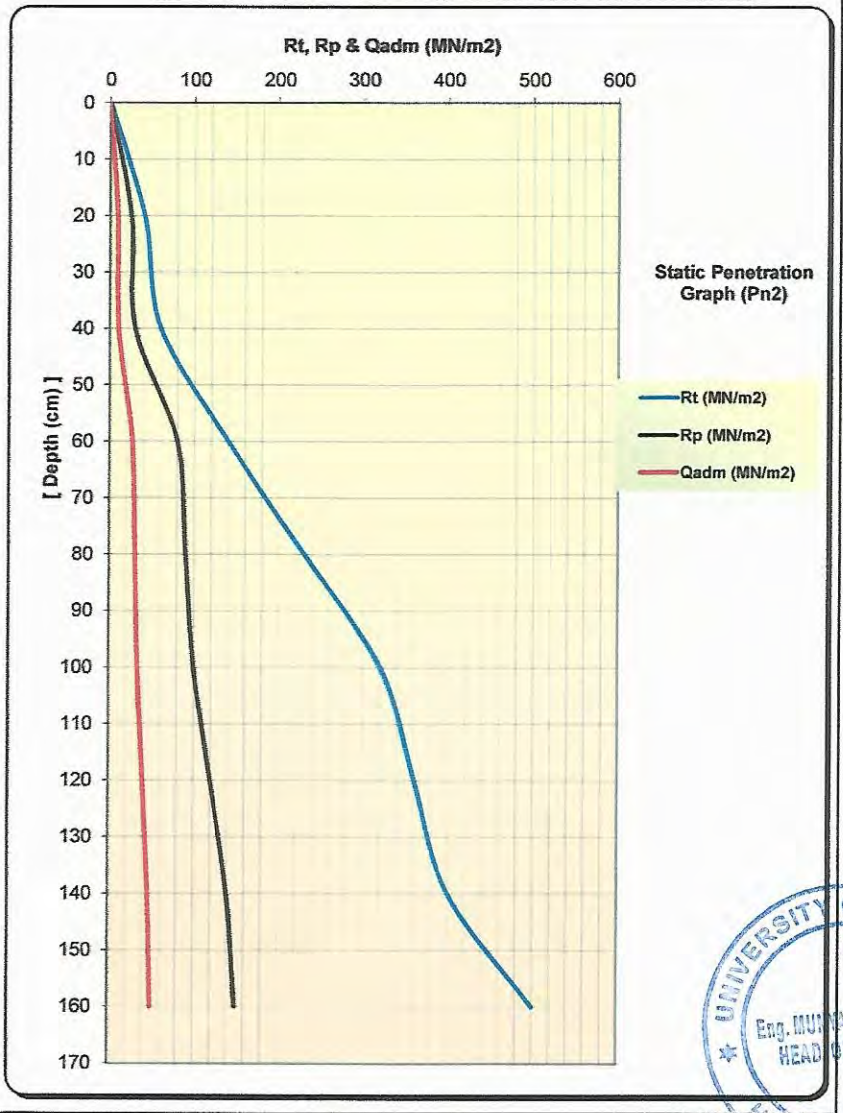
Client: PITRAD IBAMBA LTD.

Operated by: Eng. Venerand GWIZA
Verified by: Eng. Vivien MUNYABURANGA (MSc)

Date: July, 2017

Penetration Test **N° 181**

Depth (cm)	Rt (MN/m2)	Rp (MN/m2)	Qadm (MN/m2)	Qadm (kg/cm2)
0	0	0	0.00	0.00
20	40	25	8.33	84.98
40	60	30	10.00	101.97
60	140	80	26.67	271.93
80	230	90	30.00	305.92
100	320	100	33.33	339.91
120	360	120	40.00	407.89
140	400	140	46.67	475.87
160	500	150	50.00	509.86
180				



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PROJECT: IMPROVEMENT OF SUBSTATION & DISTRIBUTION NETWORK - PHASE III

SUB PROJECT: Reconstruction of transmission 110 KV Line Jabana - Birembo

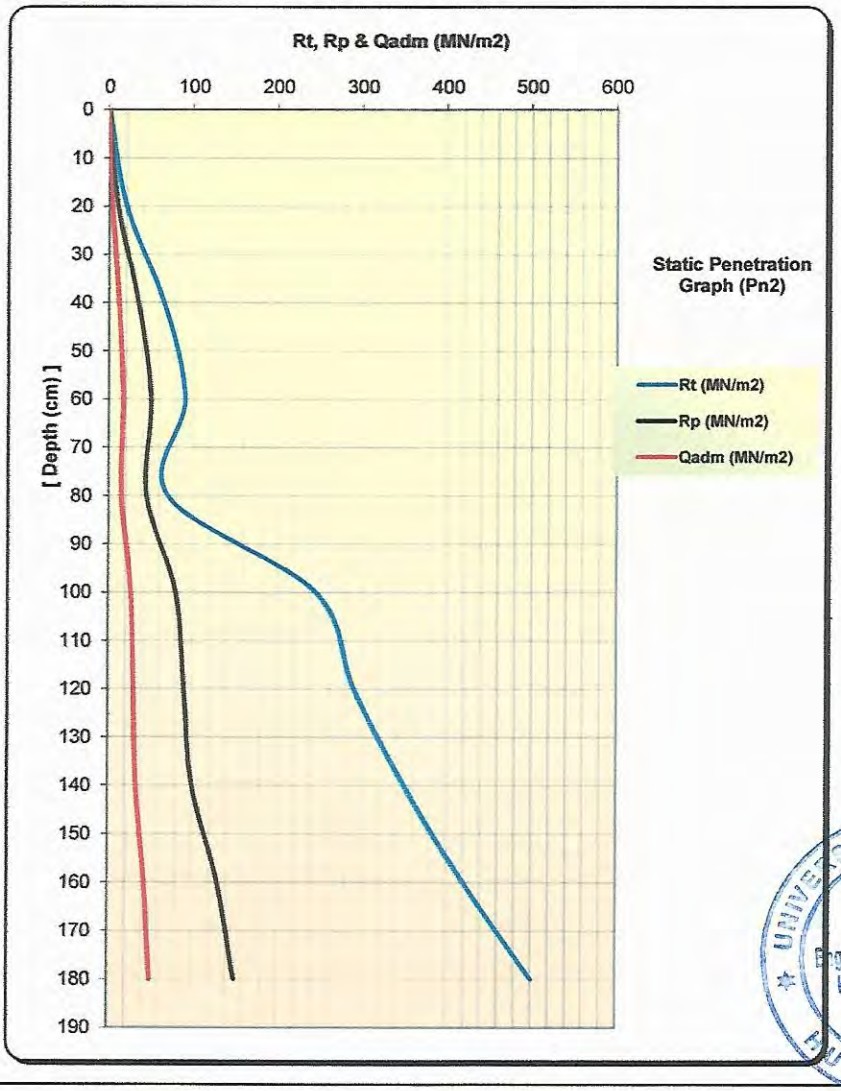
Client: PITRAD IBAMBA LTD.

Operated by: Eng. Venerand GWIZA
Verified by: Eng. Vivien MUNYABURANGA (MSc)

Date: July, 2017

Penetration Test **N° 182**

Depth (cm)	Rt (MN/m2)	Rp (MN/m2)	Qadm (MN/m2)	Qadm (Kg/cm2)
0	0	0	0.00	0.00
20	20	10	3.33	33.99
40	65	35	11.67	118.97
60	90	50	16.67	169.95
80	70	45	15.00	152.96
100	245	80	26.67	271.93
120	290	90	30.00	305.92
140	350	100	33.33	339.91
160	420	130	43.33	441.88
180	500	150	50.00	509.86
200				



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PROJECT: IMPROVEMENT OF SUBSTATION & DISTRIBUTION NETWORK - PHASE III
SUB PROJECT: Reconstruction of transmission 110 KV Line Jabana - Birembo

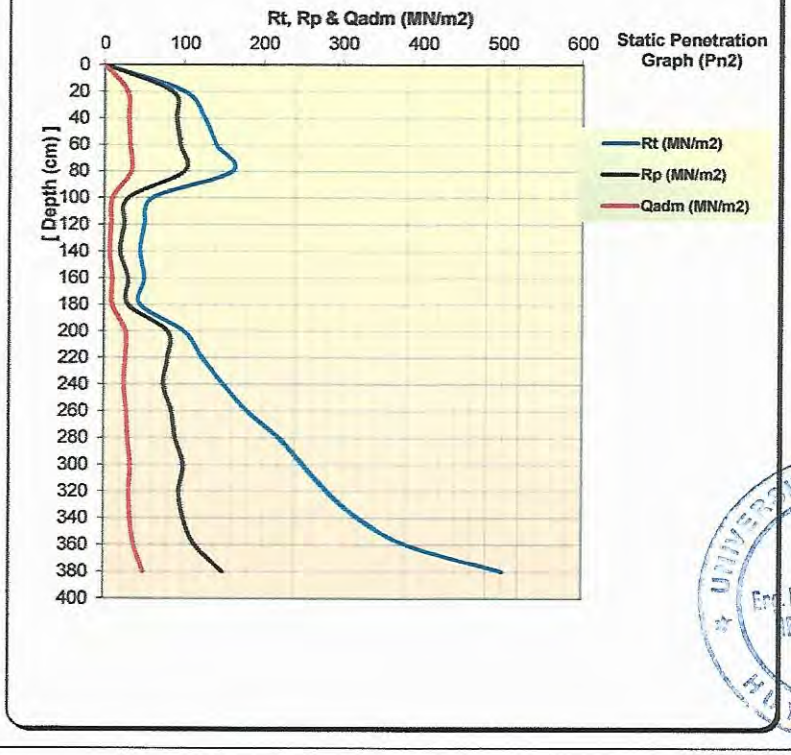
Client: PITRAD IBAMBA LTD.

Operated by: Eng. Venerand GWIZA
Verified by: Eng. Vivien MUNYABURANGA (MSc)

Date: July, 2017

Penetration Test **N° 184**

Depth (cm)	Rt (MN/m2)	Rp (MN/m2)	Qadm (MN/m2)	Qadm (kg/cm2)
0	0	0	0.00	0.00
20	100	85	28.33	288.92
40	125	90	30.00	305.92
60	140	95	31.67	322.91
80	160	100	33.33	339.91
100	60	30	10.00	101.97
120	50	25	8.33	84.98
140	45	20	6.67	67.98
160	50	30	10.00	101.97
180	45	30	10.00	101.97
200	100	80	26.67	271.93
220	123	80	26.67	271.93
240	150	75	25.00	254.93
260	180	85	28.33	288.92
280	220	90	30.00	305.92
300	250	100	33.33	339.91
320	280	95	31.67	322.91
340	320	100	33.33	339.91
360	380	115	38.33	390.89
380	500	150	50.00	509.86
400				



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PROJECT: IMPROVEMENT OF SUBSTATION & DISTRIBUTION NETWORK - PHASE III

SUB PROJECT: Reconstruction of transmission 110 KV Line Jabana - Birembo

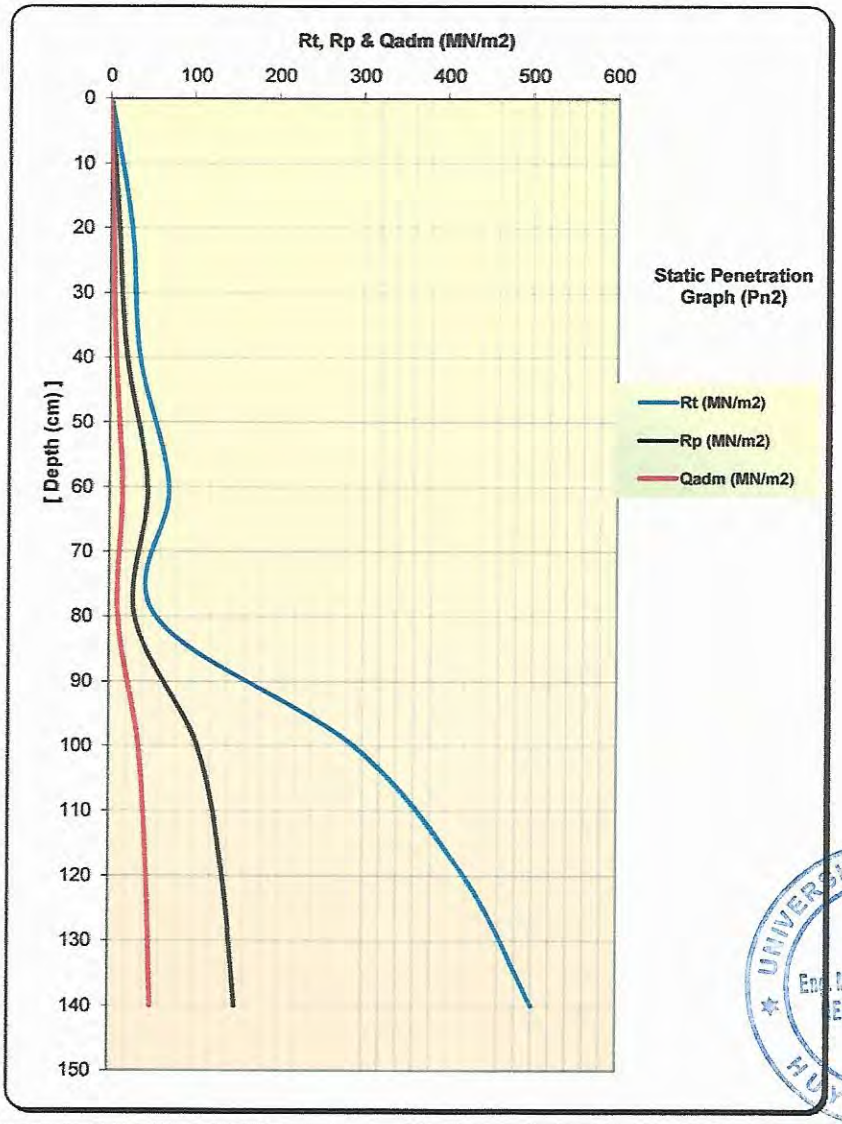
Client: PITRAD IBAMBA LTD.

Operated by: Eng. Venerand GWIZA
Verified by: Eng. Vivien MUNYABURANGA (MSc)

Date: July, 2017

Penetration Test **N° 186**

Depth (cm)	Rt (MN/m2)	Rp (MN/m2)	Qadm (MN/m2)	Qadm (kg/cm2)
0	0	0	0.00	0.00
20	25	10	3.33	33.99
40	35	20	6.67	67.98
60	70	45	15.00	152.96
80	55	30	10.00	101.97
100	290	105	35.00	356.90
120	420	135	45.00	458.87
140	500	150	50.00	509.86
160				



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PROJECT: IMPROVEMENT OF SUBSTATION & DISTRIBUTION NETWORK - PHASE III

SUB PROJECT: Reconstruction of transmission 110 KV Line Jabana - Birembo

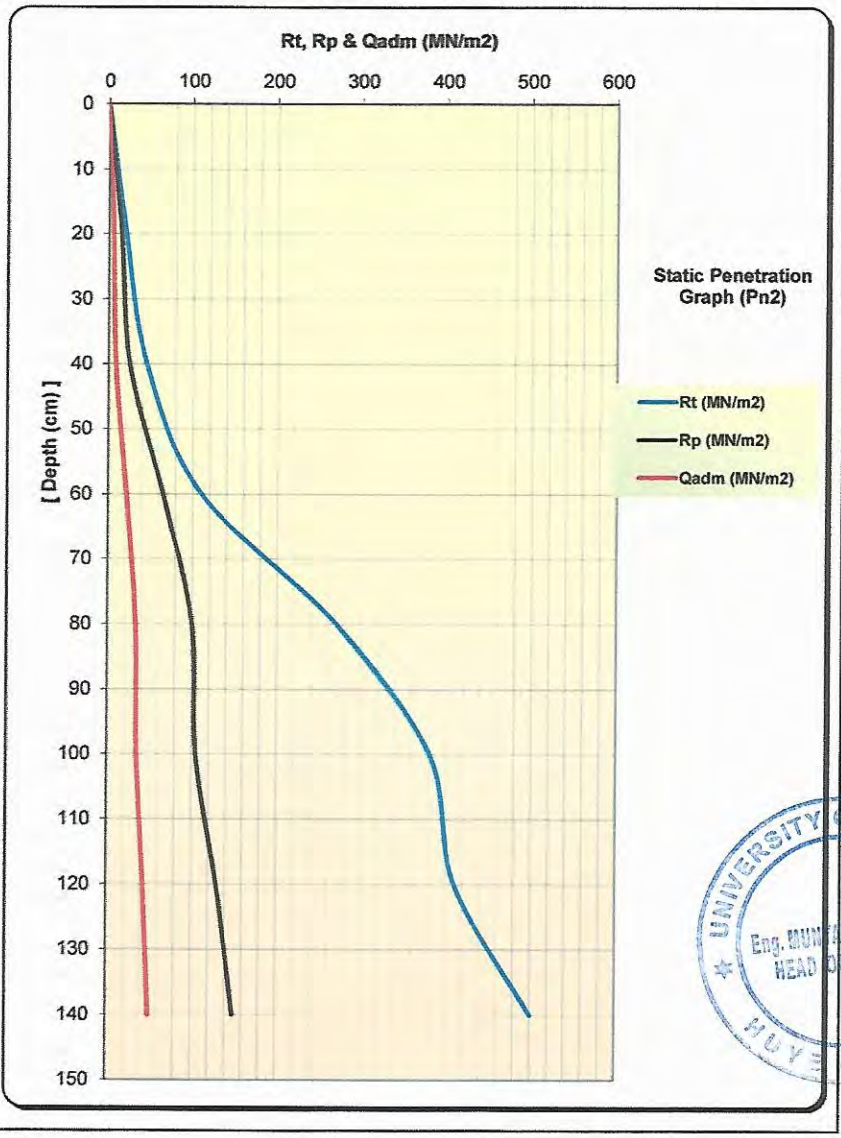
Client: PITRAD IBAMBA LTD.

Operated by: Eng. Venerand GWIZA
Verified by: Eng. Vivien MUNYABURANGA (MSc)

Date: July, 2017

Penetration Test **N° 187**

Depth (cm)	Rt (MN/m2)	Rp (MN/m2)	Qadm (MN/m2)	Qadm (kg/cm2)
0	0	0	0.00	0.00
20	20	15	5.00	50.99
40	45	25	8.33	84.98
60	110	65	21.67	220.94
80	270	100	33.33	339.91
100	380	105	35.00	356.90
120	410	130	43.33	441.88
140	500	150	50.00	509.86
160				



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PROJECT: IMPROVEMENT OF SUBSTATION & DISTRIBUTION NETWORK - PHASE III

SUB PROJECT: Reconstruction of transmission 110 KV Line Jabana - Birembo

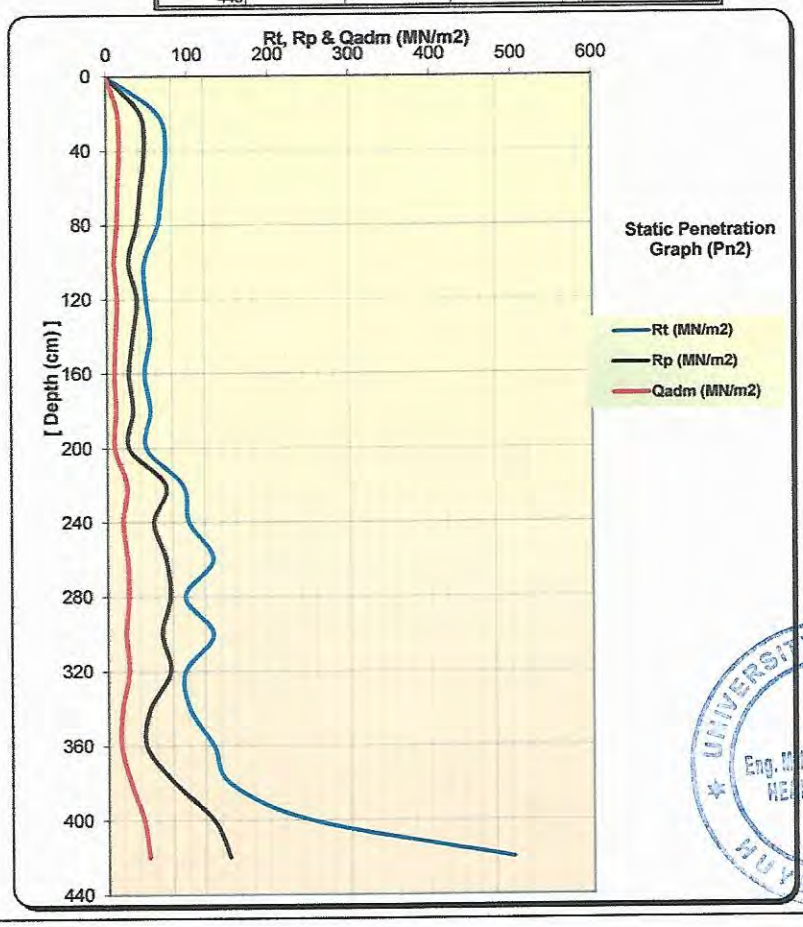
Client: PITRAD IBAMBA LTD.

Operated by: Eng. Venerand GWIZA
Verified by: Eng. Vivien MUNYABURANGA (MSc)

Date: July, 2017

Penetration Test **N° 189**

Depth (cm)	Rt (MN/m2)	Rp (MN/m2)	Qadm (MN/m2)	Qadm (kg/cm2)
0	0	0	0.00	0.00
20	63	42	14.00	142.76
40	73	47	15.67	159.76
60	68	42	14.00	142.76
80	63	37	12.33	125.77
100	46	27	9.00	91.77
120	48	37	12.33	125.77
140	53	32	10.67	108.77
160	46	27	9.00	91.77
180	53	32	10.67	108.77
200	48	27	9.00	91.77
220	93	72	24.00	244.73
240	100	57	19.00	193.75
260	130	72	24.00	244.73
280	95	77	25.67	261.73
300	130	67	22.33	227.74
320	95	77	25.67	261.73
340	100	52	17.33	176.75
360	130	47	15.67	159.76
380	150	82	27.33	278.72
400	250	130	43.33	441.88
420	500	150	50.00	509.86
440				



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PROJECT: IMPROVEMENT OF SUBSTATION & DISTRIBUTION NETWORK - PHASE III

SUB PROJECT: Reconstruction of transmission 110 KV Line Jabana - Birembo

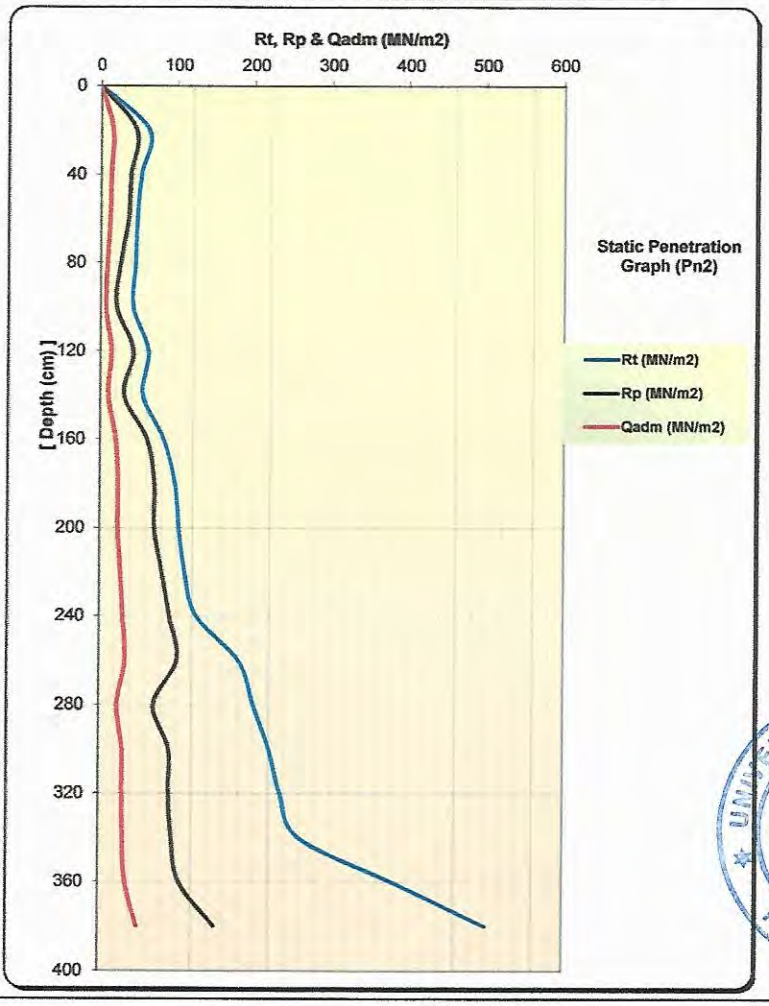
Client: PITRAD IBAMBA LTD.

Operated by: Eng. Venerand GWIZA
Verified by: Eng. Vivien MUNYABURANGA (MSc)

Date: July, 2017

Penetration Test **N°190**

Depth (cm)	Rt (MN/m2)	Rp (MN/m2)	Qadm (MN/m2)	Qadm (Kg/cm2)
0	0	0	0.00	0.00
20	62	46	15.33	156.36
40	52	39	13.00	132.56
60	47	36	12.00	122.37
80	45	26	8.67	88.38
100	42	21	7.00	71.38
120	62	43	14.33	146.16
140	55	31	10.33	105.37
160	82	61	20.33	207.34
180	97	71	23.67	241.33
200	102	71	23.67	241.33
220	110	81	27.00	275.32
240	125	91	30.33	309.32
260	180	101	33.67	343.31
280	200	71	23.67	241.33
300	220	91	30.33	309.32
320	235	91	30.33	309.32
340	260	95	31.67	322.91
360	380	105	35.00	356.90
380	500	150	50.00	509.86
400				



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SUB PROJECT: Reconstruction of transmission 110 KV Line Jabana - Birembo

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Operated by: Eng. Venerand GWIZA
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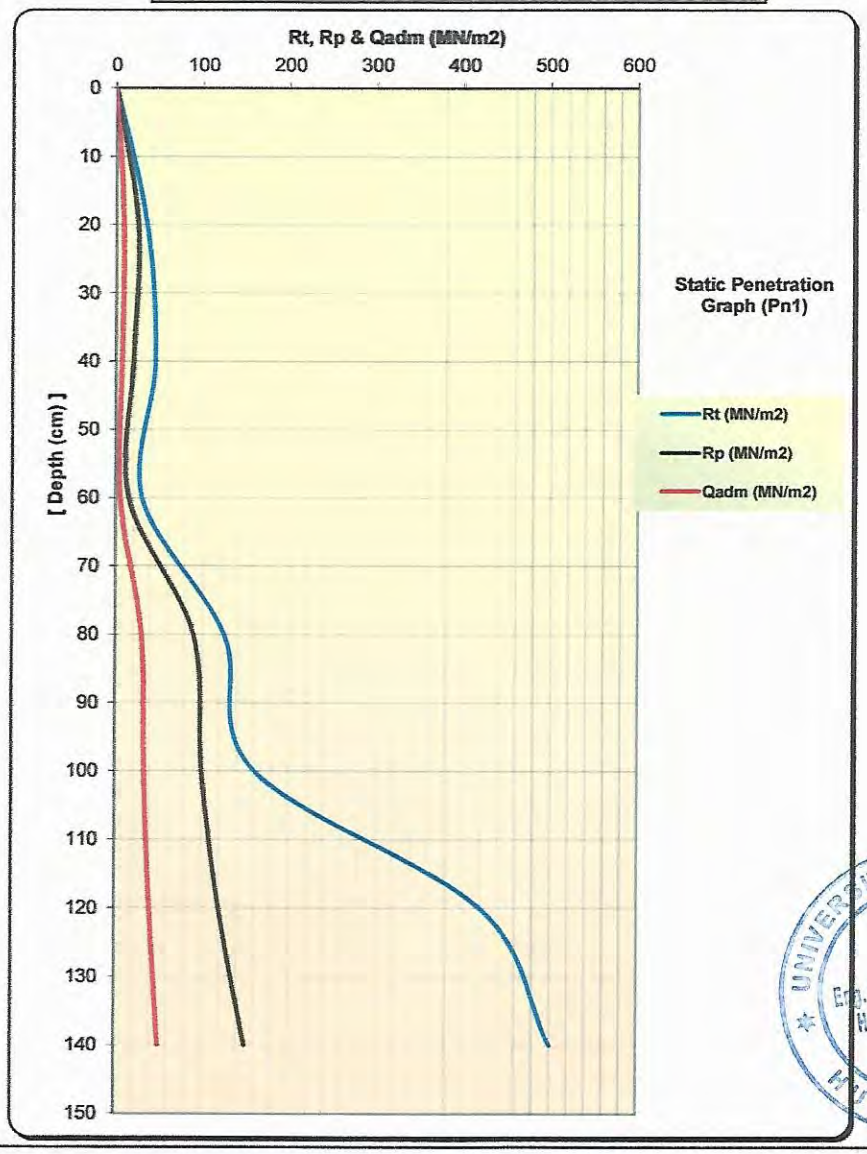
Date: July, 2017

Penetration Test **N° 195**

Depth (cm)	Rt (MN/m2)	Rp (MN/m2)	Qadm (MN/m2)	Qadm (kg/cm2)
0	0	0	0.00	0.00
20	35	25	8.33	84.98
40	45	20	6.67	67.98
60	30	15	5.00	50.99
80	125	90	30.00	305.92
100	160	100	33.33	339.91
120	420	120	40.00	407.89
140	500	150	50.00	509.86
160				



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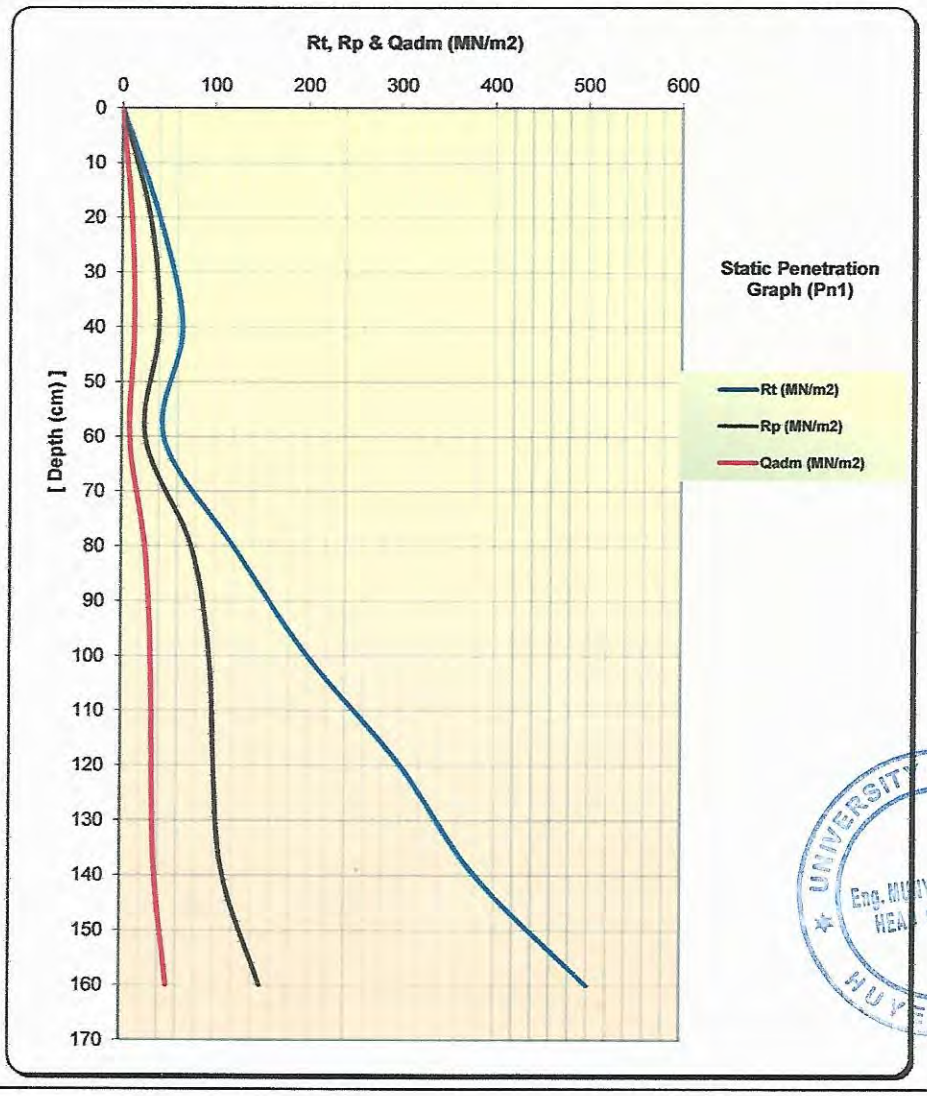
Date: July, 2017

Penetration Test **N° 196**

Depth (cm)	Rt (MN/m2)	Rp (MN/m2)	Qadm (MN/m2)	Qadm (kg/cm2)
0	0	0	0.00	0.00
20	40	30	10.00	101.97
40	65	40	13.33	135.96
60	45	25	8.33	84.98
80	120	75	25.00	254.93
100	200	95	31.67	322.91
120	300	100	33.33	339.91
140	380	110	36.67	373.90
160	500	150	50.00	509.86
180				



SOIL INVESTIGATION (File 2 / 2 : Field & laboratory tests)

II. CHEMICAL TESTS (for 50 points)

- New substation construction site & branch point line 110 kV at Gasogi (7 points) : Sip1 , Sip2, Sip3, Sip4, Sip5, Sip7

- 15 kV Distribution line Gasogi substation - Nyagasambu (15 points) : Sip1 , Sip2, Sip3, Sip4, Sip5, Sip6, Sip7 Sip9, Sip10, Sip11, Sip12, Sip13, Sip15, Sip16 & Sip17 .

- 15 kV Distribution line Gasogi substation - Masaka hospital (15 points) : Sip1 , Sip3, Sip4, Sip5, Sip6, Sip8, Sip9, Sip10, Sip12, Sip13, Sip15, Sip16, Sip17, Sip18 & Sip19.

- Reconstruction of transmission 110 kV line Jabana - Birembo (13 points) : Sip176 , Sip177, Sip178, Sip180, Sip181, Sip182, Sip184, Sip186, Sip187, Sip189, Sip190, Sip195, Sip196 .

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Chemical Lab Results with pH - Chloride & Sulfate

PROJECT: IMPROVEMENT OF SUBSTATION & DISTRIBUTION NETWORK - PHASE IIISoil Study

CLIENT: PITRAD

Operator : NZARAMBA Sylvanus

Date: July, 2017

I. NEW SUBSTATION CONSTRUCTION SITE

SN	Sample#	pH	Chloride (Cl-) (mg/L)	Sulfate (SO_4^{2-}) (mg/L)
1	S1	7.3	85	31
2	S2	6.55	191	11.7
3	S3	7.02	177	16.5
4	S4	6.63	197	19
5	S5	6.67	193	21
6	S6	5.4	78.8	11.2

II BRANCH POINT LINE 110 KV (new substation)

SN	Sample#	pH	Chloride (Cl-) (mg/L)	Sulfate (SO_4^{2-}) (mg/L)
7	S7	6.31	134	37

III. 15 KV DISTRIBUTION LINE GASOGI SUBSTATION - NYAGASAMBU

SN	Sample#	pH	Chloride (Cl-) (mg/L)	Sulfate (SO_4^{2-}) (mg/L)
8	AP1	5.9	92	7.7
9	AP2	4.62	113.4	6.7
10	AP3	5.12	99.7	8.1
11	AP4	6.98	159.3	22
12	AP5	5.4	77.8	16.6
13	AP6	4.34	85	6.7
14	AP7	4.81	79.5	6.2
15	AP9	7.03	226.9	12
16	AP10	6.71	196.7	14.7
17	AP11	4.86	120.5	5.9
18	AP12	6.09	178	12.2
19	AP13	6.43	200.3	14.4
20	AP15	7.1	81	19.4
21	AP16	4.73	213	62.6
22				

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CLIENT: PITRAD

Operator : NZARAMBA Sylvanus

Date: July, 2017

IV. 15 KV DISTRIBUTION LINE GASOGI SUBSTATION - MASAKA HOSPITAL

SN	Sample#	pH	Chloride (Cl^-) (mg/L)	Sulfate (SO_4^{2-}) (mg/L)
23	AP1	5.11	122	13
24	AP3	6.26	99.3	59.2
25	AP4	6.15	79	18
26	AP5	5.79	78	7.6
27	AP6	7.1	201.7	9.4
28	AP8	5.22	85	5
29	AP9	6.75	226.9	9.2
30	AP10	6.83	199.4	8.8
31	AP12	6.15	209.9	10.1
32	AP13	6.64	213.1	12.2
33	AP15	6.55	218.5	9.7
34	AP16	4.91	113.3	6.9
35	[illegible]	[illegible]	[illegible]	[illegible]
36	AP18	4.94	102.2	65.2
37	AP19	5.72	63.8	4.2

V. RECOSTRUCTION OF TRANSMISSION 110 KV JABANA - BIREMBO

SN	Sample#	pH	Chloride (Cl^-) (mg/L)	Sulfate (SO_4^{2-}) (mg/L)
38	[illegible]	[illegible]	[illegible]	[illegible]
39	[illegible]	[illegible]	[illegible]	[illegible]
40	178	7.04	85	70
41	180	6.2	81	8.4
42	181	6.55	145	34
43	182	6.13	101	13.7
44	184	6.22	151	28
45	186	6.44	113.4	68.4
46	187	5.42	92.2	10.9
47	189	7.24	70.9	65.9
48	190	4.81	99.3	62.6
49	195	5.88	176.9	12.2
50	196	6.11	202.4	24
51				

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Chemical Lab Results with pH - Chloride & Sulfate

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CLIENT: **PITRAD**

Operator : NZARAMBA Sylvanus

Date: July, 2017

Legend of Soil Color Ramp	Total Number of Samples
REDDISH BROWN	20
REDDISH GRAY	2
LIGHT REDDISH GRAY	2
LIGHT YELLOWISH BROWN	3
YELLOW	1
LIGHT GRAY	1
LIGHT BROWN	5
YELLOWISH BROWN	3
RED	2
DARK BROWN	1
REDDISH BROWN AND SOME YELLOW	2
BROWN, TRACE GRAY	2
OLIVE	1
GRAY	4
GRAY, TRACE YELLOW	2

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