



#### **CIVIL ENGINEERING MATERIALS TESTING LABORATORIES**

*Provides Geotechnical Investigations, Civil Engineering Materials Laboratory Testing Services, Foundation Investigations, Soil Surveys, Field Densities, All Soil Mechanics Related Lab Tests, Concrete Mix Designs, Cube Compressive Testing, Concrete Cores Boring & Testing, Pavement Investigations & Designs, Asphalt Designs, Stability Tests, Its, Ucs, Bc – Grading, Aggregates Testing*

#### **Harare Head Office**

Wallace Laboratories Building, 4 Plymouth Road, Southerton, Harare,  
Cell: 0771 187 329, 0739 155 761, 0715 887 738, 0735 849 563  
Email: civilworkslab@gmail.com, civilworksquotes@gmail.com

#### **Gweru Branch**

No. 33 Josiah Tongogara Street, Gweru  
Cell: +263 782 299 397 / +263 771 187 329

#### **Beitbridge Branch**

270 Industries Sites, Beitbridge  
Cell: +263 715 887 738 / +263 771 187 329

# UNDP – HARARE HOSPITAL PROPOSED NATPHARM WAREHOUSE

January 17

# 2016

**TO CARRY OUT IN-SITU SOIL SURVEY, LABORATORY TESTS AND  
GEOTECHNICAL REPORTING.**

## GEOTECHNICAL INVESTIGATIONS REPORT



Re: **GEOTECHNICAL INVESTIGATIONS REPORT: - PROPOSED NATPHARM  
WAREHOUSE**

**INTRODUCTION:** *Civilworks Laboratory Private Limited* was commissioned by United Nations Development Programme (UNDP) to carry out soil investigations, laboratory tests and subsequently give a geotechnical investigations report for the proposed Harare NatPharm new ware house project

**BRIEF BACKGROUND OF PROPOSED PROJECT:**



*Figure 1 Proposed New NatPharm construction site*

There is an existing NatPharm warehouse north and just adjacent to Harare Hospital. It is Undp development project that intends to construct a much bigger warehouse to carter for its

healthy fraternity programs. So a new site is given to construct this warehouse on the southern slope of Harare Hospital premises adjacent to Southerton post office. The area is approximately four hectares. The area has been cleared of vegetation long ago for the purposes of urban peasant farming. The geology is basically well graded colluvium coarse quartz from the mountain up hill.

**SCOPE OF WORKS:** To carry out geotechnical investigations for the purposes of determining the:

- (a) Preferred type of foundation.
- (b) Recommended founding depth.
- (c) To give the insitu soil bearing capacity at the recommended depth.
- (d) Recommended type of ground floor (hardcore) treatment.
- (e) Treatment of the insitu soils, i.e. *(either cut to waste or cut to fill)*.
- (f) Recommend the suitability for use of the to be excavated insitu soil.
- (g) Not the the water table if so encountered and
- (h) Any other information pertinent for foundation design.

**SITE IN INVESTIGATIONS:** Ten trial pits positions were identified in this commercial stand Civilworks Laboratory according to laid down random sampling procedures. The brief scope of work was to check for:

- (a) water lodging,
- (b) water table level,
- (c) natural landscape and formations,
- (d) erosion and gullies,
- (e) vegetation type,
- (f) etc.



**SOIL INVESTIGATIONS:** To carry out:

- 1) DCPs' (*in – situ CBR*), to determine founding depth for the proposed structure.
- 2) to excavate ten test pits for the reasons of
  - a) soil profiling,
  - b) soil geological origin identification,
  - c) sampling of in-situ soil profiles,
  - d) etc.



Figure 2 Sample of ten trial holes excavated. General they were of coarse quartz geological origin.

**SITE INFORMATION:** To carry out:

- 1) laboratory testing of soil for soil classification,
- 2) analyses of physical properties of soil,
- 3) to approve whether the in – situ soil is suitable for use as under floor material,
- 4) to recommend foundation depth to the structural engineer and or architect,
- 5) to recommend foundation type,
- 6) to give full details about the site as observed,
- 7) etc.



*Figure 3 on the left is the dark grey humic overburden averaging 200mm thickness general appearing in all ten trial holes. Still the overburden has coarse colluvium quartz in it. On the right is the red coarse seam which extends beyond the standard trial pit excavation depth of 1 000mm is from average 250mm +*



## METHODOLOGY (BRIEFLY)

- **VISUAL ON SITE OBSERVATIONS:** The site was physically identified to us by the NatPharm representative. No there was no need for us to request to see a site lay out plan. It is located in suburb of Southerton in Harare. There existing structure in these four acres. To the north on the crest is the hospital itself. The client proposes to build a single storey warehouse.
- **DCP – Dynamic Cone Penetrometer:** A 1 500mm long DCP apparatus was used for the determination of the founding depth and bearing capacities along the soil profile. After the driving, we then removed the DCP apparatus and at the same spot, started to excavate a trial pit to a depth of around 1 000mm. This means the intention was to determine bearing capacities of this soil profile up to a depth of 1 500mm below ground level.



Figure 4 Dynamic Cone Penetrometer test in progress at Nat Pharm proposed site.

- **PROFILING:** After carrying out the DCP tests on the ten trial pits site, excavation of the trial pits to 1 000mm depth, soil profiling and sampling was done. The geological origin of the subsoil material is basically red coarse quartz. By the thickness of this quartz, it's likely that it washed down to the slope of the Gomo hill. The seam stratum is fawn red quartz. No underlying was noted as the seam was deeper than 1 000mm excavated. Only the seam material was sampled for:
  - i. Laboratory foundation indicators testing
  - ii. CBR,
  - iii. etc

The overburden which is humus same coarse fawn red quartz was not sampled for test because it lies within the first 200mm thickness levels which normally it is excavated to waste in any case.

**DESCRIPTION OF SOIL CONDITIONS (TRIAL PITS):** The general description of soil conditions with reference to the configuration of the ground and variations in levels of the various strata are as follows.

#### SOIL PROFILE

High Humus overburden. Granitic  
Sand with coarse quartz.  
(0 – 200mm)

**(a)OVERBURDEN:** High humus and organic content overburden. The geological origin is being coarse quartz.

Fawn red coarse quartz  
(250mm +)

**(b)SEAM:** The geological origin of this seam which is fawn brown clay could be dolerite. The *in-situ moisture content of* seam was averaging 1.3%.The full thickness of the seam was not determinable as it continued deep down beyond the excavated depth.

**@UNDERLYING:** The underlying was not reached.

**LABORATORY TESTS:** I have limited my description to a brief mention of the various types of tests carried out and attention drawn to results which are unusual or of a particular

significance. This is a summary of different done tests and they are averages of ten similar tests carried out for ten trial pits. For detailed information of the results, please refer to work sheets attached.

- (a) **SOIL CLASSIFICATION:** Qtz/lp-07/lc- 34/lf- 12 being average classification of insitu soil for the seams tested.
- (b) **MODs:** The average ModAASHTO is 2180kg/m<sup>3</sup>. This is an indication that the material is compactible to higher bearing capacities due to an obvious low voids ratio. It shows that it has very high interlocking properties.
- (c) **OPTIMUM MOISTURE CONTENT:** 8.1% average for ten similar tests carried out for the ten trial holes. It does not have high affinity for water meaning it does not have volumetric changes expected due to seasonal changes in underground moisture content. Expansive soils with foundations less than 800mm deep tend to be affected by ground frost and this also leading to patterns of expansion and contraction of the foundation. Such soils do not have such engineering properties.
- (d) **GRADING:** It shows being a coarse graded material with occasional oversize material. The particle size analysis, shows that the in – situ material does not have very free draining particles due to high interlocking of particles. Permeability and porosity in such materials is fair to medium. These are fair draining soils, proper and good drainage is needed away from the structure drainage and in soak way designs.
- (e) **P.I.:** The *plasticity index* is 7.1 being the average for ten indicator tests. It's within the range of up to 12% plastic material
- (f) **LIQUID LIMIT:** 25.1% Shear or slip failure is not expected to structures founded on such cohesive soils.
- (g) **SHRINKAGE LIMIT:** It is 7%. From this foundation indicator and others, shrinkage limit is within the other foundation indicator parameters by its physical characteristics and engineering properties. Meaning that, consequential shrinkage is not expected at all. Shrinkage that affects buildings foundations is one that occurs in the depths of up to 500mm in the subsoil.



- (h) **REJECT INDEX:** It is nil, but there is oversize material which can be screened and used in mass concreting or masonry work on site. Quartz is suitable for use as concreting aggregates.
- (i) **CBR:** The average CBR value of the trial holes is 535. Recommendation is made that it be classified as an **SG9** and therefore treated as **T5**. (*See the under floor recommendations below*).
- (j) **SWELL:** The swell percentage 0.7%.
- (k) **GRADING MODULUS:** It is 2.7 meaning it's a very coarse graded material.

#### DCP RESULTS BRIEF ANALYSIS:

## CIVILWORKS LABORATORY PRIVATE LIMITED

## DYNAMIC CONE PENETROMETER: PENETRATION RECORD

JOB NO.: 01/2016

CLIENT: UNDP ZIMBABWE

JOB: UNDP HARARE HOSPITAL PROPOSED NEW NATPHARM WARE HOUSE

POSITION: HOLE NO 1

LOCATION	NO OF BLOWS	DEPTH (mm)	PENETRATION (mm)		N VALUE (mm/BLOW)	BEARING CAPACITY (kPa)	REMARKS
			PER BLOW	CUMULATIVE			
	0	1440					
	10	1390	5	50	5	630	
	10	1380	1	60	1	>1000	
	10	1350	3	90	3	>1000	
	10	1320	3	120	3	>1000	
	10	1280	4	160	4	795	
	10	1250	3	190	3	>1000	
	10	1170	8	270	8	315	
	10	1060	11	380	11	225	
	10	940	12	500	12	200	
	10	920	2	520	2	>1000	
	10	910	1	530	1	>1000	
	10	900	1	540	1	>1000	
	10	890	1	550	1	>1000	
	10	880	1	560	1	>1000	
	10	870	1	570	1	>1000	
	10	860	1	580	1	>1000	
	10	850	1	590	1	>1000	
				1440			The Harare City
							Council by-laws
							apply on minimum
							foundation depth.
							Stepped reinforced
							Strip foundation or
							pad foundation with
							a ground beam

**REMARKS:**

The site is sloping to the south with a gradient of not more than 9%. A recommendation is made that the structural engineers choose from a pad foundation with a ground beam or a stepped reinforced strip foundation. General all the following ten trial holes exhibited similar physical and engineering properties. A recommendation is made that the design engineer treats the next trial holes with similarity. All 10 holes are dominated by coarse quartz gravel seam of 400mm minimum thickness. It has very high insitu soil bearing capacities.

DATE: 10 January 2016

SIGNED:

Thandazani Sibanda

## CIVILWORKS LABORATORY PRIVATE LIMITED

## DYNAMIC CONE PENETROMETER: PENETRATION RECORD

JOB NO.: 01/2016

CLIENT: UNDP

JOB: Harare Hospital Proposed New NatPharm Warehouse

POSITION:

HOLE NO. 2

LOCATION	NO OF BLOWS	DEPTH (mm)	PENETRATION (mm)		N VALUE (mm/BLOW)	BEARING CAPACITY	REMARKS
			PER BLOW	CUMULATIVE			
	0	1450					
	10	1310	14	140	14	165	
	10	1230	8	220	8	315	
	10	1050	18	400	18	125	
	10	880	17	570	17	135	
	10	760	12	690	12	200	Stepped
	10	680	8	770	8	315	Reinforced
	10	600	8	850	8	315	strip foundation
	10	520	8	930	8	315	or pad foundation
	10	460	6	990	6	500	with ground beam
	10	400	6	1050	6	500	
	10	350	5	1100	5	630	
	10	300	5	1150	5	630	
	10	240	6	1210	6	500	
	10	180	6	1270	6	500	
	10	130	5	1320	6	630	
	10	70	6	1380	6	500	
	6	40	5	1410	5	630	
				1450			

REMARKS:

Highlighted are the proposed founding depth in all trial holes. But the proposed foundation types are stepped reinforced strip foundation and or pad foundation with a ground beam. The next 8 trial holes are also highlighted in light green denoting the proposed founding depth and the two options of foundation types to the design engineer. For such light loaded structures an insitu soil bearing capacity of >150kpa will suffice as the founding depth of a structure of a warehouse without widening the bases.

DATE: 10 January 2016

SIGNED:

Thandazani Sibanda



# DYNAMIC CONE PENETROMETER: PENETRATION RECORD

JOB NO.: 01/2016

CLIENT: UNDP

JOB: HARARE HOSPITAL PROPOSED NEW NATPHARM WAREHOUSE

POSITION:

HOLE NO. 3

LOCATION	NO OF BLOWS	DEPTH (mm)	PENETRATION (mm)		N VALUE (mm/BLOW)	BEARING CAPACITY (kPa)	REMARKS
			PER BLOW	CUMULATIVE			
	0	1460					
	10	1370	9	90	9	280	
	10	1320	5	140	5	630	
	10	1300	2	160	2	>1000	
	10	1270	3	190	3	>1000	
	10	1240	3	220	3	>1000	
	10	1190	5	270	5	630	
	10	1140	5	320	5	630	
	10	940	20	520	20	110	
	10	850	9	610	9	280	
	10	760	9	700	9	280	Same as previous
	10	620	14	840	14	165	trial holes
	10	530	9	930	9	280	
	10	480	5	980	5	630	
	10	400	8	1060	8	315	
	10	310	9	1150	9	280	
	10	220	9	1240	9	280	
	10	150	7	1310	7	400	
	10	80	7	1380	7	400	
	4	40	10	1420	10	250	
				1460			

REMARKS:

Same as previous trial holes

DATE:

10-Jan-16

SIGNED:

Thandazani Sibanda

## CIVILWORKS LABORATORY PRIVATE LIMITED

## DYNAMIC CONE PENETROMETER: PENETRATION RECORD

JOB NO.: 01/2016

CLIENT: UNPD

JOB: HARARE HOSPITAL PROPOSED NEW NATPHARM WAREHOUSE

POSITION:

HOLE NO 4

LOCATION	NO OF BLOWS	DEPTH (mm)	PENETRATION (mm)		N VALUE (mm/BLOW)	BEARING CAPACITY (kPa)	REMARKS
			PER BLOW	CUMULATIVE			
	0	1440					
	10	1360	8	80	8	315	
	10	1310	5	130	5	630	
	10	1210	10	230	10	250	
	10	1130	8	310	8	315	
	10	1030	10	410	10	250	
	10	910	12	530	12	200	
	10	780	15	680	15	155	
	10	640	12	800	12	200	Same as
	10	580	8	880	8	315	previous trial
	10	490	7	950	7	400	holes
	10	420	7	1020	7	400	
	10	350	7	1090	7	400	
	10	270	8	1170	8	315	
	10	220	5	1220	5	630	
	10	150	7	1290	7	400	
	10	80	7	1360	7	400	
	6	40	7	1400	7	400	
				1440			

REMARKS:

Refer to trial holes 1 and 2 recommendations and remarks.

DATE: 10 January 2016

SIGNED:

Thandazani Sibanda

## CIVILWORKS LABORATORY PRIVATE LIMITED

## DYNAMIC CONE PENETROMETER: PENETRATION RECORD

JOB NO.: 01/2016

CLIENT: UNDP

JOB: HARARE HOSPITAL PROPOSED NEW NATPHARM WARE HOUSE

POSITION:

HOLE NO 5

LOCATION	NO OF BLOWS	DEPTH (mm)	PENETRATION (mm)		N VALUE (mm/BLOW)	BEARING CAPACITY (kPa)	REMARKS
			PER BLOW	CUMULATIVE			
	0	1450					
	10	1280	17	170	17	135	
	10	1250	3	200	3	>1000	
	10	1220	3	230	3	>1000	
	10	1200	2	250	2	>1000	
	10	1180	2	270	2	>1000	
	10	1160	2	290	2	>1000	
	10	1140	2	310	2	>1000	
	10	1060	8	390	8	315	
	10	900	16	550	16	145	
	10	560	34	890	34	59	Same as
	10	440	12	1010	12	200	previous trial
	10	280	16	1170	16	145	holes
	10	180	10	1270	10	250	
	10	90	9	1360	9	280	
	6	40	8	1410	8	315	
				1450			

REMARKS:

Refer to recommendations and remarks of trial holes 1 and 2.

DATE: 7 January 2016

SIGNED:

Thandazani Sibanda



## CIVILWORKS LABORATORY PRIVATE LIMITED

## DYNAMIC CONE PENETROMETER: PENETRATION RECORD

JOB NO.: 01/2016

CLIENT: UNDP

JOB: HARARE HOSPITAL NEW NATPHARM WAREHOUSE

POSITION:

HOLE NO 6

LOCATION	NO OF BLOWS	DEPTH (mm)	PENETRATION (mm)		N VALUE (mm/BLOW)	BEARING CAPACITY (kPa)	REMARKS
			PER BLOW	CUMULATIVE			
	0	1450					
	10	1240	21	210	21	105	
	10	1020	22	430	22	100	
	10	940	8	510	8	315	
	10	790	15	660	15	155	
	10	650	14	800	14	165	
	10	560	9	890	9	280	Refer to
	10	460	10	990	10	250	previous trial
	10	360	10	1090	10	250	holes
	10	270	9	1180	9	280	
	10	160	11	1290	11	225	
	10	70	9	1380	9	280	
	4	40	8	1410	8	315	
				1450			

REMARKS:

Refer to trial holes 1 and 2 recommendations and remarks

DATE: 10 January 2016

SIGNED:

Thandazani Sibanda

## CIVILWORKS LABORATORY PRIVATE LIMITED

## DYNAMIC CONE PENETROMETER: PENETRATION RECORD

JOB NO.: 01/2018

CLIENT: UNDP

JOB: HARARE HOSPITAL PROPOSED NEW NATPHARM WAREHOUSE

POSITION:

HOLE NO 7

LOCATION	NO OF BLOWS	DEPTH (mm)	PENETRATION (mm)		N VALUE (mm/BLOW)	BEARING CAPACITY (kPa)	REMARKS
			PER BLOW	CUMULATIVE			
	0	1430					
	10	1360	7	70	7	400	
	10	1320	4	110	4	795	
	10	1260	6	170	6	500	
	10	1200	6	230	6	500	
	10	1140	6	290	6	500	
	10	1040	10	390	10	250	
	10	930	11	500	11	225	
	10	820	11	610	11	225	
	10	710	11	720	11	225	Refer to
	10	630	8	800	8	315	previous trial
	10	540	9	890	9	280	holes
	10	440	10	990	10	250	
	10	320	12	1110	12	200	
	10	180	14	1250	14	165	
	10	80	10	1350	10	250	
	4	40	10	1390	10	400	
				1430			

REMARKS:

Refer to recommendations and remarks of trial holes 1 and 2.

DATE: 10 January 2018

SIGNED:

Thandazani Sibanda

## CIVILWORKS LABORATORY PRIVATE LIMITED

## DYNAMIC CONE PENETROMETER: PENETRATION RECORD

JOB NO.: 01/2016

CLIENT: UNDP

JOB: HARARE HOSPITAL PROPOSED NEW NATPHARM WAREHOUSE

POSITION:

HOLE NO 8

LOCATION	NO OF BLOWS	DEPTH (mm)	PENETRATION (mm)		N VALUE (mm/BLOW)	BEARING CAPACITY (kPa)	REMARKS
			PER BLOW	CUMULATIVE			
	0	1430					
	10	1340	9	90	9	280	
	10	1290	5	140	5	630	
	10	1270	2	160	2	>1000	
	10	1240	3	190	3	>1000	
	10	1210	3	220	3	>1000	
	10	1170	4	260	4	795	
	10	1120	5	310	5	630	
	10	1040	8	390	8	315	
	10	930	11	500	11	225	
	10	830	10	600	10	250	
	10	720	11	710	11	225	refer to previous
	10	620	10	810	10	250	trial holes
	10	510	11	920	11	225	
	10	420	9	1010	9	280	
	10	310	11	1120	11	225	
	10	210	10	1220	10	250	
	10	90	12	1340	12	200	
	7	40	7	1390	7	400	
				1430			

REMARKS:

Refer to trial holes 1 and 2 comments. Recommendations and remarks

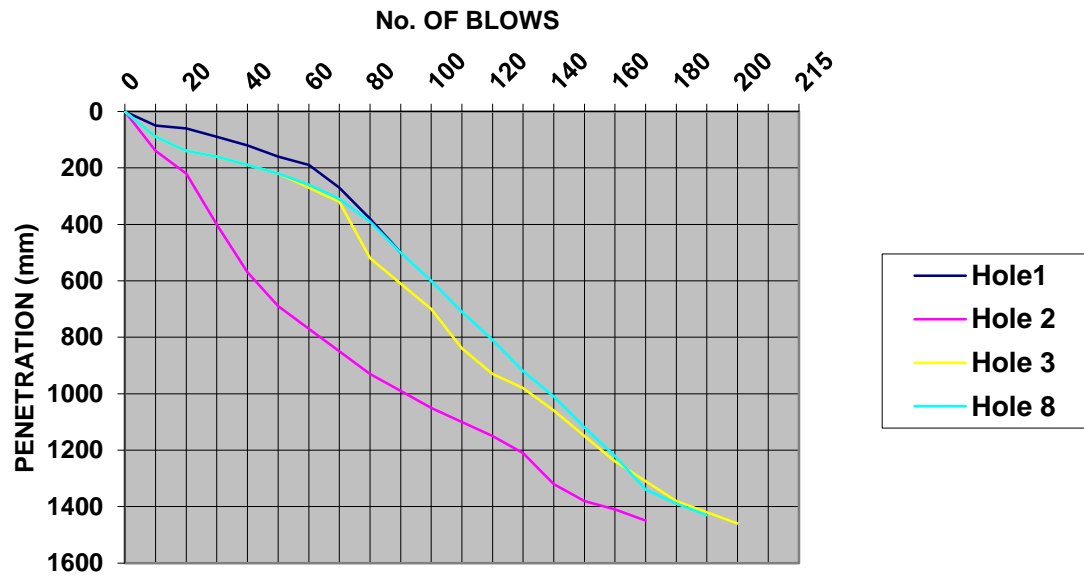
DATE: 10 January 2016

SIGNED:

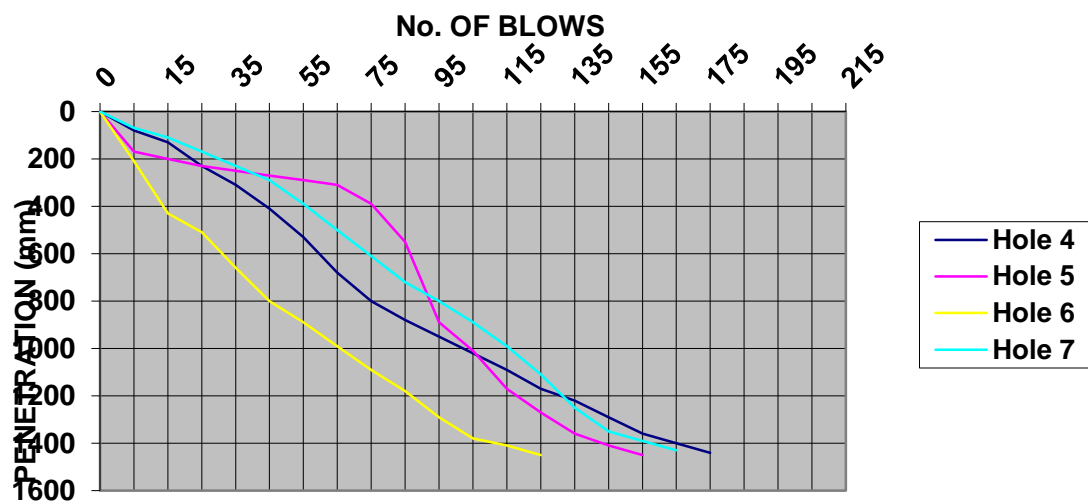
Thandazani Sibanda



### UNDP Harare Hospital New NatPharm E Warehouse - DCP TEST RESULTS



### UNDP Harare Hospital New NatPharm Warehouse - DCP TEST RESULTS



## CIVILWORKS LABORATORY PRIVATE LIMITED

## DYNAMIC CONE PENETROMETER: PENETRATION RECORD

JOB NO.: 01/2016

CLIENT: UNDP ZIMBABWE

JOB: UNDP HARARE HOSPITAL PROPOSED NEW NATPHARM WARE HOUSE

POSITION: HOLE NO 9

LOCATION	NO OF BLOWS	DEPTH (mm)	PENETRATION (mm)		N VALUE (mm/BLOW)	BEARING CAPACITY (kPa)	REMARKS
			PER BLOW	CUMULATIVE			
	0	1460					
	10	1370	9	90	9	280	
	10	1350	2	110	2	>1000	
	10	1330	2	130	2	>1000	
	10	1310	2	150	2	>1000	
	10	1280	3	180	3	>1000	
	10	1240	4	220	4	795	
	10	1140	10	320	10	250	
	10	930	21	530	21	105	
	10	810	12	650	12	200	
	10	750	6	710	6	500	Stepped
	10	670	8	790	8	315	Reinforced
	10	580	9	880	9	280	Strip foundation
	10	490	9	970	9	280	or pad with
	10	390	10	1070	10	250	ground beam
	10	290	10	1170	10	250	
	10	220	7	1240	7	400	
	10	150	7	1310	7	400	
	10	60	9	1400	9	280	
	3	40	7	1420	7	400	
				1460			

REMARKS:

DATE: 10 January 2016

SIGNED:

Thandazani Sibanda

## CIVILWORKS LABORATORY PRIVATE LIMITED

## DYNAMIC CONE PENETROMETER: PENETRATION RECORD

JOB NO.: 01/2016

CLIENT: UNDP

JOB: Harare Hospital Proposed New NatPharm Warehouse

POSITION:

HOLE NO. 10

LOCATION	NO OF BLOWS	DEPTH (mm)	PENETRATION (mm)		N VALUE (mm/BLOW)	BEARING CAPACITY	REMARKS
			PER BLOW	CUMULATIVE			
	0	1430					
	10	1290	14	140	14	165	
	10	1270	2	160	2	>1000	
	10	1240	3	190	3	>1000	
	10	1240	0	190	0	>1000	
	10	1230	1	200	1	>1000	
	10	1220	1	210	1	>1000	
	10	1190	3	240	3	>1000	
	10	1130	6	300	6	500	
	10	980	15	450	15	155	
	10	570	41	860	41	47	Stepped Reinforced
	10	430	14	1000	14	165	Strip or pad
	10	380	7	1070	7	400	foundation with
	10	270	9	1160	9	280	ground beam
	10	200	7	1230	7	400	
	10	120	8	1310	8	315	
	10	50	7	1380	7	400	
	2	40	5	1430	5	630	

## REMARKS:

Due to the gradient of the building site (sloping to the south), a recommendation is made to either adopt reinforced strip foundation or pad /& column with a ground beam. General the founding depths are shallow or the minimum allowable by the Harare City Council by - laws on single storey buildings. These remarks are the same for hole number 2 up to hole number 10.

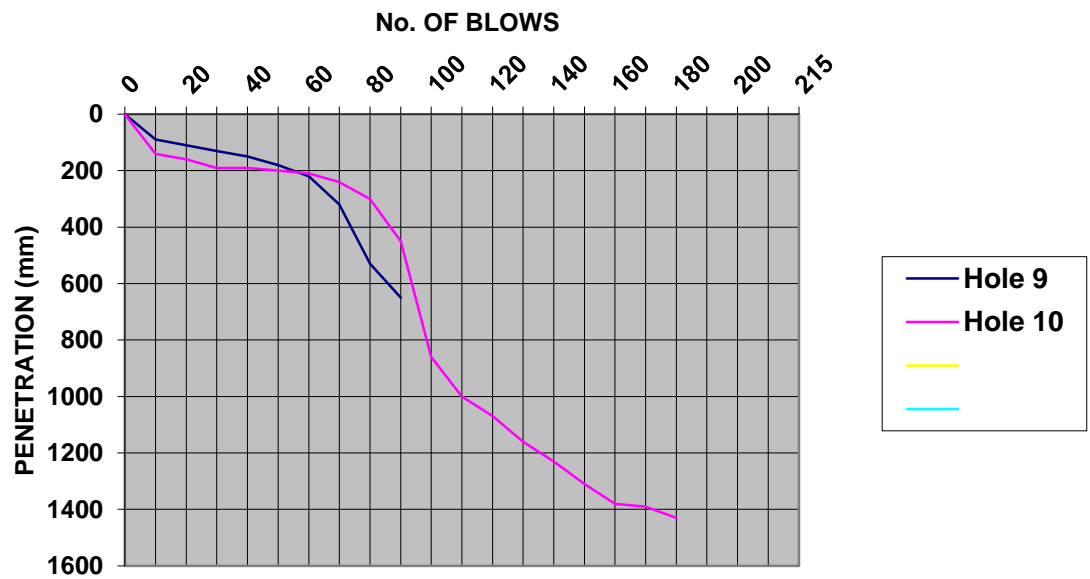
DATE: 10 January 2016

SIGNED:

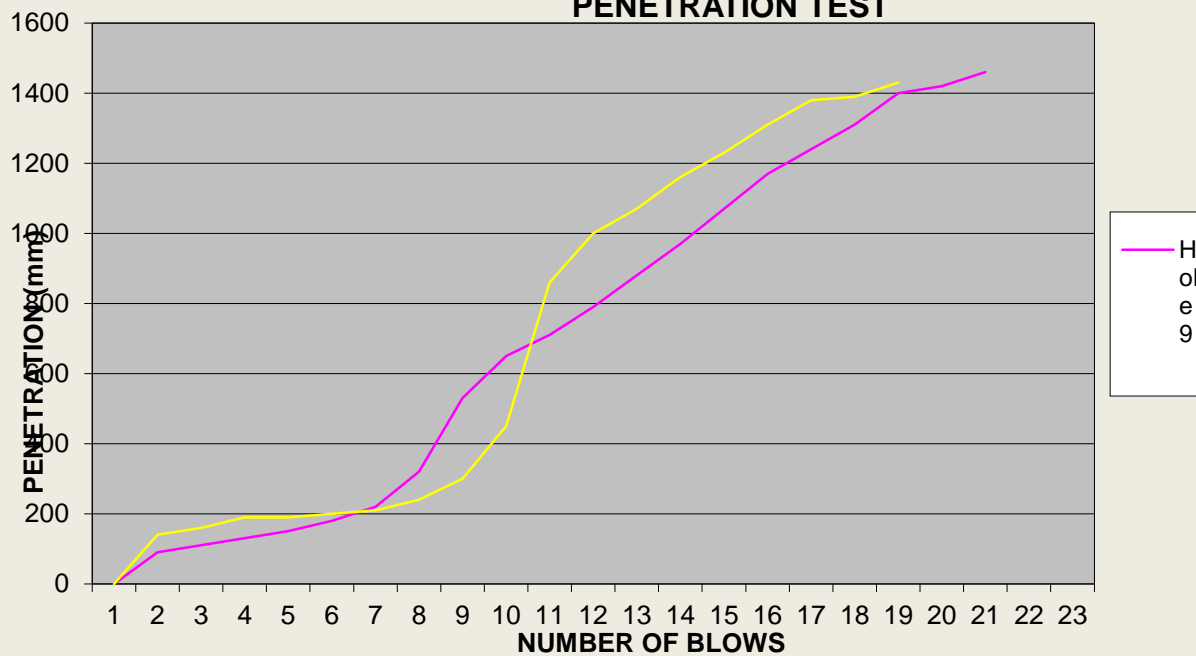
Thandazani Sibanda



### UNDP Harare Hospital New NatPharm E Warehouse - DCP TEST RESULTS



### Harare Hospital New NatPharm Warehouse - DYNAMIC CONE PENETRATION TEST



**RECOMMENDATIONS:**

- a) **FOUNDATION TYPE:** The stepped reinforced strip or stub and column are recommended to the structural engineer as foundation types. Stepped due to the gradient as this will reduce earthworks excavation costs.
- b) **FOUNDATION EXCAVATION DEPTH:** Structural engineer to decide. But we recommend in the range of 900mm depth if the design engineer adopts the reinforced strip foundation. Bases do not need to be widened than normal to distribute loads as the insitu material has more than enough bearing capacity at proposed founding depth.
- c) **“N” VALUE:** Results show “N” values of by enlarge lower than 8 in most trial holes at good founding depths. Normally for such proposed single storey warehouses, an “N” value of ranging to 12max will be accepted.
- d) **BEARING CAPACITY:** For a proposed single storey warehouse like this one, insitu bearing capacities ranging from 150kpa – 200kpa would be accepted for medium loaded single storey structures. .
- e) **CBR:** Its average value is 53. This shows that the subsoil at proposed design depth falls under **SG9** therefore meaning it needs a **T5** treatment. The subgrade treatment of such subsoil’s will be the mandatory removal of the humus overburden thickness. Such overburden excavated can be used for cladding purposes. Then excavate to founding depth and excavate to use as hardcore fill material the material excavated.
- f) **Finally**, the structural engineer and or architect have the final approval on these above recommendations proposals.

**UNDERFLOOR CONSTRUCTION:** The following are suggested foundation treatment.

- a) **Excavate to the founding depth approved by the structural engineer. The excavated in – situ material is suitable for use as backfill. In-situ material with a CBR value greater than 20 can be used as wedge backfill material. e.**

**HARDCORE TREATMENT**

- b) **Each fill layer in the under floor should be compacted to 90% of MOD AASHTO in layers of 150mm (*compacted thickness*) each.**
- c) **The number of 150mm compacted back fill layers will be determined by the structural engineer or architect according to his recommended founding depth.**
- d) **Then the uppermost fill layer (*not of the above*), should be compacted to at least 93% MOD ASSHTO as under floor sub grade.**
- e) **Lay a 150mm (*compacted thickness*) layer of imported approved inert granular gravel material of Tri-axial Class 2.8 or better (*natural*). Compact to at least 98% MOD ASSHTO as under floor base.**
- f) **Spread coal ash or sand blinding.**
- g) **Spread polythene sheeting of recommended microns (*not less than 0.5mm thick or 250 microns*).**

- h) Cast plain in – situ concrete slab in accordance with relevant specifications. A recommendation is proposed of concrete class of 20MPa (*28 days*) cast in - situ with a slump test of 50 – 90mm range.**
- i) Bases and columns should be a minimum of 25Mpa concrete class.**
- j) A concrete mix design and other quality control tests to be done.**
- k) All the above are subject to approval by the structural engineer and or the architect.**