

**Data Sheet and Calculation for Determination of Natural Moisture Content of Soil**

**Location** : Halishahar Shishupark Field, Halishahar I Block, Chittagong, Bangladesh  
**GPS Co-ordinate** : [22°20'26.1"N 91°47'02.3"E](#)  
**Date of Boring** : 18 / 07 / 2022  
**Sample Depth** : 1.5 m.  
**Type of Sample** : D  
**Date of Test** : 18 / 07 / 2022

Serial No.	Container No.	Weight of Container ( $W_0$ )	Weight of Container + Moist Soil ( $W_1$ ), gm.	Weight of Container + Dry Soil ( $W_2$ ), gm.	Moisture Content, %	Standard Reference
1	70	22.15	75.85	65.87	22.82708143	ASTM D2216-19
2	12	22.33	54.61	48.42	23.72556535	
3	89	22.74	58.74	52.34	21.62162162	

Natural Moisture Content of Soil (%) = 22.72475613

**Data Sheet and Calculation for Determination of Specific Gravity of Soil**

**Location** : Halishahar Shishupark Field, Halishahar I Block, Chittagong, Bangladesh  
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**Date of Boring** : 18 / 07 / 2022  
**Sample Depth** : 1.5 m.  
**Type of Sample** : D  
**Date of Test** : 21 / 07 / 2022

	Value	Unit
Pycnometer No.	8	
Calibrated Temperature of Pycnometer, $T_C$	20	°C
Calibrated Volume of Pycnometer, $V_B$	250	mL
Weight of Pycnometer, $W_B$	98.46	gm.
Thermal Coefficient of Cubical Expansion of Pyrex Glass, $\epsilon$	0.00001	per °C
Unit Weight of Air, $\gamma_a$	0.0012	gm./cm. <sup>3</sup>
Dry Weight of Sample, $W_s$	50	gm.
Test Temperature, $T_T$	36	°C
Specific Gravity of Water at Test Temperature, $G_T$	0.99373	
Weight of Pycnometer + Water + Soil, $W_1$	377.36	gm.

**a. Calibration of Pycnometer (Experimental Method)**

Serial No.	Test Temperature, $T$ (°C)	Weight of Pycnometer + Water, $W_2$ (gm.)	Unit Weight of Water at $T$ °C, $\gamma_T$ (gm./cm. <sup>3</sup> )
1	31	346.24	0.99541
2	33	346.09	0.99476
3	35	345.97	0.99408
4	37	345.84	0.99337
5	39	345.63	0.99263

**b. Calibration of Pycnometer (Theoretical Method)**

Serial No.	Test Temperature, $T$ (°C)	Weight of Pycnometer + Water, $W_2$ (gm.)	Unit Weight of Water at $T$ °C, $\gamma_T$ (gm./cm. <sup>3</sup> )
1	31	347.0398408	0.99541
2	33	346.8822907	0.99476
3	35	346.717233	0.99408
4	37	346.5446672	0.99337
5	39	346.3645929	0.99263

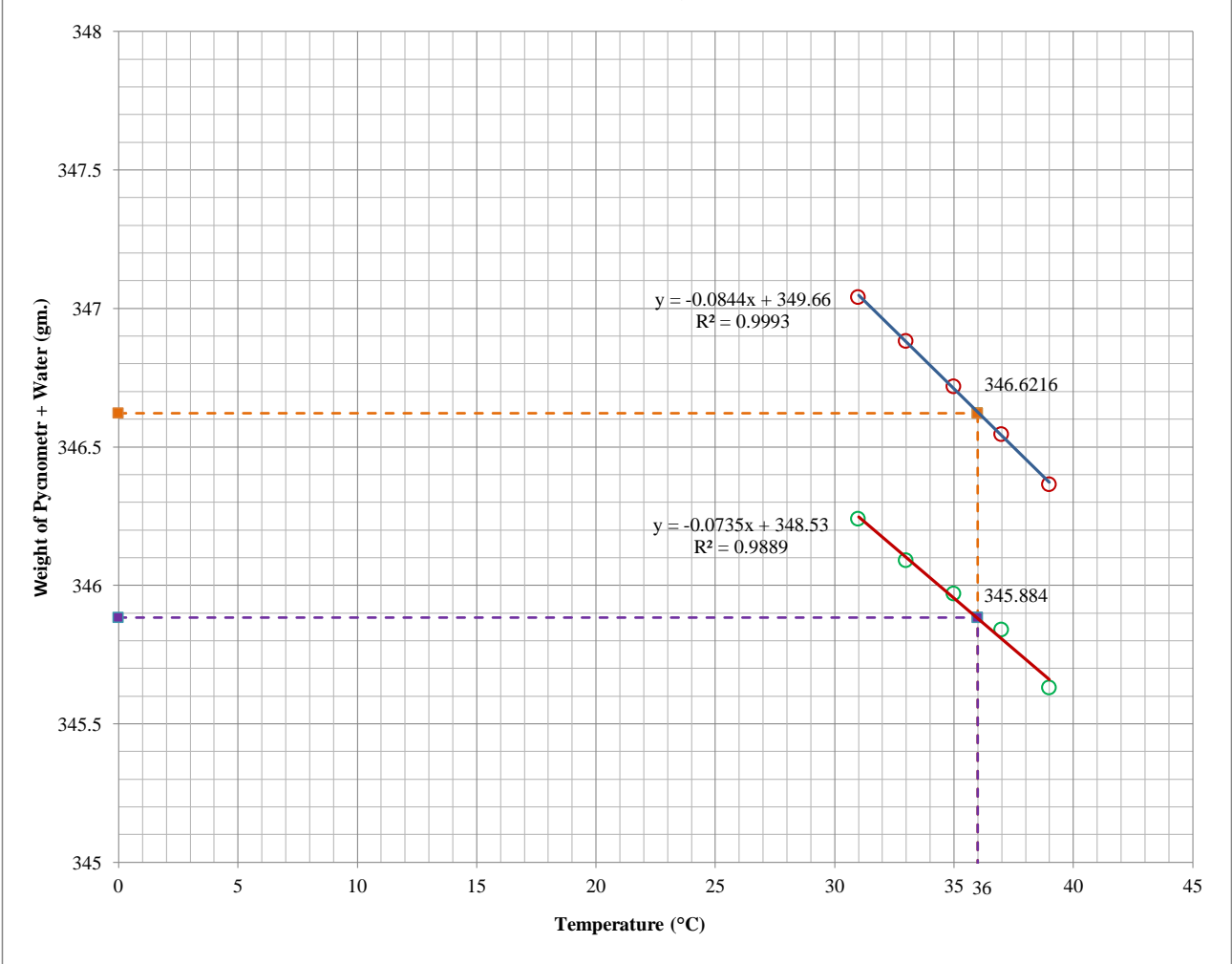
Method	Test Temperature, $T$ (°C)	Weight of Pycnometer + Water, $W_2$ (gm.)
Experimental	36	345.884
Theoretical	36	346.6216

**c. Determination of Specific Gravity**

Method	Test Temperature, $T$ (°C)	Specific Gravity of Water at Test Temperature, $G_T$	Dry Weight of Sample, $W_s$ (gm.)	Weight of Pycnometer + Water + Soil, $W_1$ (gm.)	Weight of Pycnometer + Water, $W_2$ (gm.)	Specific Gravity of Soil, $G_s$	Standard Reference
Experimental	36	0.99373	50	377.36	345.884	2.682277046	ASTM D854-14
Theoretical	36				346.6216	2.579562445	

Specific Gravity of Soil,  $G_s$  = 2.630919746

Calibration Curve of Pycnometer



# Data Sheet and Calculation for Grain Size Analysis of Soil by Sieve and Hydrometer

**Location** : Halishahar Shishupark Field, Halishahar I Block, Chittagong, Bangladesh  
**GPS Co-ordinate** : [22°20'26.1"N 91°47'02.3"E](#)  
**Date of Boring** : 18 / 07 / 2022  
**Sample Depth** : 1.5 m.  
**Type of Sample** : D  
**Date of Test** : 21 / 07 / 2022 (Sieve Analysis)  
: 26 / 07 / 2022 (Hydrometer Analysis)

## a. Sieve Analysis

Weight of Sample Taken : 500 gm.

Sieve No.	Prtical Size (mm.)	Weight Retained (gm.)	% Weight Retained	Cumulative % Retained	% Finer	Standard Reference
#4	4.75	0	0	0	0	ASTM D6913M-17
#8	2.36	2.81	0.562832993	0.562832993	99.43716701	
#16	1.18	30.27	6.0629732	6.625806193	93.37419381	
#30	0.6	75.02	15.02623883	21.65204503	78.34795497	
#50	0.3	74.23	14.86800465	36.52004967	63.47995033	
#100	0.15	69.28	13.87653728	50.39658695	49.60341305	
#200	0.075	102.01	20.43223971	70.82882666	29.17117334	
Pan		145.64	29.17117334	100	0	
		499.26	100			

% Sample Loss : 0.148

## b. Hydrometer Analysis

	Value	Unit
Hydrometer Number	328	ASTM 152H
Weight of Sample Soil Particles Passing Through No. 200 Sieve, $M_d$	30	gm.
Weight of Sample Taken for Combined Sieve and Hydrometer Analysis, M	499.26	gm.
Specific Gravity of Soil, $G_s$	2.63	
Mass Density of Water at 20°C, $\rho_w$	0.9981	gm./cm. <sup>3</sup>
Viscosity of Water at 20°C, $\mu$	0.01	gm./cm.
Gravitational Acceleration, g	980.7	cm./s <sup>2</sup>
Volume of Hydrometer Bulb up to The Stem, $V_{hs}$	60	c.m. <sup>3</sup>
Height of Water Rise in the Wash Cylinder When Hydrometer is Submerged, h	2.1	c.m.
Cross-sectional Area of The Cylinder, $A_c$	28.57142857	c.m. <sup>2</sup>
Meniscus Correction, $C_m$	1	gm./L
Volume of Suspension, $V_{sp}$	1000	mL
Distance Between The Center of Buoyancy & The Maximum Hydrometer Reading, $H_1$	17.8	gm./L
Distance Between The Center of Buoyancy & The Minimum Hydrometer Reading, $H_2$	8.5	gm./L
Maximum Hydrometer Reading, $r_1$	-5	gm./L
Minimum Hydrometer Reading, $r_2$	60	gm./L

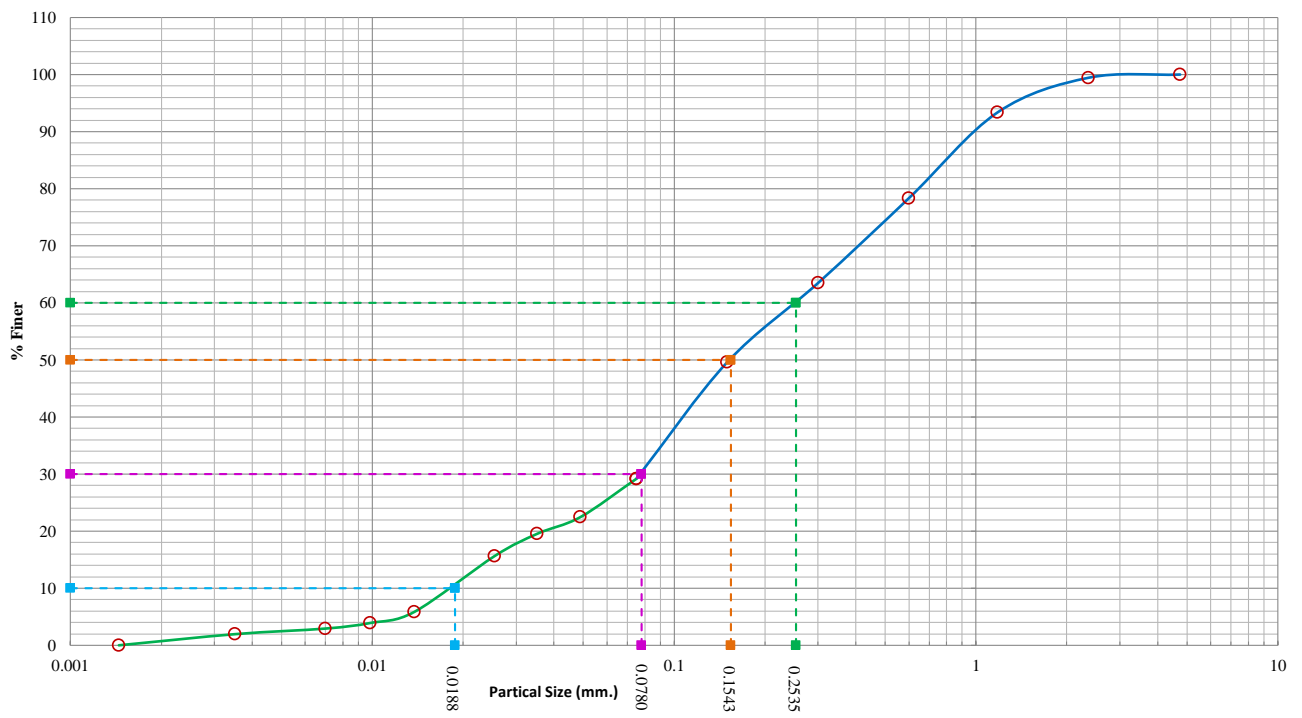
Elapsed Time, $t_m$ (min.)	Temperature, T (°C)	Hydrometer Reading in Suspension, $r_m$ (gm./L)	Hydrometer Reading in Reference Solution, $r_{dms}$ (gm./L)	Effective Depth, $H_m$ (cm.)	Partical Diameter, $D_m$ (m.m.)	Mass % Finer, $N_m$	Adjusted Mass % Finer	Standand Reference
1	28	24	1	12.74384615	0.048951045	77.01651125	22.46661999	ASTM D7928-21e1
2	28	21	1	13.17307692	0.035191706	66.97087935	19.5361913	
4	28	17	1	13.74538462	0.0254191	53.57670348	15.62895304	
15	28	7	1	15.17615385	0.013792625	20.0912638	5.86085739	
30	28	5	1	15.46230769	0.009844377	13.39417587	3.90723826	
60	28	4	1	15.60538462	0.006993158	10.0456319	2.930428695	
240	28	3	1	15.74846154	0.003512571	6.697087935	1.95361913	
1440	28	1	1	16.03461538	0.001446971	0	0	

## c. Combined Grain Size Distribution

Partical Size (mm.)	% Finer	
4.75	100	$D_{10} = 0.0188$
2.36	99.43716701	
1.18	93.37419381	
0.6	78.34795497	$D_{30} = 0.0780$
0.3	63.47995033	
0.15	49.60341305	
0.075	29.17117334	$D_{60} = 0.2535$
0.048951045	22.46661999	
0.035191706	19.5361913	
0.0254191	15.62895304	$C_u = 13.48404255$
0.013792625	5.86085739	
0.009844377	3.90723826	
0.006993158	2.930428695	$C_c = 1.276595745$
0.003512571	1.95361913	
0.001446971	0	

Soil Type	Unit	Value	Remarks
Gravel	%	0	
Sand	%	70.82882666	
Fines	%	29.17117334	
Silt	%	28.64812518	
Clay	%	0.523048157	
$D_{10}$	mm.	0.0188	From Grain Distribution Curve
$D_{30}$	mm.	0.078	From Grain Distribution Curve
$D_{60}$	mm.	0.1543	From Grain Distribution Curve
$D_{90}$	mm.	0.2535	From Grain Distribution Curve
$C_u$		13.48404255	
$C_c$		1.276595745	

Grain Size Distribution Curve (%Finer Vs Partical Size)



Data Sheet and Calculation for Atterberg Limits Test of Soil

Location : Halishahar Shishupark Field, Halishahar I Block, Chittagong, Bangladesh  
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Date of Boring : 18 / 07 / 2022  
Sample Depth : 1.5 m.  
Type of Sample : D  
Date of Test : 21 / 07 / 2022

**a. Liquid Limit Test**

Serial No.	No. of Blow	Container No.	Weight of Container ( $W_0$ ), gm.	Weight of Container + Moist Soil ( $W_1$ ), gm.	Weight of Container + Dry Soil ( $W_1$ ), gm.	Moisture Content, %
1	14	38	22.04	37.17	33.66	30.207
2	17	78	22.14	40.6	36.54	28.194
3	26	15	22.46	48.45	42.79	27.841
4	30	37	21.73	44.38	39.51	27.390

**Flow Curve**

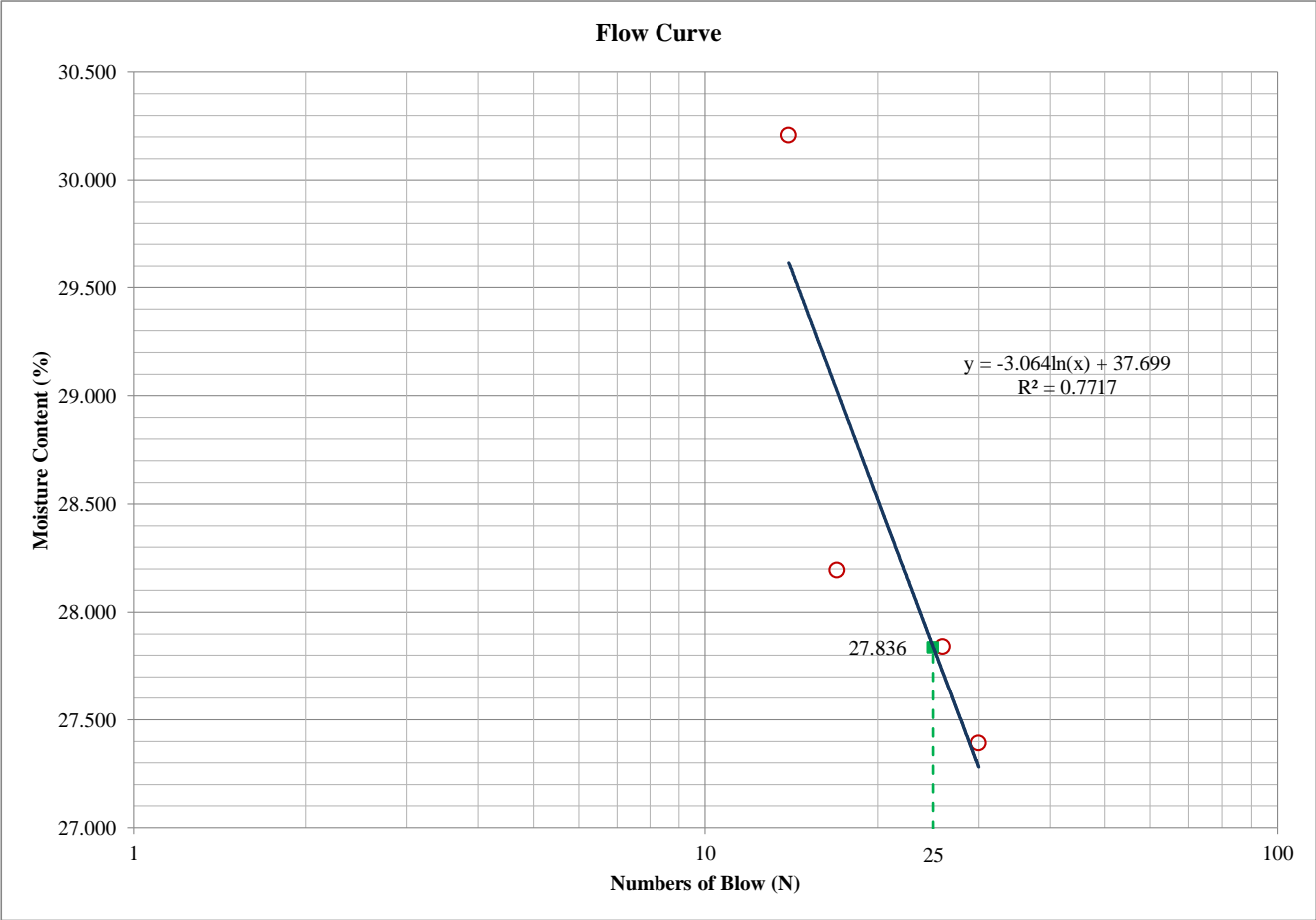
No. of Blow	Moisture Content, %
14	30.207
17	28.194
26	27.841
30	27.390

No. of Blow	Moisture Content, %
25	27.836

**b. Plastic Limit Test**

Serial No.	Container No.	Weight of Container ( $W_0$ ), gm.	Weight of Container + Moist Soil ( $W_1$ ), gm.	Weight of Container + Dry Soil ( $W_1$ ), gm.	Moisture Content, %
1	47	22.86	29.91	28.63	22.184
2	70	22.15	30.33	28.84	22.272

Atterberg Limits	Moisture Content, %
Liquid Limit, LL	27.836
Plastic Limit, PL	22.228
Plasticity Index, PI	5.608



**Test Result:**

**Location** : Halishahor Sishupark Field, Halishahor I-Block, Chittagong, Bangladesh

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**Sample Depth** : 1.5 m.

**Type of Sample** : D

Specific Gravity	Natural Moisture Content	Grain Size Analysis				Atterberg Limits			Soil Type As Per BNBC-2020
		Sand (%)	Fines (%)	Silt (%)	Clay (%)	Liquid Limit (LL) (%)	Plastic Limit (PL) (%)	Plasticity Index (PI) (%)	
2.63	22.72	70.83	29.17	28.65	0.52	27.84	22.23	5.61	SM (Silty Sand)

**Discussion:**

- I. Testing for index properties of soil revealed the soil to be Silty Sand (SM).
- II. Upper 0.76 meters of soil is discarded due to the presence of rubbish and foreign matter. So soil sample is collected and tested for soil layer at a depth of 1.5 meter.
- III. Sample collection took place on a hot and dry season thus the soil condition came out to be close to plastic limit (a transitional state between plastic and semi-solid state) which is confirmed by natural moisture content (22.72%), liquid limit (LL = 27.84%) and plastic limit (PL = 22.23%). These parameters give an apparent idea that the current ground water table is below 1.5 meter from EGL.
- IV. The tested soil is inorganic, since its specific gravity (2.63) is greater than 2.60. Also the from field observation the soil have no odor and has a brownish color.
- V. From grain size analysis the major and minor soil constituents are found to be sand and silt respectively which concludes the soil sample to be coarse grain soil (%Fines = 29.17% < 50%).
- VI. Both grain size distribution and Atterberg limits separately proves the presence of high percentage of silt (28.65%) as fines which led the classification of the tested soil sample to be Silty Sand (SM) as per BNBC-2020.