

MEMO

TO	Neath Port Talbot County Borough Council	FROM	Owen George
DATE	15 May 2020	CONFIDENTIALITY	Confidential
SUBJECT	Port Talbot Harbourside Geotechnical Assessment – R2		

INTRODUCTION

This memo details information from historical ground investigations carried out at Port Talbot Harbourside and provides a preliminary assessment of potential settlement and foundation solutions.

BACKGROUND

The site is located adjacent to the Old Dock Road and Harbour Way (A4241) to the south with Cramic Way and Port Talbot Parkway Railway Station on the northern boundary. The site comprises a roughly rectangular parcel of land which is approximately 2.8 hectares (28,000m²).

The British Geological Survey (BGS) geological map of the area (Sheet 247) and online Geology of Britain Viewer indicate the site is underlain by Landscaped Ground (defined as an area where extensive earth moving has occurred) overlying Tidal Flat Deposits (generally described as a consolidated soft silty clay, with layers of sand, gravel and peat) overlying South Wales Middle Coal Measures Formation (generally described as mudstone with coal seams, seatearths and thin sandstone beds).

A Phase 1 Desk Study Report was produced by Opus in July 2017 (report ref: V-C8602.01/OIC/00/XX/RP/01). The report provides information on the ground conditions identified during a ground investigation carried out by Structural Soils Limited in August 2007 (ref. 61667). The investigation comprised fourteen cable percussion borehole locations (of which four were advanced using rotary coring techniques) sunk to a maximum depth of 20.4m bgl and ninety-three machine dug trial pits excavated to a maximum depth of 5.5m bgl.

Additional historical reports produced for the site include:

- Opus International Consultants (UK) Limited (December 2007), Land Reclamation Sites, Port Talbot – Ground Investigation Report (ref. CC7179.16/GI-1.1).
- Opus International Consultants (UK) Limited (March 2009), Port Talbot Central, Port Talbot, South Wales – Site Investigation for HMCS (ref. CC7179.38-GIR-1.0).
- Terra Firma (Wales) Limited (January 2012), Geotechnical & Geo-environmental Report – Proposed Commercial Development – Tata Harbour Side, Port Talbot (ref. 11614).

Additional ground investigation for the Controlled Waters Detailed Quantitative Risk Assessment was undertaken by Quantum on behalf of WSP in 2019. The ground investigation comprised seven cable percussion boreholes, of which six were advanced using rotary coring, to a maximum depth of 10.0m bgl.

In May 2020 a series of 15 plate load tests were performed across the site by Apex Testing Solutions to provide an indication of the strength of the underlying strata across the site. The tests were specified by Neath Port Talbot County Borough Council and comprised the 300mm diameter plate in accordance with BS

1377 Part 9. A copy of the test results are included within Appendix A of this memo. It is understood that tests were undertaken from the ground surface, with numerous tests undertaken on Topsoil which is not ideal and therefore the results are to be treated with caution. Each pressure increment was held for approximately 2minutes before increasing the pressure at the base of the plate. Eight of the tests performed in the south and east of the site included four load increments up to a final pressure of 554.4kN/m² with a maximum settlement of 10.25mm recorded. The other seven tests were undertaken in the western and northern part of the site and reached a maximum pressure between 138.6kN/m² and 415.8kN/m² with a maximum recorded settlement of 14.33mm. It is acknowledged that there is a large difference in the maximum test pressure in the two areas of the site and it is understood that topsoil/softened surface material was present in the western and northern parts of the site but this material was not present in the south and east of the site. The test results demonstrate ultimate bearing capacity of the tested soils exceeds 138kN/m² but topsoil is not an appropriate founding material and should be removed prior to construction. It should also be noted that the load increments were held for 2minutes and this is likely to reflect undrained, elastic settlement, rather than measuring any drained, consolidation settlement of the underlying soils. Any design should consider long-term consolidation settlement of the strata and the impact on serviceability of structures.

A summary of the ground conditions recorded during historical ground investigations at the site is shown in **Table 1**.

Table 1 – Preliminary ground model for Port Talbot Harbourside based on historical borehole data

Geology	Typical Description	Depth to top of stratum (m bgl)	Depth to bottom of stratum (m bgl)	Thickness (m)
Made Ground	Medium dense gravelly silty sand with occasional bands of soft and firm gravelly clay recorded across the site. Gravel is angular to subangular, fine to coarse of ash, slag, clinker, sandstone, brick and concrete.	0.00	0.70 - 4.70	0.70 - 4.70
Cohesive Superficial Deposits	Soft and firm sandy gravelly clay with occasional organic matter. Gravel is subrounded, fine to coarse sandstone.	0.75 – 4.70	0.70 - 6.00	0.15 - 2.80
Granular Superficial Deposits	Medium dense to very dense, grey and brown sandy gravel with low to medium cobble content. Cobbles are angular to subrounded of sandstone. Gravel is fine to coarse, subangular to rounded of sandstone and siltstone.	0.70 – 6.00	6.50 - >20.40	5.50 - >15.70
South Wales Middle Coal Measures Formation	Thinly interbedded strong grey highly weathered sandstone and grey weak highly weathered mudstone	6.50*	>8.00	>1.50

* Bedrock recorded beneath the Granular Superficial Deposits in BHH04R only (i.e. east/ north-east area of the site).

PRELIMINARY CHARACTERISTIC PARAMETERS

Table 2 details the characteristic parameters based on historical ground investigation data for the different strata anticipated at the site.

Table 2 – Preliminary Characteristic Parameters for Port Talbot Harbourside

Geology	Uncorrected SPT N Value	Bulk density, γ (Mg/m ³)	Undrained Shear Strength, C_u (kN/m ²)	Effective Angle of Friction, ϕ' (°)	Drained Stiffness, E' (MN/m ²)	Coefficient of Volume Compressibility, m_v (m ² /MN)
Granular Made Ground	20	20	-	32	20	0.050
Cohesive Made Ground	8	17	40	24	7	0.140
Cohesive Superficial Deposits	12	18	50	25	11	0.090
Granular Superficial Deposits	30	20	-	35	30	0.030

GEOTECHNICAL ASSESSMENT

Ground Model

Based on the available borehole data, the ground conditions across the north/ north-west area of the site generally comprise 3.0m of Granular Made Ground overlying 1.5m of Cohesive Made Ground overlying 0.5m of Cohesive Superficial Deposits overlying Granular Superficial Deposits, proven to a maximum depth of 20.4m bgl.

The ground conditions across the south/ south-east area of the site generally comprise 2m of Granular Made Ground overlying 1m of Cohesive Made Ground overlying Granular Superficial Deposits, proven to a maximum depth of 8.5m bgl.

The underlying South Wales Middle Coal Measures Formation was recorded beneath the Granular Superficial Deposits in BHH04R only at 6.5m bgl (i.e. in the east/ north-east area of the site).

Medium to high groundwater seepage was generally recorded within the Granular Made Ground between 1.0 and 3.5m bgl. For preliminary purposes, groundwater is assumed to be at 1.0m bgl across the site.

Settlement Analysis

The proposed development platform covers an area of approximately 28,000m². The proposed earthworks comprise the placement of 0.6 – 1.0m of imported fill across this area, therefore the approximate volume of fill is between 17,000 and 28,000m³.

Assuming the imported fill has a bulk density of 2.0Mg/m³, the underlying ground is expected to undergo an approximate additional loading of 20kN/m². Preliminary settlement calculations indicate the total settlement as a result of placing the fill at existing ground level would be in the order of 25mm.

Foundation Options

Made Ground varies in thickness and composition across the area of proposed works; therefore, this is not considered to be suitable bearing stratum for foundations.

For low rise or otherwise lightly loaded structures, the underlying Cohesive Superficial Deposits and Granular Superficial Deposits could provide allowable bearing capacities in the order of 85kN/m² and 250kN/m² respectively for shallow pad foundations (assumed dimensions 2m x 2m). Note the Cohesive Superficial Deposits were recorded to overlie the Granular Superficial Deposits across the north/ north western area of the site only.

Ground improvement in the form of vibro-stone columns may be used to increase the bearing capacity of shallow soils by keying the columns into the underlying Granular Superficial Deposits. The columns would be designed to penetrate the Made Ground and Cohesive Superficial Deposits (where present), however the presence of ground obstructions (e.g. existing foundations and cobbles) may limit the effectiveness. Consideration to preferential pathways should also be made in environmentally sensitive areas. The reinforcing action of the stone columns serves to improve the load bearing characteristics of the ground, thereby increasing the allowable bearing capacity to around 125kN/m². It is recommended that the design of ground improvement is undertaken following confirmation of building locations and structural loads.

For a more heavily loaded structure or where the top of the natural ground is located deeper than 2m bgl, consideration may need to be given to piles toeing into the Granular Superficial Deposits. The advice of a reputable piling specialist, experienced in the ground conditions considered here, should be sought. The approximate pile capacity for a single pile has been calculated based on guidance from Tomlinson (2001). **Table 3** details a summary of approximate safe working capacities for a range of pile diameters/ lengths. The following assumptions have been implemented for this assessment:

- Self-weight of the pile and weight of the soil displaced during construction approximately cancel each other out;
- Groundwater assumed to 1m below ground level;
- Assuming suspended floor slabs are adopted;
- No shaft resistance from Made Ground/ Cohesive Superficial Deposits and proposed engineered fill;
- No allowance has been made for negative skin friction resulting from the Cohesive Made Ground/ Superficial Deposits;
- Global factor of safety of 2.5;
- No load testing of working or preliminary piles;
- Pile spacing of at least 3 x pile diameter;
- Pile lengths from existing ground level; and
- C40 Concrete.

Table 3 – Preliminary Pile Calculations for Port Talbot Harbourside

Pile Length (m)	Safe Working Capacity (kN)			
	300mm diameter	450mm diameter	600mm diameter	750mm diameter
10	265	505	810	1150
12	360	670	1070	1550

Floor slabs

Considering the final finished level of the development platform and variable nature of the Made Ground across the site, it is recommended that a suspended floor slab is chosen unless ground improvement is adopted.

APPENDIX A

- Plate bearing test results
- Plate bearing test location plan

**Apex Testing Solutions**

Sturmi Way
Village Farm Industrial Estate
Pyle
Bridgend
CF33 6BZ
Telephone :01656 746762
Facsimile :01656 749096
Email : andrew.grogan@apex-drilling

REPORT No. : D20008-20

CLIENT :

SITE :

MATERIAL DESCRIPTION : See Individual Test Results

DATE TESTED : 04 May 2020

TESTING REQUIRED : 15 No. Plate Load Bearing Tests

RELEVANT SPECIFICATION : BS 1377 : Part 9 : 1990
In House Method / Clients Specification
IAN 73/06 (supersedes HD 25/94)

TEST METHOD : Clause 4.1.6.4.2

TEST RESULTS : See Pages 3 – 17



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 Facsimile :01656 749096
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REPORT No. : D20008-20
 CLIENT :
 SITE :
 TEST LOCATION : 15 No. Locations as instructed by Client
 DEPTH (m) : See Individual Test Results
 Reaction Load : 9T excavator + Load
 Plate Diameter : 300mm
 Seating Pressure : 5kN/m2

TEST RESULTS

kN/m ²	Settlement mm									
Test No.	1	2	3	4	5	6	7	8	9	10
5.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
138.6	2.37	1.12	1.54	5.24	5.75	7.45	6.22	7.92	10.16	7.26
277.2	3.69	2.84	2.67	8.55	8.98	11.05	9.65	-	-	9.81
415.8	4.54	4.69	3.35	10.39	-	-	13.62	-	-	14.33
554.4	5.02	5.36	3.91	-	-	-	-	-	-	-
693.0	-	-	-	-	-	-	-	-	-	-
0.0	-	-	-	-	-	-	-	-	-	-
Equivalent CBR%	2.9	9.3	5.8	0.8	0.7	0.5	0.6	0.5	0.3	0.5
Test No.	11	12	13	14	15					
5.0	0.00	0.00	0.00	0.00	0.00					
138.6	3.20	3.35	2.97	5.40	3.98					
277.2	4.73	5.54	4.00	7.91	6.24					
415.8	5.77	7.35	4.57	9.20	7.60					
554.4	6.46	8.64	5.48	10.25	8.48					
693.0	-	-	-	-	-					
0.0	-	-	-	-	-					
Equivalent CBR%	1.8	1.6	2.0	0.8	1.3					

COMMENTS

During tests 1-3 & 11-15 the machine acting as the reaction lifted, during tests 4 -10 the dials maxed out meaning for each test the full cycle was not able to be completed.

Weather - Sunny

CHECKED BY: L.Davis

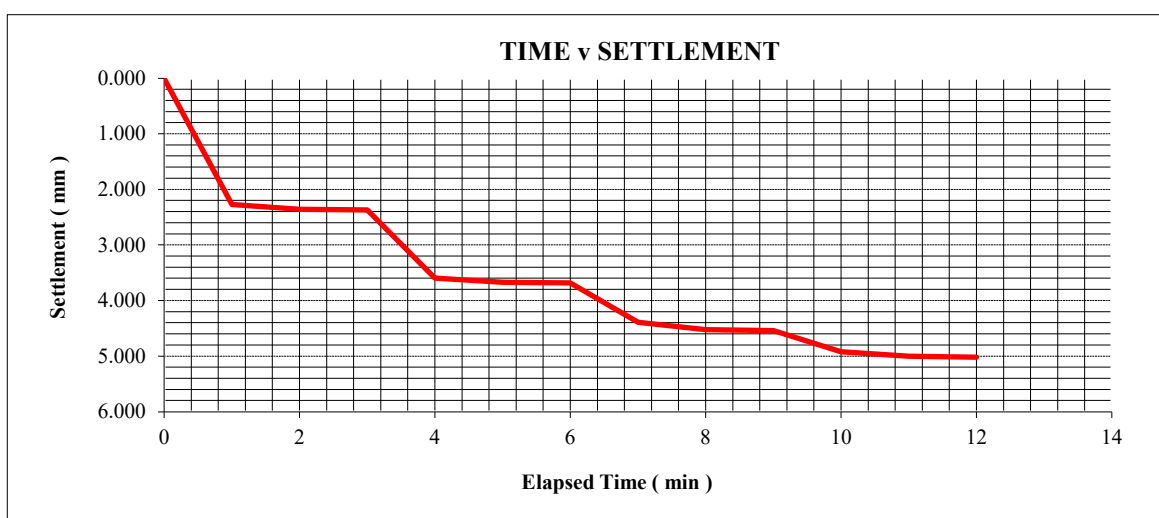
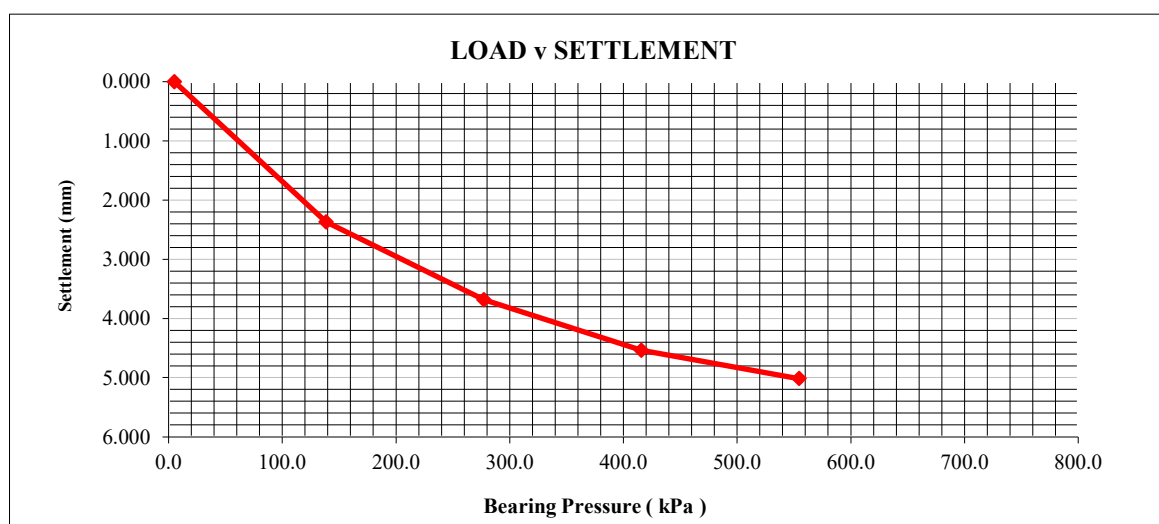
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REPORT No : D20008-20:
CLIENT :
SITE :

TEST RESULTS

TEST No.	: 1
DATE TESTED	: 04 May 2020
SAMPLE TYPE	: Natural
DEPTH (mm)	: EGL
SAMPLE DESCRIPTION	: Top Soil
LOCATION	: Test location 1
Plate Size	: 300 mm
LOAD TO ACHIEVE 1.25mm SETTLEMENT >	: 75.46 kN/m ²
MODULUS OF SUBGRADE REACTION (k_{762}) >	: 26666 kN/m ² /m
Equivalent CBR VALUE >	: 2.9 %

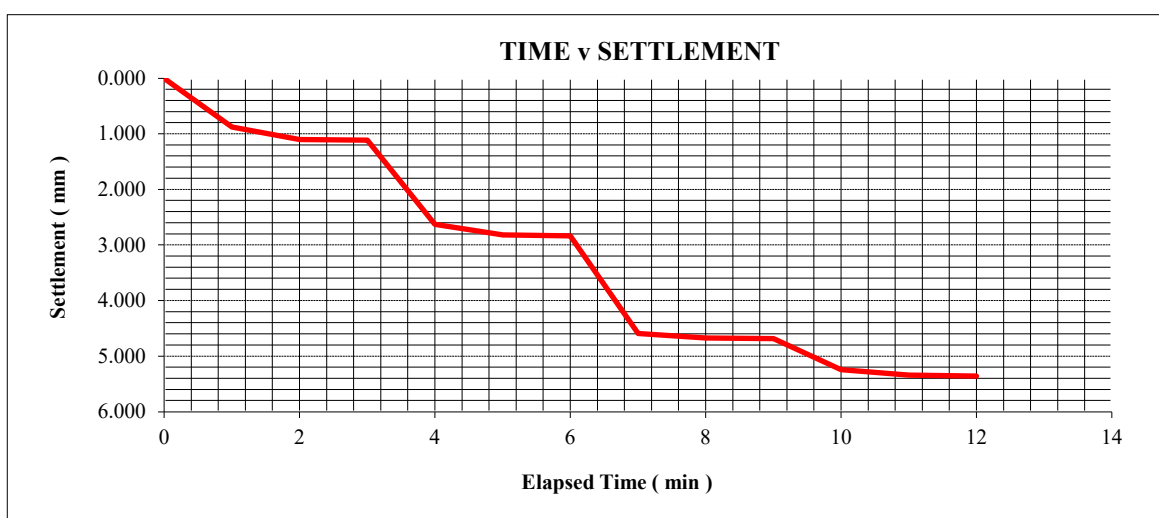
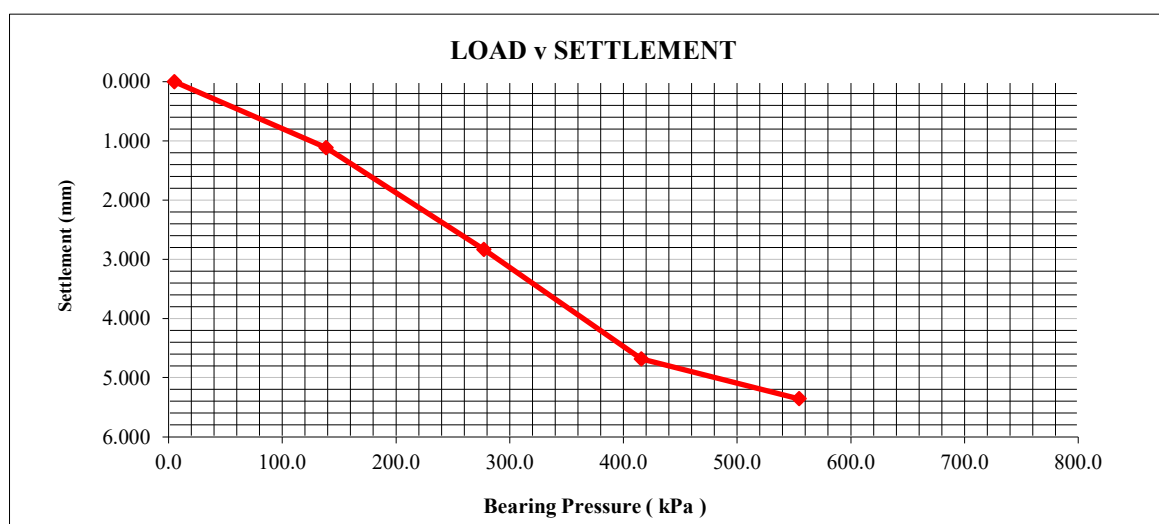




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SITE :

TEST RESULTS

TEST No.	: 2
DATE TESTED	: 04 May 2020
SAMPLE TYPE	: Natural
DEPTH (mm)	: EGL
SAMPLE DESCRIPTION	: Top Soil
LOCATION	: Test location 2
Plate Size	: 300 mm
LOAD TO ACHIEVE 1.25mm SETTLEMENT >	: 149.48 kN/m ²
MODULUS OF SUBGRADE REACTION (k_{762}) >	: 52820 kN/m ² /m
Equivalent CBR VALUE >	: 9.3 %

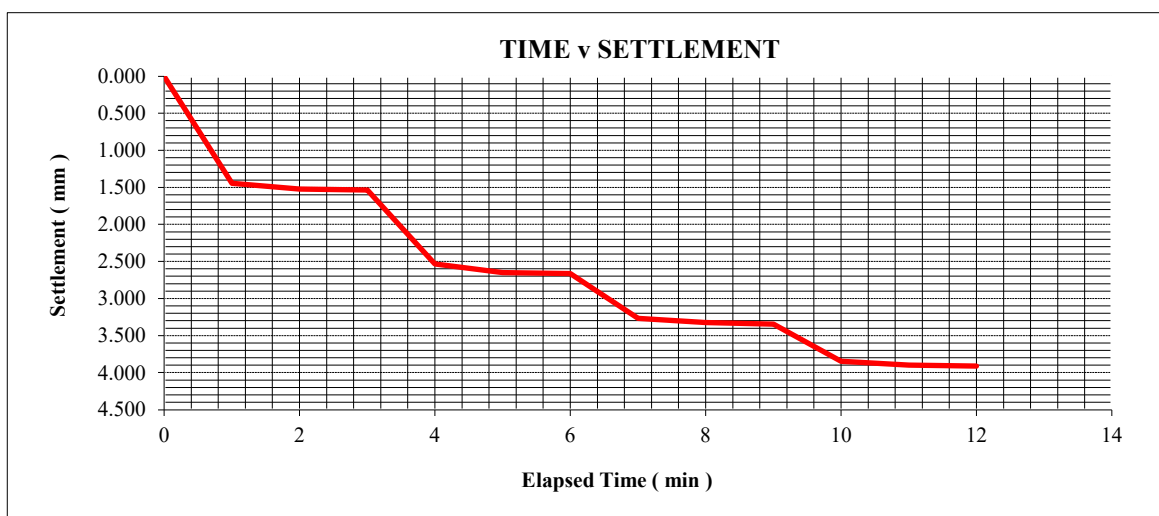
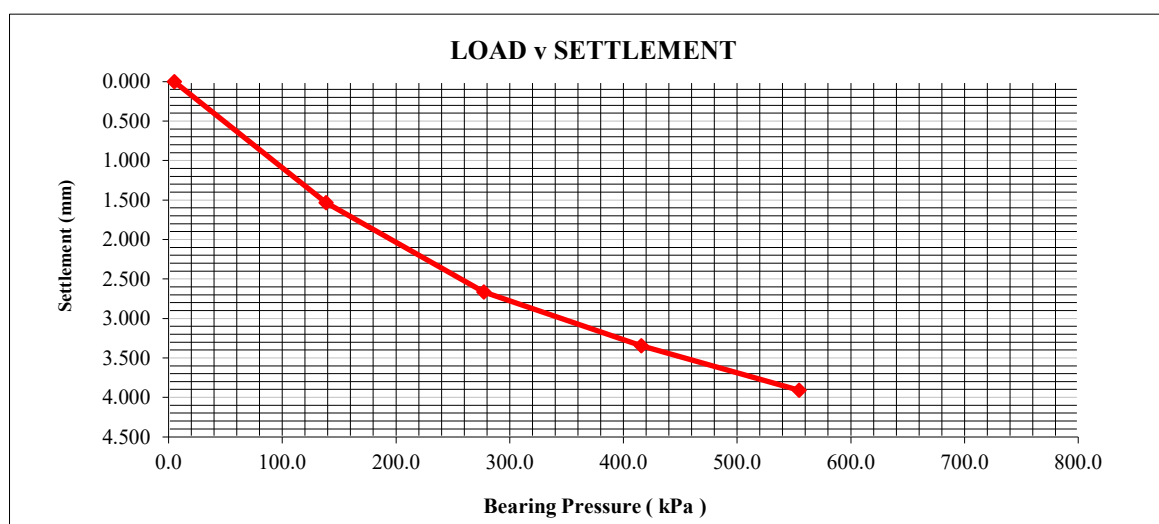




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SITE

TEST RESULTS

TEST No.	: 3
DATE TESTED	: 04 May 2020
SAMPLE TYPE	: Natural
DEPTH (mm)	: EGL
SAMPLE DESCRIPTION	: Top Soil
LOCATION	: Test location 3
Plate Size	: 300 mm
LOAD TO ACHIEVE 1.25mm SETTLEMENT >	: 113.79 kN/m ²
MODULUS OF SUBGRADE REACTION (k_{762}) >	: 40211 kN/m ² /m
Equivalent CBR VALUE >	: 5.8 %

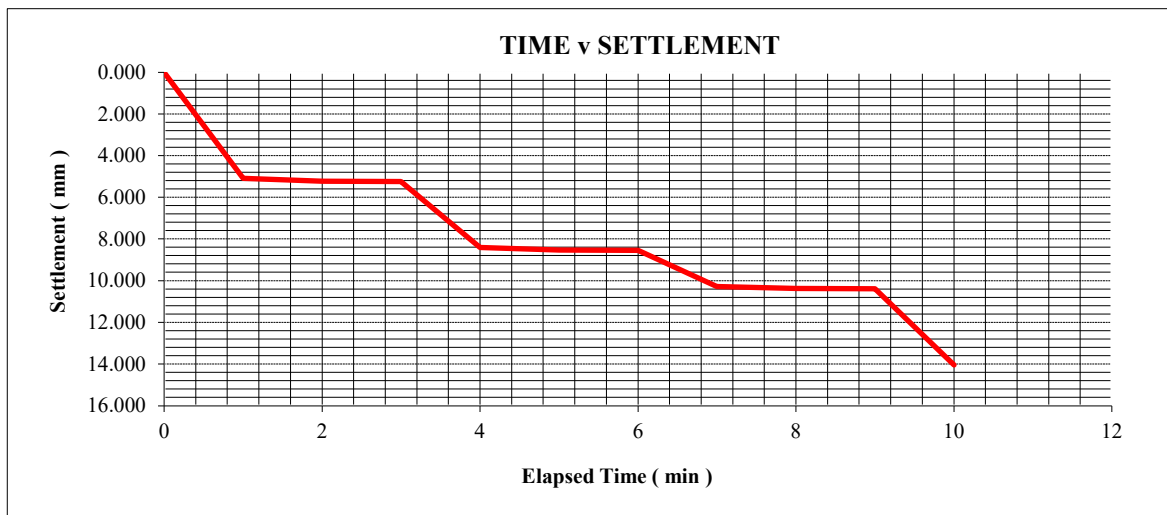
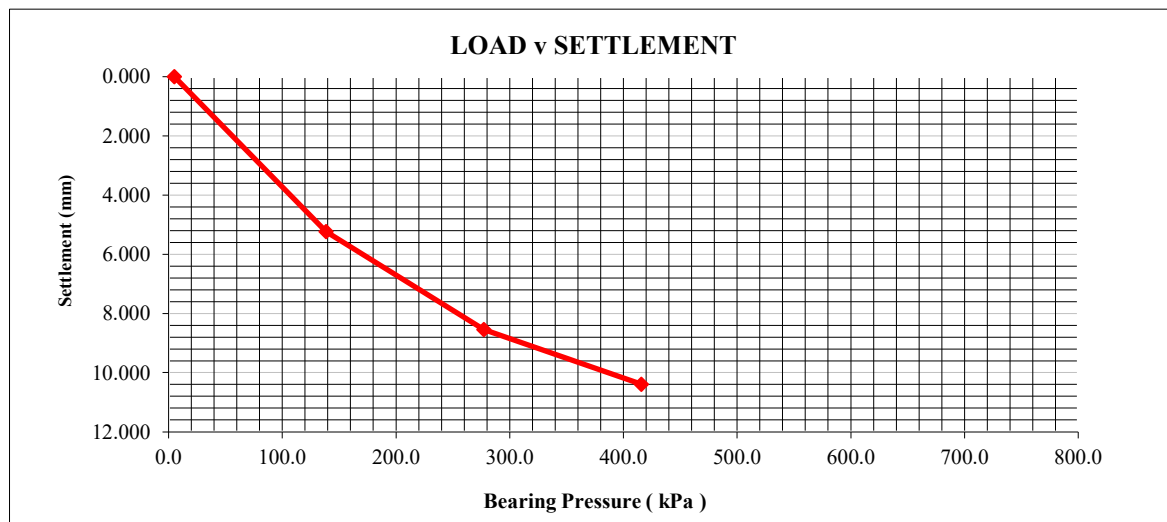




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TEST RESULTS

TEST No.	: 4
DATE TESTED	: 04 May 2020
SAMPLE TYPE	: Natural
DEPTH (mm)	: EGL
SAMPLE DESCRIPTION	: Top Soil
LOCATION	: Test location 4
Plate Size	: 300 mm
LOAD TO ACHIEVE 1.25mm SETTLEMENT >	: 36.87 kN/m ²
MODULUS OF SUBGRADE REACTION (k_{762}) >	: 13028 kN/m ² /m
Equivalent CBR VALUE >	: 0.8 %

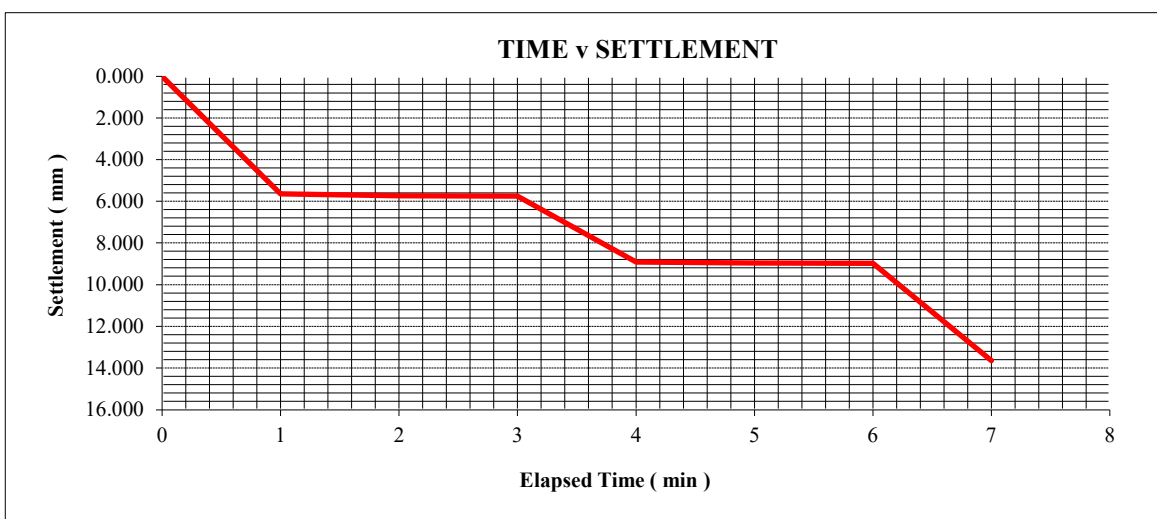
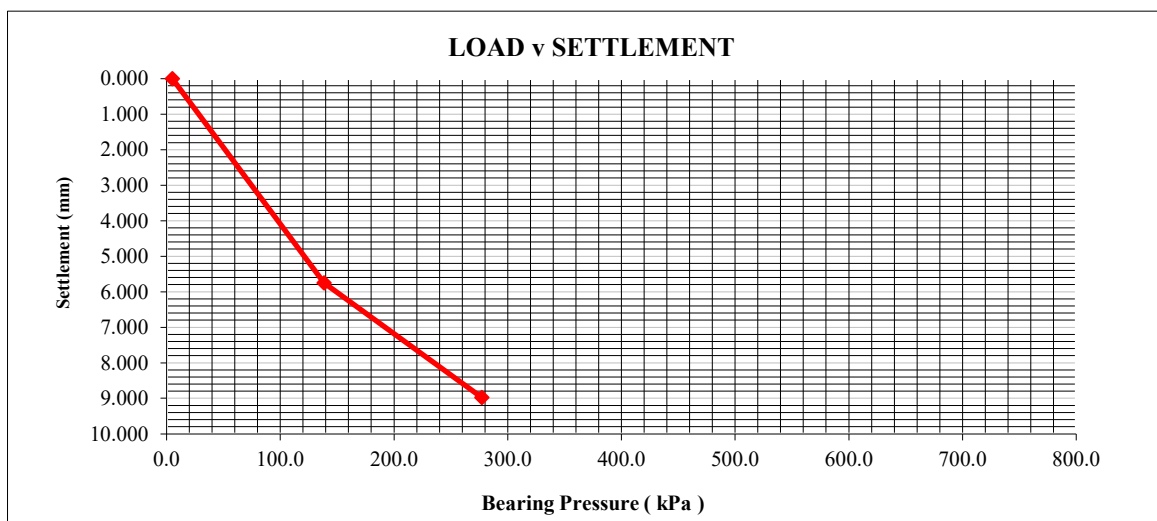




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TEST RESULTS

TEST No.	: 5
DATE TESTED	: 04 May 2020
SAMPLE TYPE	: Natural
DEPTH (mm)	: EGL
SAMPLE DESCRIPTION	: Top Soil
LOCATION	: Test location 5
Plate Size	: 300 mm
LOAD TO ACHIEVE 1.25mm SETTLEMENT >	: 34.04 kN/m ²
MODULUS OF SUBGRADE REACTION (k_{762}) >	: 12030 kN/m ² /m
Equivalent CBR VALUE >	: 0.7 %

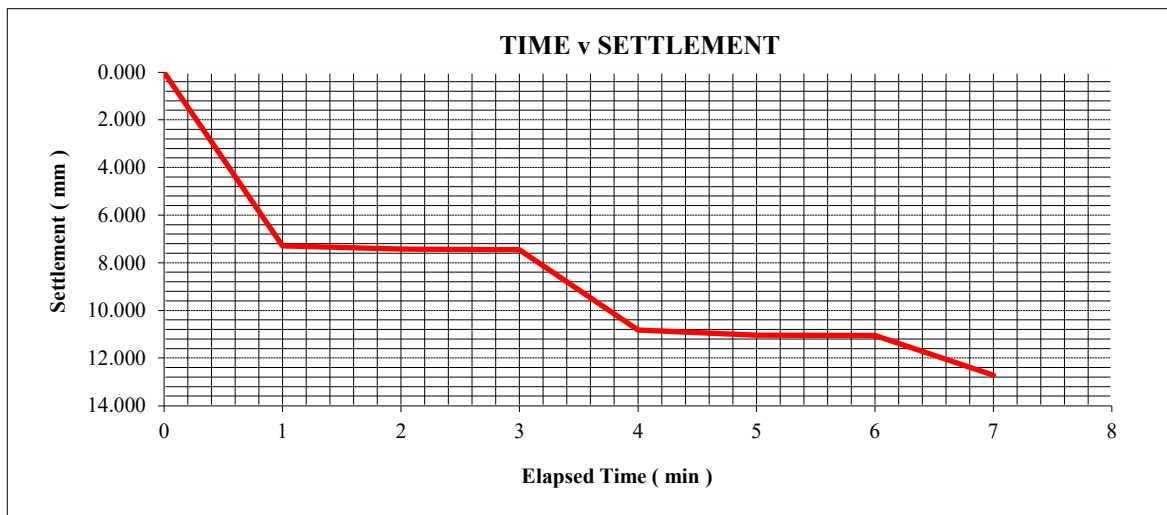
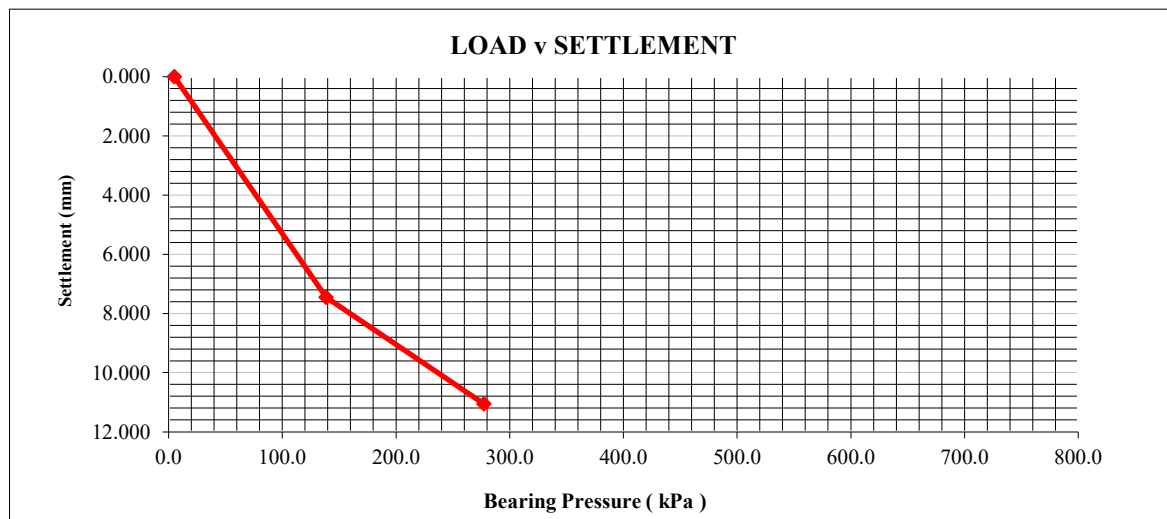




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SITE

TEST RESULTS

TEST No.	: 6
DATE TESTED	: 04 May 2020
SAMPLE TYPE	: Natural
DEPTH (mm)	: EGL
SAMPLE DESCRIPTION	: Top Soil
LOCATION	: Test location 6
Plate Size	: 300 mm
LOAD TO ACHIEVE 1.25mm SETTLEMENT >	: 27.42 kN/m ²
MODULUS OF SUBGRADE REACTION (k_{762}) >	: 9688 kN/m ² /m
Equivalent CBR VALUE >	: 0.5 %

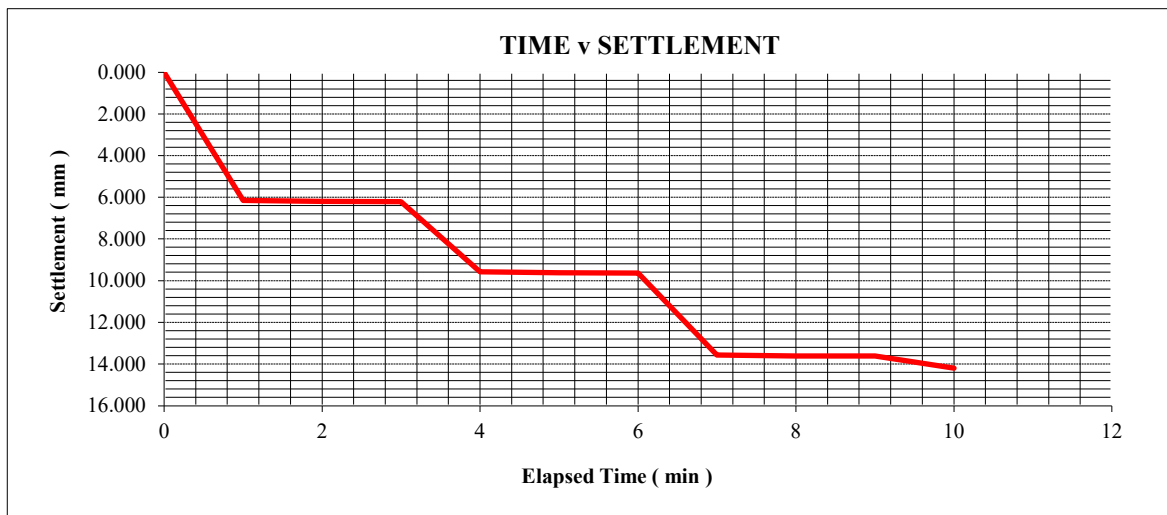
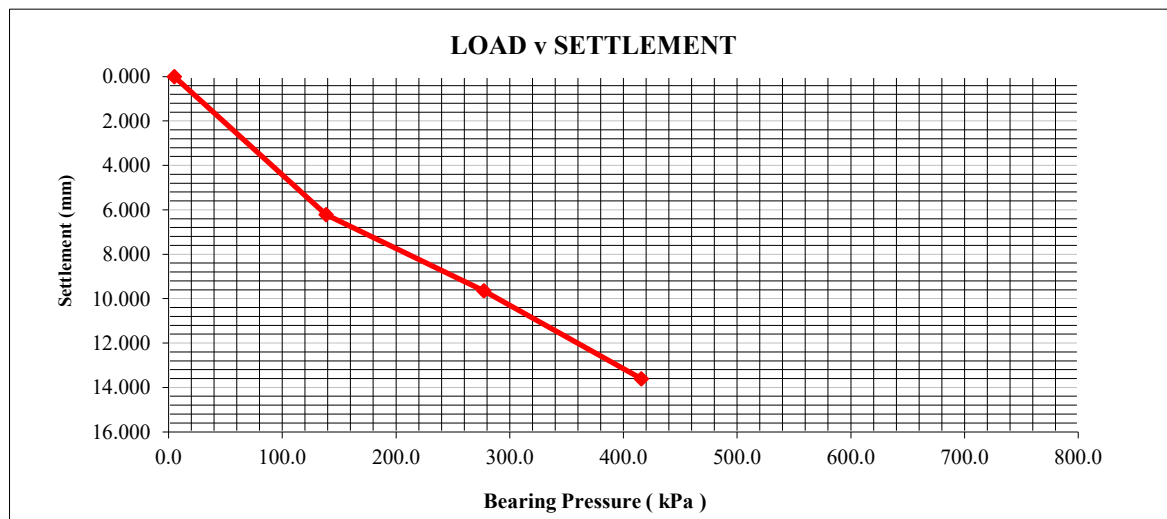




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TEST RESULTS

TEST No.	: 7
DATE TESTED	: 04 May 2020
SAMPLE TYPE	: Natural
DEPTH (mm)	: EGL
SAMPLE DESCRIPTION	: Top Soil
LOCATION	: Test location 7
Plate Size	: 300 mm
LOAD TO ACHIEVE 1.25mm SETTLEMENT >	: 31.87 kN/m ²
MODULUS OF SUBGRADE REACTION (k_{762}) >	: 11262 kN/m ² /m
Equivalent CBR VALUE >	: 0.6 %

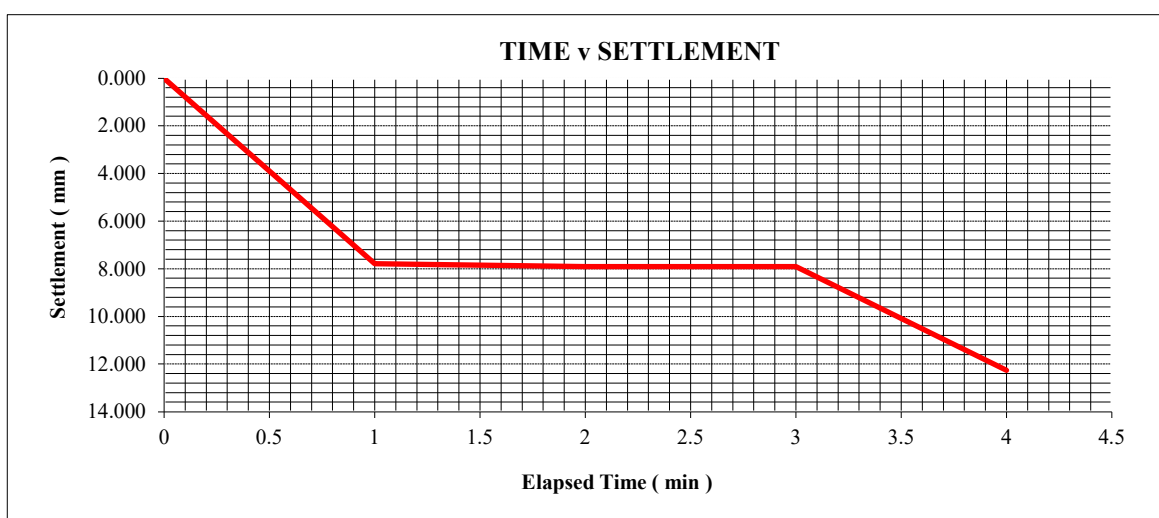
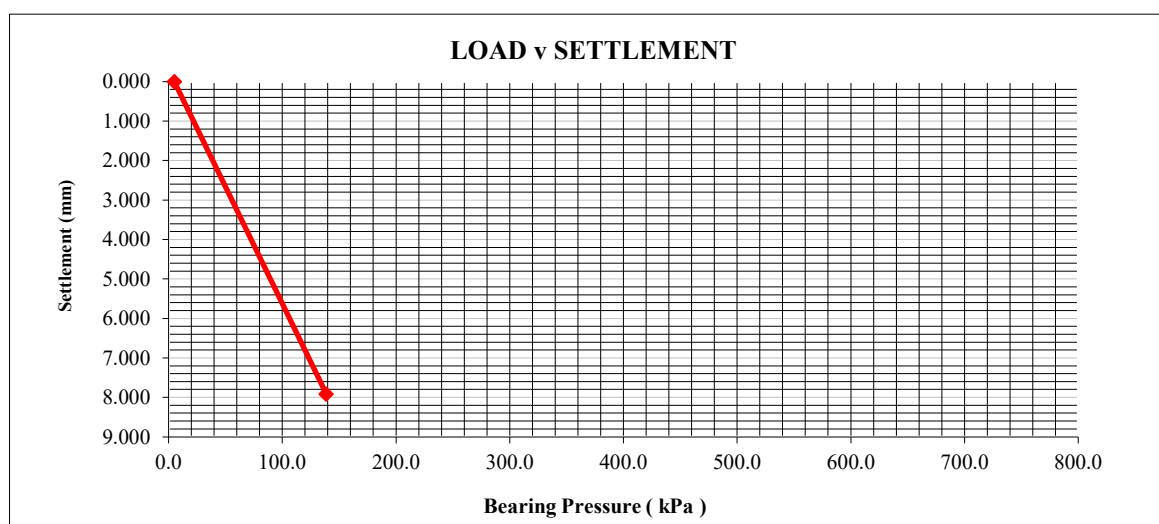




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TEST RESULTS

TEST No.	: 8
DATE TESTED	: 04 May 2020
SAMPLE TYPE	: Natural
DEPTH (mm)	: EGL
SAMPLE DESCRIPTION	: Top Soil
LOCATION	: Test location 8
Plate Size	: 300 mm
LOAD TO ACHIEVE 1.25mm SETTLEMENT >	: 26.10 kN/m ²
MODULUS OF SUBGRADE REACTION (k_{762}) >	: 9222 kN/m ² /m
Equivalent CBR VALUE >	: 0.5 %

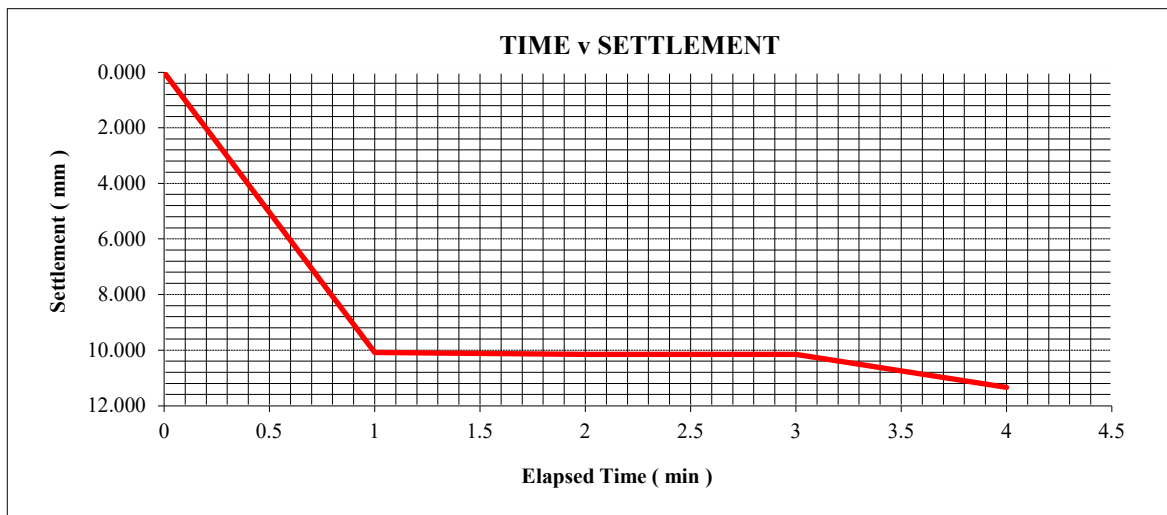
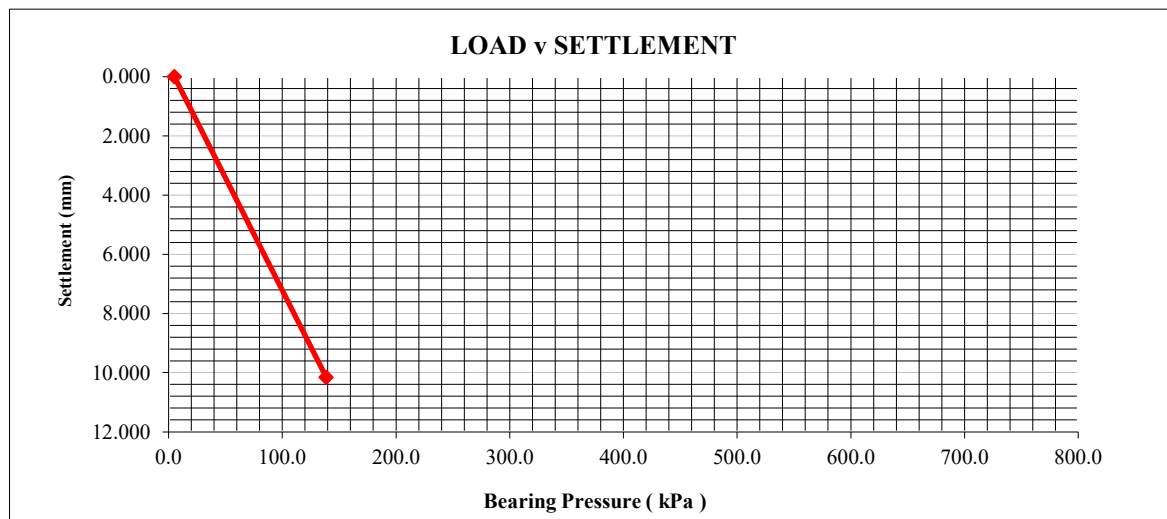




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TEST RESULTS

TEST No.	: 9
DATE TESTED	: 04 May 2020
SAMPLE TYPE	: Natural
DEPTH (mm)	: EGL
SAMPLE DESCRIPTION	: Top Soil
LOCATION	: Test location 9
Plate Size	: 300 mm
LOAD TO ACHIEVE 1.25mm SETTLEMENT >	: 21.44 kN/m ²
MODULUS OF SUBGRADE REACTION (k_{762}) >	: 7575 kN/m ² /m
Equivalent CBR VALUE >	: 0.3 %

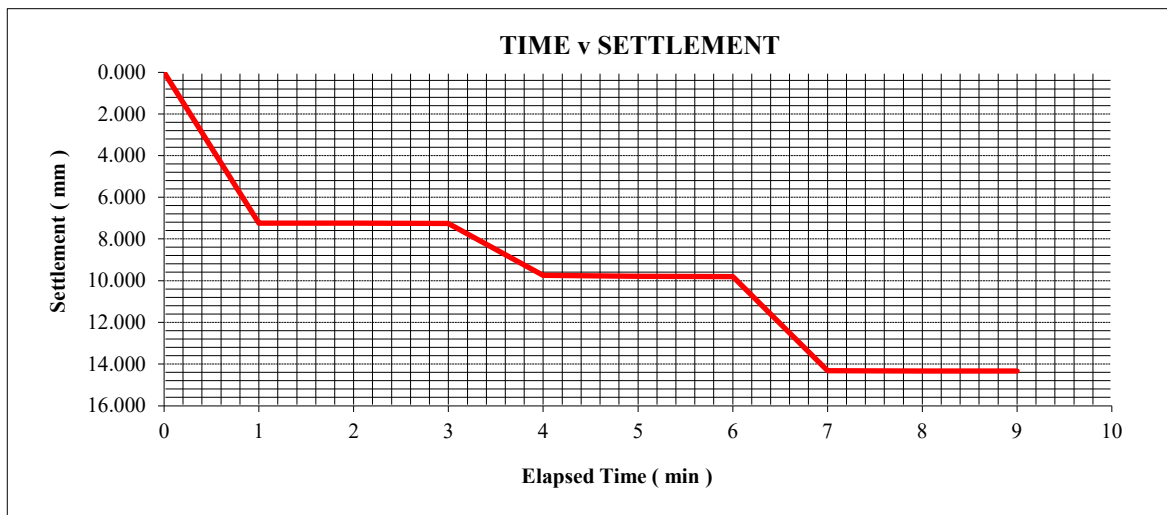
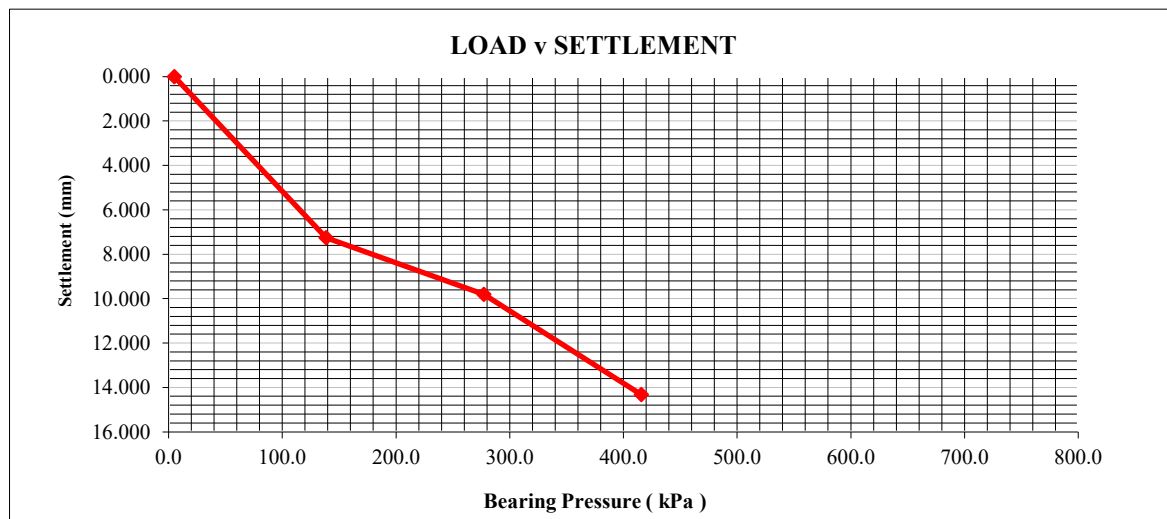




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TEST RESULTS

TEST No.	: 10
DATE TESTED	: 04 May 2020
SAMPLE TYPE	: Natural
DEPTH (mm)	: EGL
SAMPLE DESCRIPTION	: Top Soil
LOCATION	: Test location 10
Plate Size	: 300 mm
LOAD TO ACHIEVE 1.25mm SETTLEMENT >	: 28.00 kN/m ²
MODULUS OF SUBGRADE REACTION (k_{762}) >	: 9895 kN/m ² /m
Equivalent CBR VALUE >	: 0.5 %

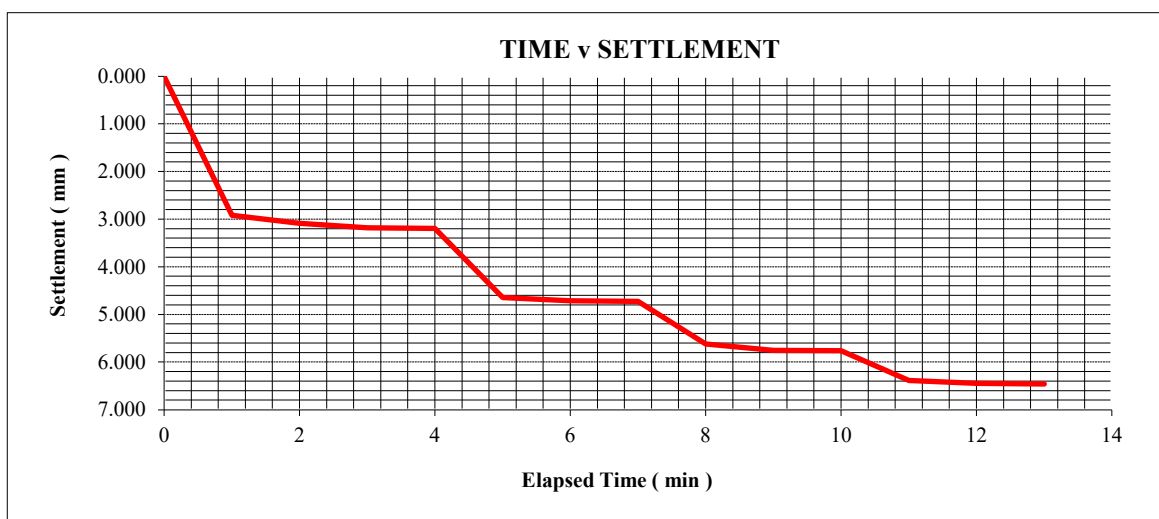
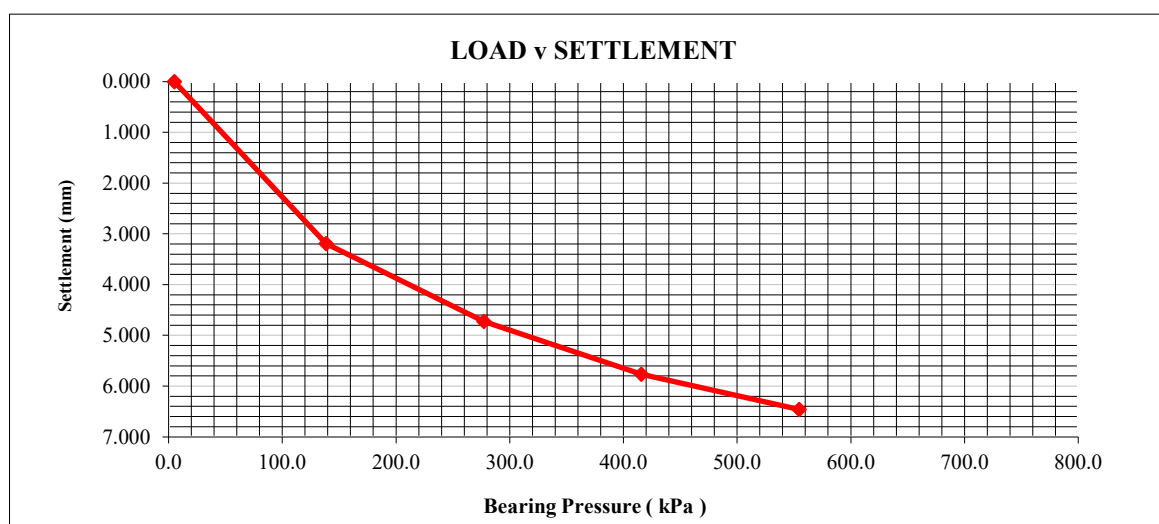




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SITE :

TEST RESULTS

TEST No.	: 11
DATE TESTED	: 04 May 2020
SAMPLE TYPE	: Natural
DEPTH (mm)	: EGL
SAMPLE DESCRIPTION	: Top Soil
LOCATION	: Test location 11
Plate Size	: 300 mm
LOAD TO ACHIEVE 1.25mm SETTLEMENT >	: 57.27 kN/m ²
MODULUS OF SUBGRADE REACTION (k_{762}) >	: 20237 kN/m ² /m
Equivalent CBR VALUE >	: 1.8 %

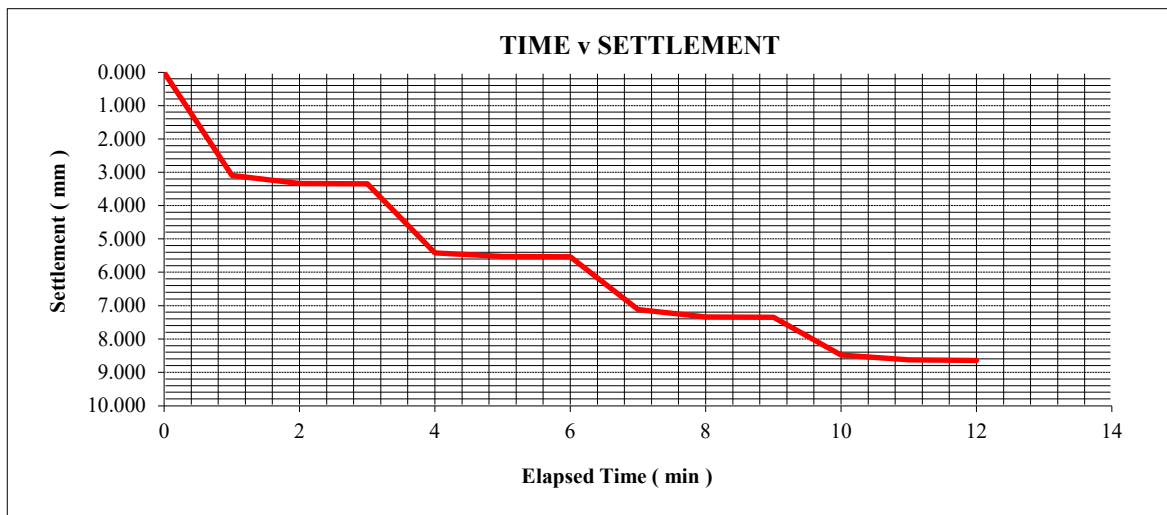
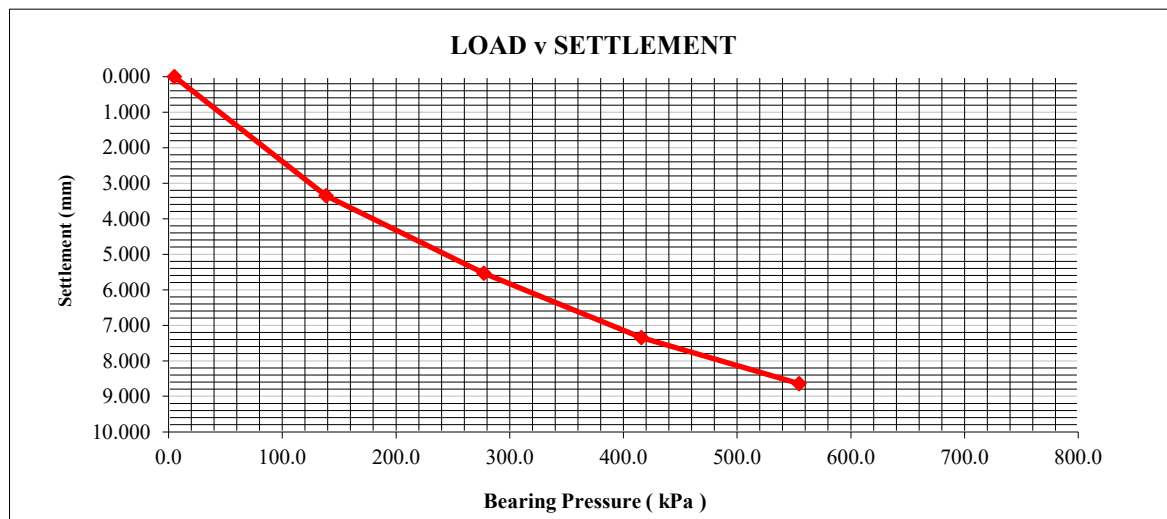




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TEST RESULTS

TEST No.	: 12
DATE TESTED	: 04 May 2020
SAMPLE TYPE	: Natural
DEPTH (mm)	: EGL
SAMPLE DESCRIPTION	: Top Soil
LOCATION	: Test location 12
Plate Size	: 300 mm
LOAD TO ACHIEVE 1.25mm SETTLEMENT >	: 54.85 kN/m ²
MODULUS OF SUBGRADE REACTION (k_{762}) >	: 19382 kN/m ² /m
Equivalent CBR VALUE >	: 1.6 %

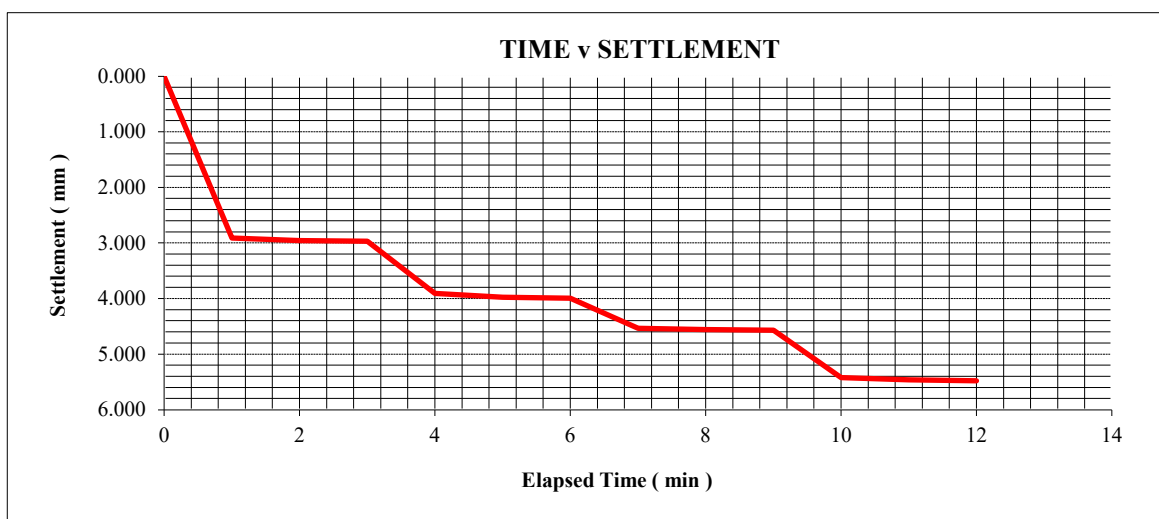
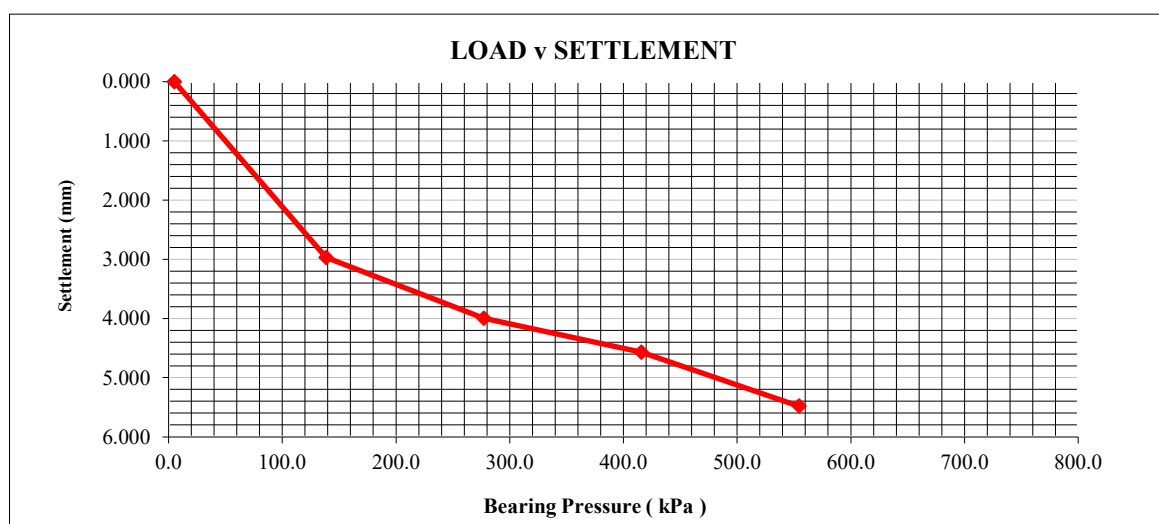




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TEST RESULTS

TEST No.	: 13
DATE TESTED	: 04 May 2020
SAMPLE TYPE	: Natural
DEPTH (mm)	: EGL
SAMPLE DESCRIPTION	: Top Soil
LOCATION	: Test location 13
Plate Size	: 300 mm
LOAD TO ACHIEVE 1.25mm SETTLEMENT >	: 61.23 kN/m ²
MODULUS OF SUBGRADE REACTION (k_{762}) >	: 21636 kN/m ² /m
Equivalent CBR VALUE >	: 2.0 %

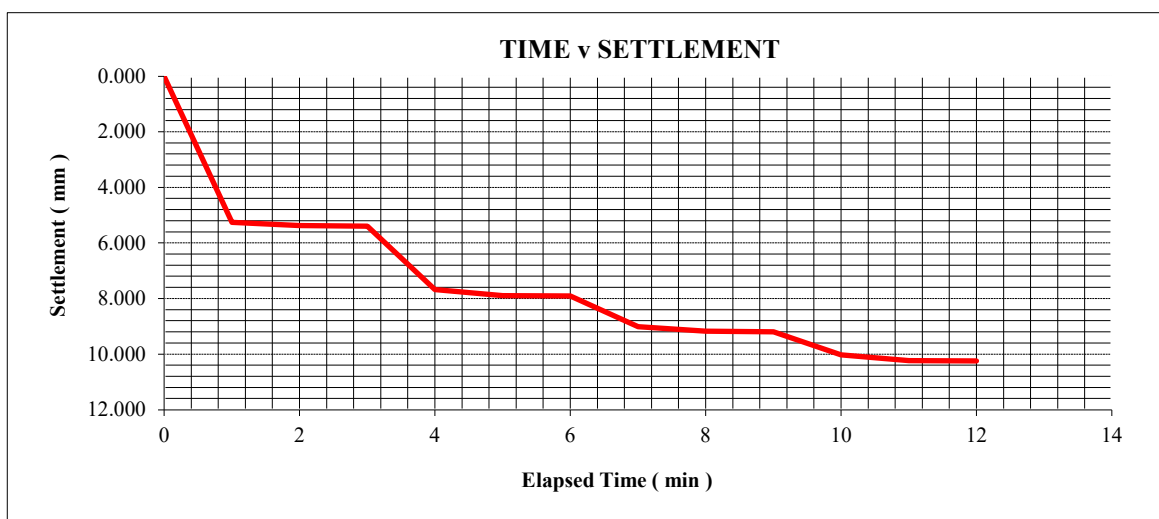
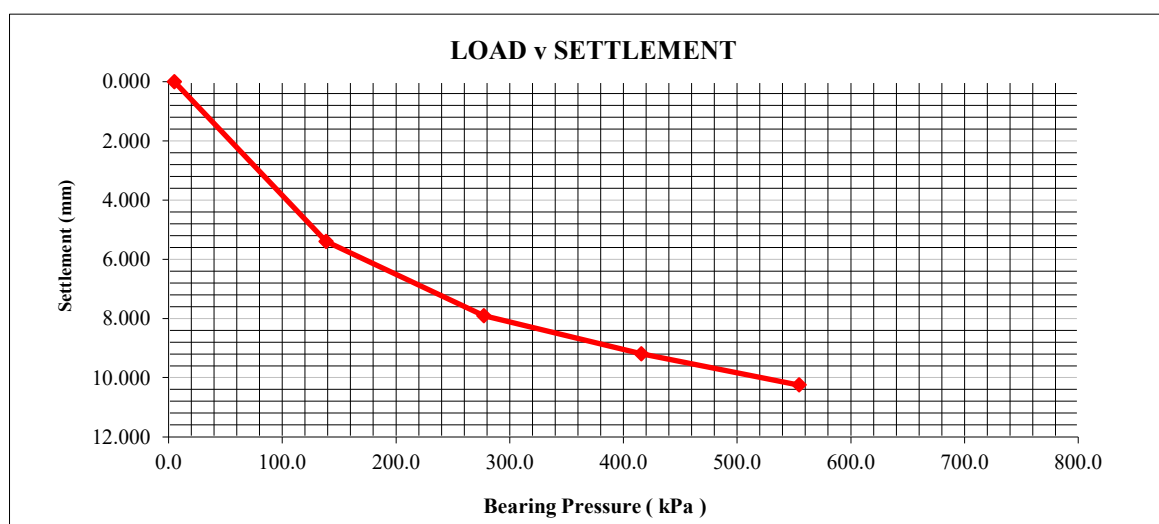




REPORT No : D20008-20:
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SITE

TEST RESULTS

TEST No.	: 14
DATE TESTED	: 04 May 2020
SAMPLE TYPE	: Natural
DEPTH (mm)	: EGL
SAMPLE DESCRIPTION	: Top Soil
LOCATION	: Test location 14
Plate Size	: 300 mm
LOAD TO ACHIEVE 1.25mm SETTLEMENT >	: 35.95 kN/m ²
MODULUS OF SUBGRADE REACTION (k_{762}) >	: 12705 kN/m ² /m
Equivalent CBR VALUE >	: 0.8 %





REPORT No : D20008-20::
CLIENT
SITE

TEST RESULTS

TEST No.	: 15
DATE TESTED	: 04 May 2020
SAMPLE TYPE	: Natural
DEPTH (mm)	: EGL
SAMPLE DESCRIPTION	: Top Soil
LOCATION	: Test location 15
Plate Size	: 300 mm
LOAD TO ACHIEVE 1.25mm SETTLEMENT >	: 46.96 kN/m ²
MODULUS OF SUBGRADE REACTION (k_{762}) >	: 16594 kN/m ² /m
Equivalent CBR VALUE >	: 1.3 %

