2012

SOIL SAMPLING AND TESTING REPORT.

In reference to GEOSFF JORDAN – MANAGED AQUIFER RECHARGE Project (PN 2002.3510.1)

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Contents

Introduction:

Within the scope of this work 30 disturbed samples were collected from the five test sites (6 from each). In addition to that 18 undisturbed samples were collected in a standard 10 cm sampling cylinders. All the disturbed samples were subjected to lab analysis to calculate EC, pH, TOC,TIC and grain size analysis, the undisturbed samples was used to calculate water retention curves and dry bulk density. All the collected samples details are given in table 1:

Table 1: Soil samples location and general description.

Sample ID	Wadi name	Sampling date	Analysis date	Location description	East	North	Depth cm	Weight kg
Samp.1	Wadi Janab	23/5/2012	24/5/2012	Wadi Bed	291383	1126833	20	5.49
Samp.2	Wadi Janab	23/5/2012	24/5/2012	BIT no. 1	291550	1126727	40	5.52
Samp.3	Wadi Janab	23/5/2012	24/5/2012	Wadi Bed	291712	1126640	30	5.15
Samp.4	Wadi Janab	23/5/2012	24/5/2012	BIT no. 2	291314	1126807	30	6.12
Samp.5	Wadi Janab	23/5/2012	27/5/2012	Wadi side	291415	1126871	20	5.55
Samp.6	Wadi Janab	23/5/2012	27/5/2012	Wadi side	284616	1126569	20	5.7
Samp.7	Wadi Hassan	24/5/2012	27/5/2012	DRIT no. 1	327983	1150625	30	6.15
Samp.8	Wadi Hassan	24/5/2012	27/5/2012	BIT	327972	1150639	30	6.5
Samp.9	Wadi Hassan	24/5/2012	27/5/2012	DRIT no. 2	327968	1150598	30	5.5
Samp.10	Wadi Hassan	24/5/2012	27/5/2012	Wadi bed	327976	1150792	20	5.25
Samp.11	Wadi Hassan	24/5/2012	28/5/2012	DRIT no. 3	327985	1150730	30	5.5
Samp.12	Wadi Hassan	24/5/2012	28/5/2012	Wadi bed	327973	1150760	25	5.54
Samp.13	Maf-Saf West	27/5/2012	28/5/2012	Wadi Bed	313678	1177286	15	6.65
Samp.14	Maf-Saf West	27/5/2013	28/5/2012	BIT no. 2	313652	1177253	25	6.58
Samp.15	Maf-Saf West	27/5/2014	28/5/2012	BIT no. 1	313652	1177241	10	4.72
Samp.16	Maf-Saf West	27/5/2015	29/5/2012	wadi bed	313706	1177320	20	5.24
Samp.17	Maf-Saf West	27/5/2016	29/5/2012	Wadi side	313682	1177282	20	5.5
Samp.18	Maf-Saf West	27/5/2017	29/5/2012	Wadi side	313628	1177225	15	6.1
Samp.19	Maf-Saf East	28/5/2012	29/5/2012	BIT	327734	1172645	30	5.8
Samp.20	Maf-Saf East	28/5/2012	29/5/2012	DRIT no. 1	327751	1172622	25	6.3
Samp.21	Maf-Saf East	28/5/2012	30/5/2012	DRIT no. 2	327735	1172640	30	5.58
Samp.22	Maf-Saf East	28/5/2012	30/5/2012	DRIT no. 3	327711	1172659	30	6.31
Samp.23	Maf-Saf East	28/5/2012	30/5/2012	Wadi bed	327698	1172669	25	5.56
Samp.24	Maf-Saf East	28/5/2012	30/5/2012	Wadi bed	327667	1172691	20	5.88
Samp.25	Wadi Dhuliel	29/5/2012	31/5/2012	BIT	277943	1171048	30	5.25
Samp.26	Wadi Dhuliel	29/5/2012	31/5/2012	Wadi bed	277955	1171057	30	6.58
Samp.27	Wadi Dhuliel	29/5/2012	31/5/2012	DRIT no. 2	277951	1171039	30	7.1
Samp.28	Wadi Dhuliel	29/5/2012	31/5/2012	DRIT no. 1	277972	1171034	30	6.65
Samp.29	Wadi Dhuliel	29/5/2012	31/5/2012	Wadi bed	277889	1171046	25	6.78
Samp.30	Wadi Dhuliel	29/5/2012	31/5/2012	DRIT no. 3	277930	1171054	30	6.62

Chemical analysis:

The results of chemical analysis of the collected samples are given in table 2 below:

Table 2: Chemical analysis of soil samples.

Sam. ID	1st test	2nd test	3rd test	Avg.	1st test	2nd test	3rd test	Avg.	1st test	2nd test	3rd test	Avg.	1st test	2nd test	3rd test	Avg.
	EC µS/cm	**EC µS/cm**	**EC µS/cm**	**EC µS/cm**	**pH**	**pH**	**pH**	**pH**	**TOC %**	**TOC %**	**TOC %**	**TOC %**	**IC %**	**IC %**	**IC %**	**IC %**
S1	205.0	203.0	198.0	202.0	8.02	7.94	8.10	8.02	0.037	0.033	0.039	0.036	0.451	0.458	0.452	0.454
S2	186.0	188.0	184.0	186.0	7.91	7.87	7.92	7.90	0.032	0.035	0.030	0.032	0.003	0.004	0.002	0.003
S3	245.0	242.0	239.0	242.0	7.96	7.98	7.90	7.95	0.047	0.047	0.045	0.046	0.303	0.298	0.308	0.303
S4	195.0	190.0	188.0	191.0	7.90	7.94	7.92	7.92	0.029	0.031	0.028	0.029	0.675	0.672	0.674	0.674
S5	260.0	266.0	257.0	261.0	7.85	7.93	7.92	7.90	0.310	0.330	0.360	0.333	0.035	0.042	0.039	0.039
S6	225.0	228.0	221.0	224.7	7.91	7.95	7.88	7.91	0.035	0.038	0.037	0.037	0.042	0.044	0.048	0.045
S7	420.0	424.0	428.0	424.0	7.90	7.74	7.68	7.77	0.043	0.045	0.041	0.043	0.393	0.388	0.397	0.393
S8	280.0	284.0	282.0	282.0	7.95	7.83	7.92	7.90	0.042	0.042	0.045	0.043	0.126	0.131	0.129	0.129
S9	421.0	425.0	417.0	421.0	7.65	7.69	7.75	7.70	0.039	0.034	0.041	0.038	1.538	1.532	1.502	1.524
S10	489.0	493.0	485.0	489.0	7.82	7.89	7.78	7.83	0.228	0.229	0.220	0.226	0.342	0.344	0.337	0.341
S11	479.0	488.0	488.0	485.0	7.42	7.38	7.45	7.42	0.189	0.187	0.192	0.189	0.774	0.779	0.775	0.776
S12	851.0	843.0	840.0	844.7	7.62	7.68	7.65	7.65	0.362	0.358	0.360	0.360	0.228	0.233	0.226	0.229
S13	326.0	325.0	332.0	327.7	7.91	7.94	7.95	7.93	0.185	0.182	0.187	0.185	1.052	1.055	1.048	1.052
S14	195.0	191.0	196.0	194.0	8.01	8.02	8.05	8.03	0.030	0.039	0.031	0.033	0.398	0.405	0.393	0.399
S15	259.0	264.0	260.0	261.0	7.90	7.95	7.91	7.92	0.032	0.035	0.029	0.032	0.510	0.532	0.488	0.510
S16	245.0	250.0	249.0	248.0	7.92	7.90	7.94	7.92	0.390	0.410	0.380	0.393	0.060	0.063	0.058	0.060
S17	270.0	275.0	271.0	272.0	7.93	7.93	7.94	7.93	0.220	0.220	0.180	0.207	0.402	0.405	0.407	0.405
S18	352.0	359.0	348.0	353.0	7.71	7.71	7.75	7.72	0.035	0.033	0.030	0.033	0.614	0.620	0.617	0.617
S19	181.0	182.0	175.0	179.3	7.80	7.82	7.85	7.82	0.390	0.410	0.360	0.387	0.095	0.089	0.097	0.094
S20	187.0	188.0	183.0	186.0	8.01	8.10	8.05	8.05	0.420	0.490	0.510	0.473	0.282	0.286	0.279	0.282
S21	209.0	207.0	214.0	210.0	8.08	8.05	8.11	8.08	0.029	0.030	0.026	0.028	0.548	0.546	0.544	0.546
S22	288.0	278.0	270.0	278.7	7.85	7.89	7.91	7.88	0.027	0.028	0.026	0.027	0.512	0.510	0.505	0.509
S23	481.0	485.0	486.0	484.0	7.83	7.81	7.85	7.83	0.167	0.164	0.155	0.162	0.781	0.773	0.774	0.776
S24	416.0	417.0	415.0	416.0	7.75	7.73	7.71	7.73	0.290	0.320	0.260	0.290	0.121	0.126	0.118	0.122

Cont. Table 2: Chemical analysis of soil samples.																
Sam. ID	1st test	2nd test	3rd test	Avg.	1st test	2nd test	3rd test	Avg.	1st test	2nd test	3rd test	Avg.	1st test	2nd test	3rd test	Avg.
	EC µ/Scm	**EC µ/Scm**	**EC µS/cm**	**EC µS/cm**	**pH**	**pH**	**pH**	**pH**	**TOC %**	**TOC %**	**TOC %**	**TOC %**	**IC %**	**IC %**	**IC %**	**IC %**
S25	108.0	115.0	107.0	110.0	7.96	7.92	7.98	7.95	0.033	0.031	0.035	0.033	0.489	0.488	0.493	0.490
S26	281.0	285.0	289.0	285.0	7.67	7.65	7.66	7.66	0.028	0.032	0.026	0.029	0.503	0.512	0.502	0.506
S27	265.0	272.0	278.0	271.7	7.60	7.65	7.63	7.63	0.032	0.035	0.033	0.033	0.490	0.496	0.488	0.491
S28	169.0	173.0	175.0	172.3	7.75	7.78	7.77	7.77	0.021	0.025	0.020	0.022	0.474	0.482	0.472	0.476
S29	263.0	261.0	265.0	263.0	7.80	7.85	7.82	7.82	0.049	0.052	0.048	0.050	0.494	0.492	0.496	0.494
S30	191.0	198.0	196.0	195.0	7.70	7.60	7.70	7.67	0.025	0.029	0.030	0.028	0.394	0.398	0.392	0.395

Discussion of chemical analysis results:

The EC values of the collected soil samples ranged from 110 µS/cm to 490 µS/cm with an exception of one sample with an EC value of 840 µS/cm collected from wadi Hassan (S 12).

Therefore, the soils the area will not form a source of salinity of groundwater when flood water with EC values of 120 – 280 µS/cm are used for groundwater recharge (Salameh 1996).

The salt content of the sample S12 can be caused by contamination with salt or as a result from flood water collected in an impermeable depression where all the water evaporated leaving behind the salt in the soil profile. But, this sample is actually an exception and should be discarded.

The pH values are within the normal range of soils affected by carbonate dust (7.6 to 8.1), actually slightly alkaline, with no adverse effects on groundwater recharge.

In addition the total organic carbon and inorganic carbon contents are very small, typical for plant cover and human activities.

Allowing flood water to infiltrate through such soils as samples S1 to S30 show will not have any adverse or negative effects on the soils or the groundwaters measures 700-1500 µS/cm with normal slightly alkaline pH and depreciation of organic and inorganic carbon content.

Grain size analysis:

Grain size analysis diagrams and raw data are shown in Appendices 1-30.

The sieving results indicate sorted to well sorted grain size distribution. Badly sorted samples are no 7, 8, 25, 27, and 28.

But only in samples 25, 27 and 28 the effective diameter (10% of samples has smaller diameter) is relatively low (<0.05 mm).

This means that all the collected samples except 25, 27 and 28 have high potential to transmit water with a calculated permeability (Hazen method and Ziechang equation) ranging from $7.4*10^{-5}$ m/s to $2.2*10^{-4}$ m/s. Samples 25, 27 and 28 have calculated permeabilities of 10^{-6} to 10^{-7} m/s.

The collected samples and the sampling areas do of course not represent the situation in the Jordanian steppe, but they can be compared with other experiments ad studies, such as these performed on Muwaqqar weirs with very similar permeabilities of $5*10^{-4}$ to $5*10^{-5}$ m/s.

The silt accumulated in Muwaqqar weirs has permeabilities of around $2*10^{-5}$ m/s, which is excellent one for groundwater recharge.

Dry bulk analysis:

All the collected samples we analyzed for dry bulk density, also porosity testing was carried out for the samples. Samples were in two types semi disturbed samples and undisturbed samples. The results of semi disturbed samples are given in table 3 and for the undisturbed samples in table 4.

Table 3: Dry bulk Density and porosity for semi disturbed soil samples		
Sample Id	Bulk Density	Porosity
Samp. 1	1.87	0.29
Samp. 2	1.76	0.34
Samp. 3	1.99	0.25
Samp. 4	1.96	0.26
Samp. 5	1.94	0.27
Samp. 6	1.82	0.28
Samp. 7	1.66	0.37
Samp. 8	1.4	0.47
Samp. 9	1.27	0.52
Samp. 10	1.48	0.44
Samp. 11	1.16	0.56
Samp. 12	1.78	0.33
Samp. 13	1.44	0.46
Samp. 14	1.54	0.42
Samp. 15	1.38	0.49
Samp. 16	1.36	0.49
Samp. 17	1.63	0.38
Samp. 18	1.63	0.38
Samp. 19	1.56	0.41
Samp. 20	1.96	0.26
Samp. 21	1.27	0.52
Samp. 22	2.03	0.24
Samp. 23	1.66	0.37
Samp. 24	1.79	0.3
Samp. 25	1.5	0.43
Samp. 26	1.56	0.4
Samp. 27	1.44	0.46
Samp. 28	1.39	0.48
Samp. 29	1.39	0.47
Samp. 30	1.45	0.45

Table 4: Dry bulk Density for undisturbed soil samples		
Sample	Bulk density	Porosity %
Sample 1	1.33	49.8
Sample 3	1.27	52.1
Sample 7	1.4	47.2
Sample 8	1.41	46.8
Sample 9	1.25	52.8
Sample 10	1.22	54.0
Sample 11	1.15	56.6
Sample 12	1.27	52.1
Sample 14	1.21	54.3
Sample 15	1.14	57.0
Sample 19	1.24	53.2
Sample 20	1.15	56.6
Sample 21	1.18	55.5
Sample 22	1.23	53.6
Sample 23	1.38	47.9
Sample 25	1.33	49.8
Sample 26	1.19	55.1
Sample 27	1.31	50.6
Sample 28	1.15	56.6
Sample 29	1.13	57.4

Soil retention measurements.

Within this work 20 undisturbed samples were collected for soil water retention measurements. The test was conducted in dewatering condition to give the following results (Table 5).
The resulted PF curves are shown in appendices 31 to 50.

Table 5: Soil retention test results (Dewatering).

Sample	Bulk density	Bar				
		0.33	1	5	10	15
Sample 1	1.33	16.20	14.10	13.50	12.20	8.40
Sample 3	1.27	19.20	17.30	15.10	13.20	11.60
Sample 7	1.4	17.80	14.80	13.20	11.60	10.60
Sample 8	1.41	25.00	22.90	19.70	16.10	15.80
Sample 9	1.25	22.10	20.20	16.00	14.60	11.60
Sample 10	1.22	22.50	19.20	18.20	15.70	13.70
Sample 11	1.15	25.60	22.50	19.30	15.80	11.60
Sample 12	1.27	22.90	20.50	18.60	16.40	11.20
Sample 14	1.21	18.20	14.20	12.00	11.20	10.70
Sample 15	1.14	42.50	33.60	28.20	27.00	26.10
Sample 19	1.24	28.80	26.10	22.70	20.40	16.80
Sample 20	1.15	38.20	35.50	31.70	28.90	19.50
Sample 21	1.18	34.30	24.10	19.80	18.20	16.40
Sample 22	1.23	25.10	23.20	20.00	18.70	16.60
Sample 23	1.38	26.50	20.70	18.60	16.70	15.10
Sample 25	1.33	19.80	16.60	13.30	11.50	10.50
Sample 26	1.19	17.70	15.20	13.80	12.30	11.60
Sample 27	1.31	35.80	31.80	28.40	23.60	21.80
Sample 28	1.15	29.20	21.90	18.50	16.20	15.70
Sample 29	1.13	28.50	23.20	20.30	19.10	15.90

Discussion of Bulk density and soil retention measurements.

The bulk densities of disturbed samples shown in table 3 ranging between 1.16 and 2.02 g/cm^3 are within the range of sorted wadi deposits with a small percentage of fine grained particles which normally fill voids in between larger particles.

The densities are will reflected in the porosity of the soils which ranged from 0.24 to 0.56, indicating sorted but un compacted soil particles.

For infiltration processes these porosities and relatively large sizes of particles (see sieving curves) will not allow the very fine silt particles coming with the flood waters to settled and captured between the soil grains and lessen soil permabilities.

The undisturbed samples show in general lower both densities (table 4) than disturbed ones. This is a clear indication that the soils were rapidly deposited from a stream without any later compaction so that even disturbing the soil or shaking it results in a type of grains rearrangements and compaction.

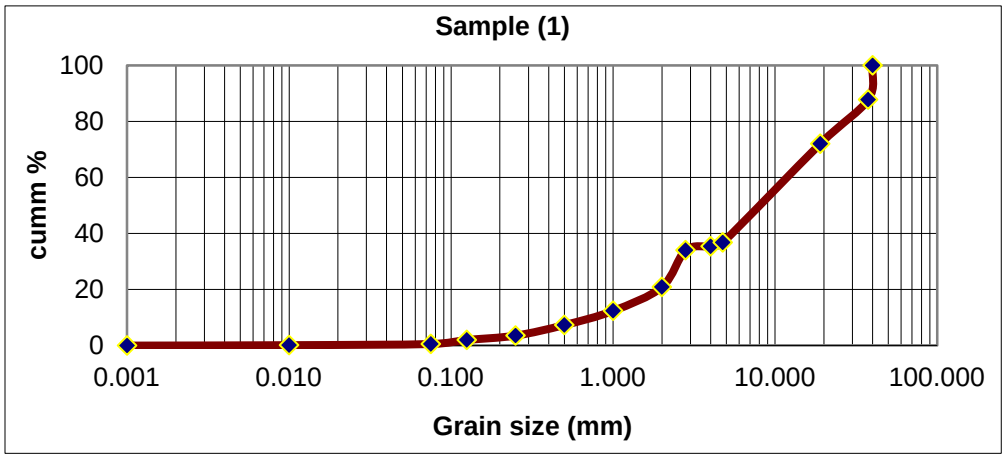
Undisturbed samples have calculated porosities of 0.47 to 0.69. Their grains are unrounded, totally loose and uncompacted.

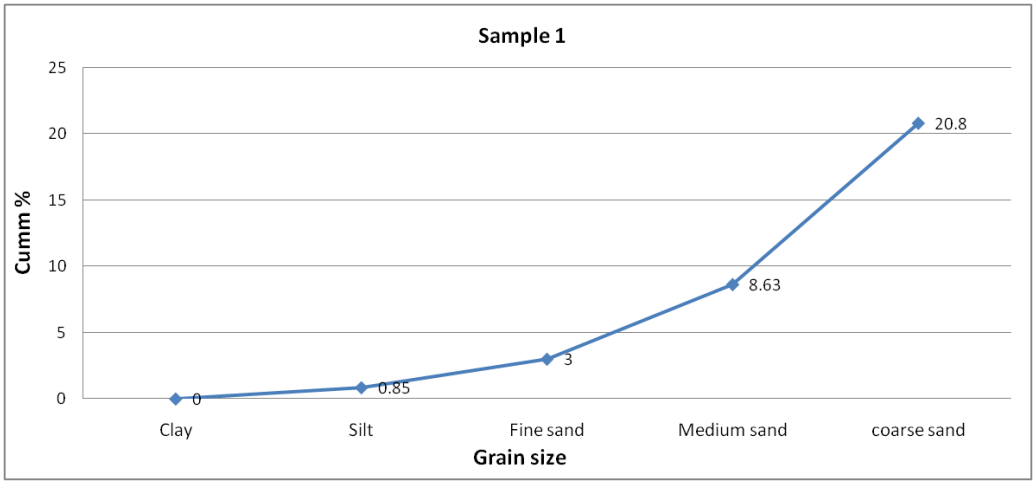
The soil retention under natural pressure ranged for the undisturbed samples from 14.1% to 35.5, on average 1/3 to 1/2 of the porosity, which means the soil upon saturation will only behold one third to half of the water needed to saturate it. Of course most of that water, will leak on, when the soil is exposed to evaporation , be lost by evaporation.

But again, since these soils in the desert along wadis are only a few dm thick. The recharge amounts using weirs be appreciable.

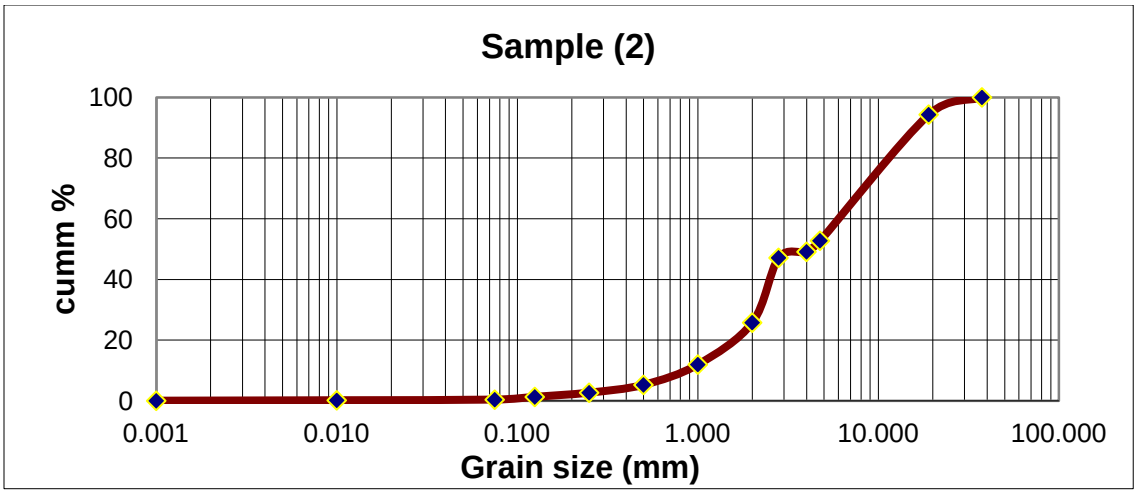
Appendices

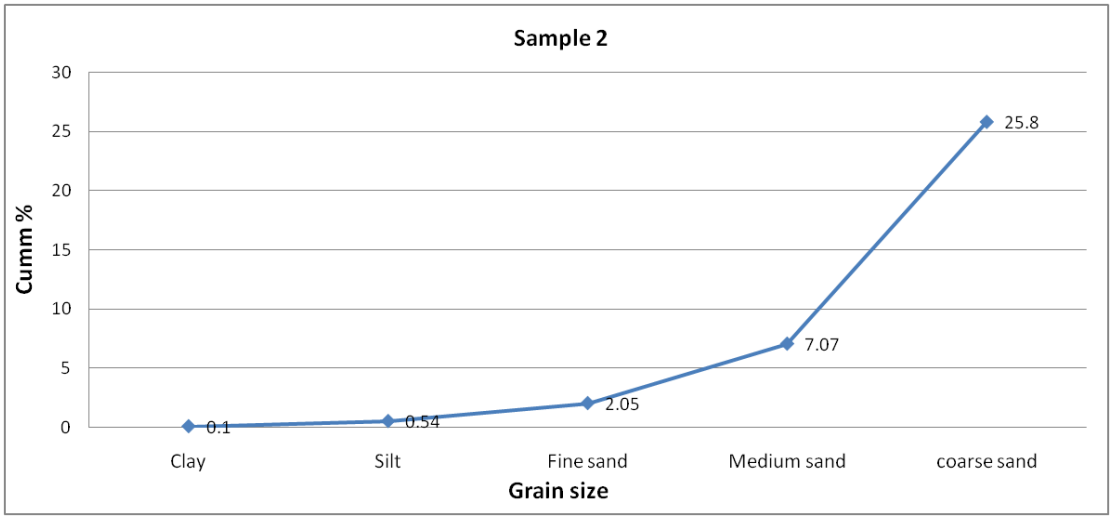
Appendences 1-30: Sieve Analysis results for the collected soil samples.



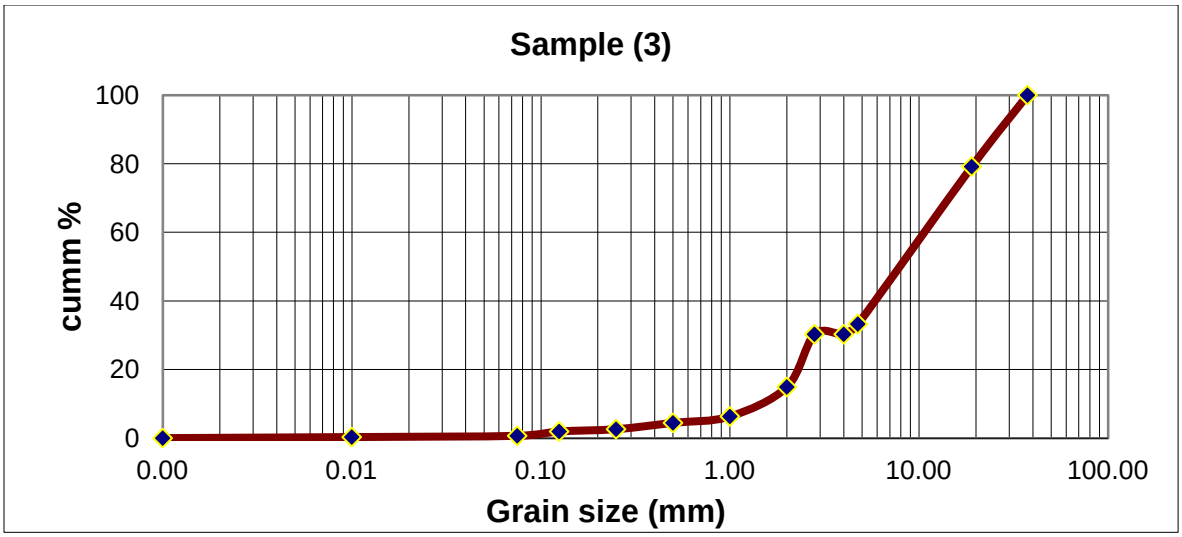


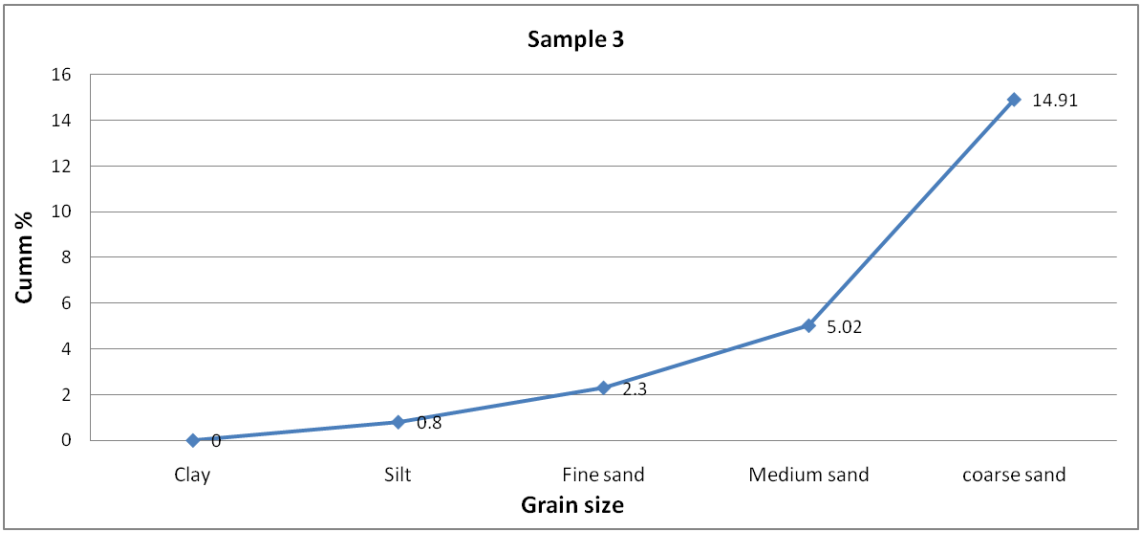
Samp.1	
Grain size (mm)	Cum %
0.001	0.00
0.010	0.15
0.075	0.56
0.125	2.00
0.250	3.56
0.500	7.33
1.000	12.40
2.000	20.90
2.800	34.03
4.000	35.41
4.750	36.80
19.000	72.02
37.500	87.77
40.000	100.00



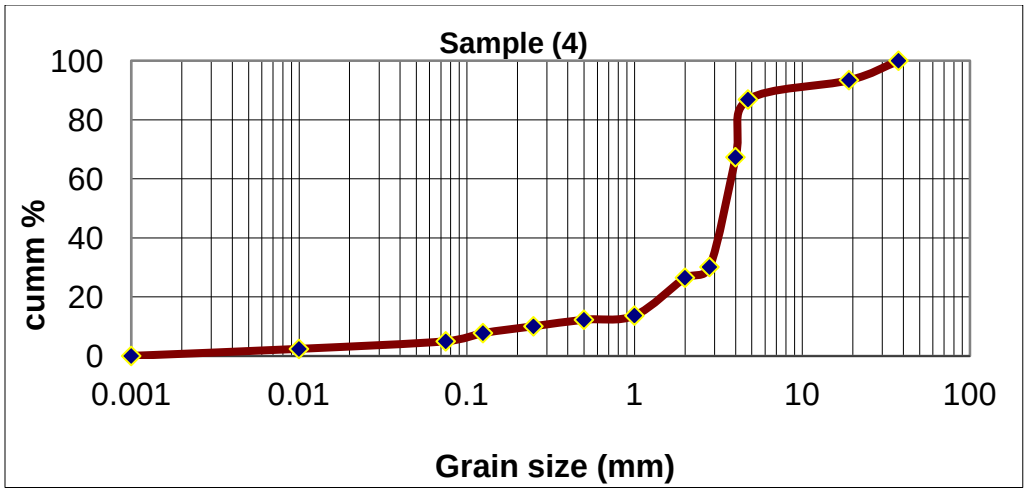


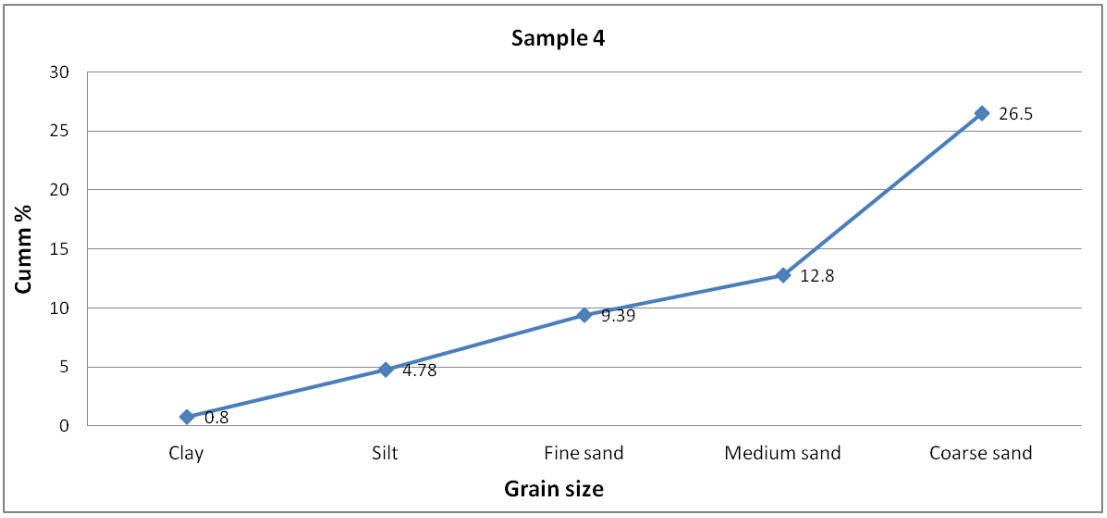
Sample 2	
Grain size (mm)	Cum %
0.001	0.00
0.010	0.15
0.075	0.36
0.125	1.27
0.250	2.66
0.500	5.24
1.000	11.94
2.000	25.76
2.800	47.12
4.000	49.10
4.750	52.75
19.000	94.32
37.500	100.00



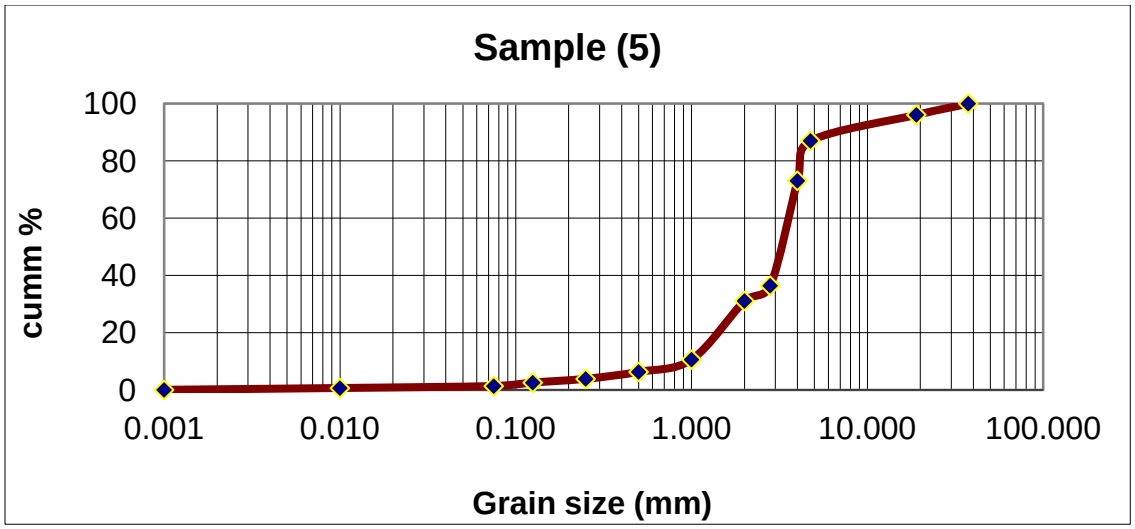


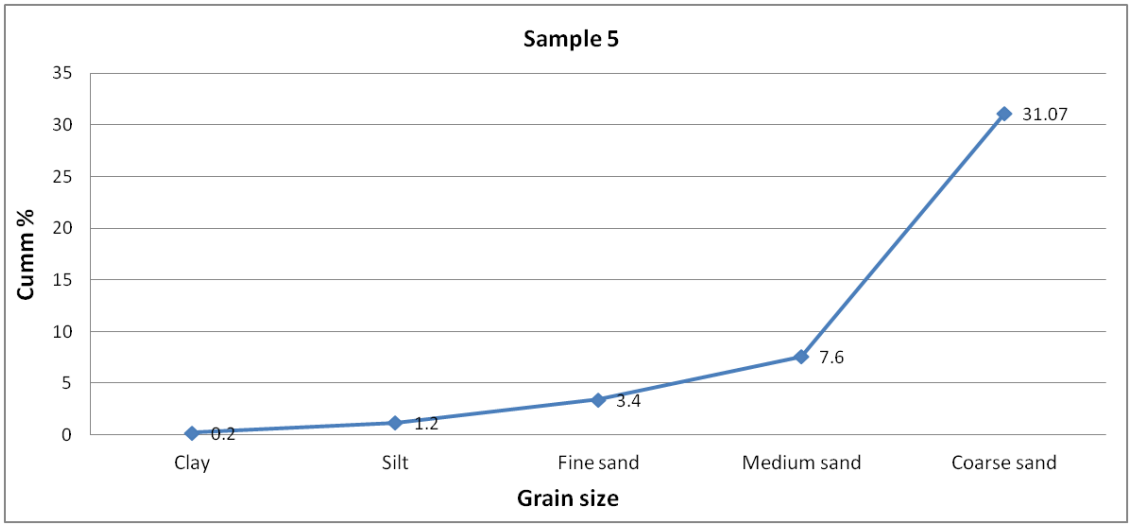
Sample 3	
Grain size (mm)	Cum %
0.00	0.00
0.01	0.31
0.08	0.67
0.13	1.93
0.25	2.60
0.50	4.44
1.00	6.31
2.00	14.91
2.80	30.27
4.00	30.27
4.75	33.26
19.00	79.15
37.50	100.00



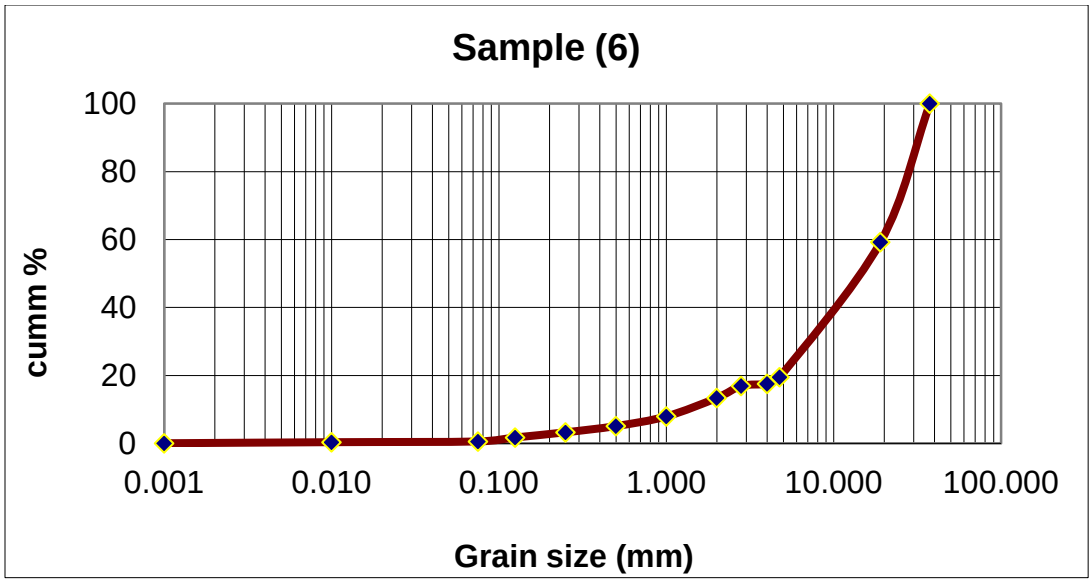


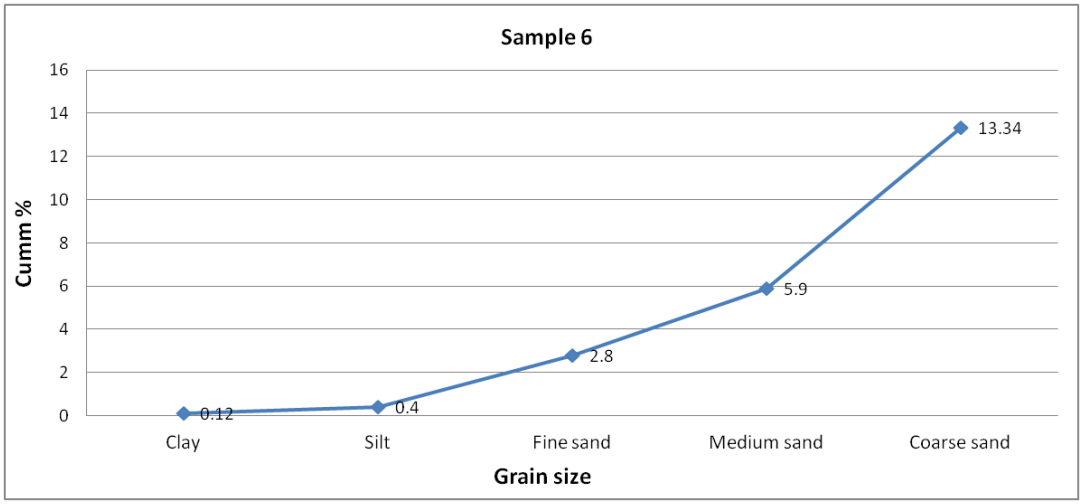
Sample 4	
Grain size (mm)	Cum %
0.001	0.00
0.01	2.38
0.075	4.96
0.125	7.74
0.25	10.04
0.5	12.26
1	13.67
2	26.50
2.8	30.13
4	67.32
4.75	86.85
19	93.43
37.5	100.00



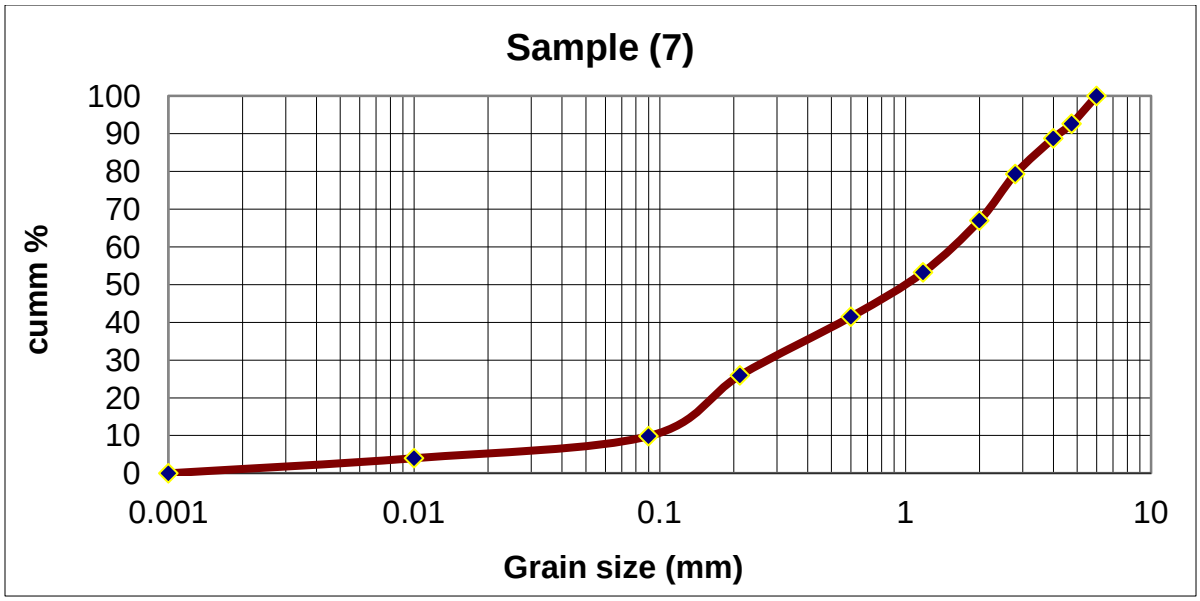


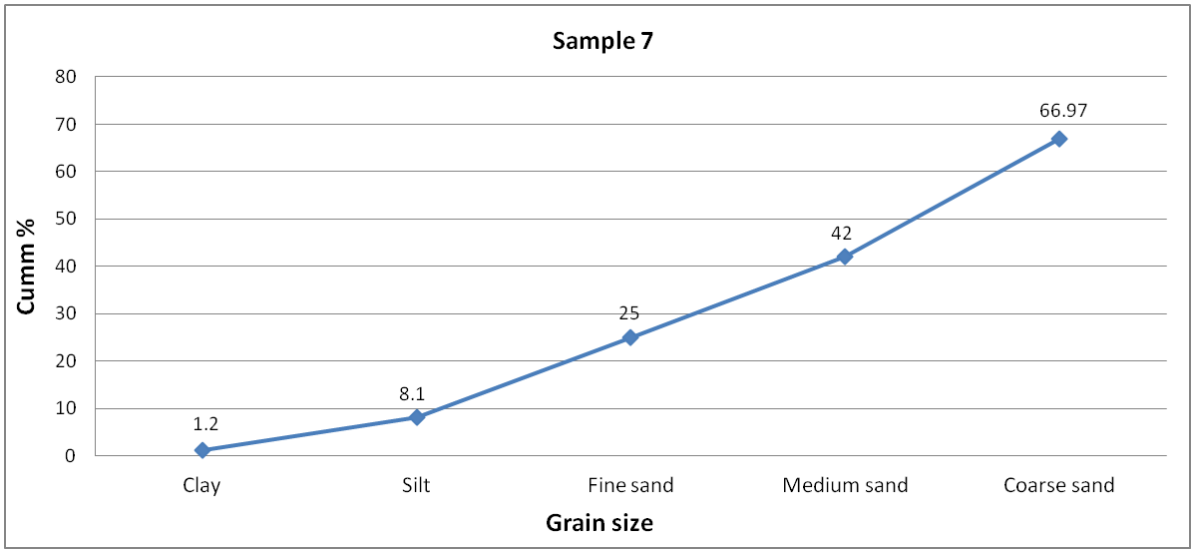
Sample.5	
Grain size (mm)	Cum %
0.001	0.00
0.010	0.63
0.075	1.33
0.125	2.54
0.250	3.84
0.500	6.29
1.000	10.58
2.000	31.07
2.800	36.39
4.000	73.04
4.750	87.00
19.000	96.10
37.500	100.00



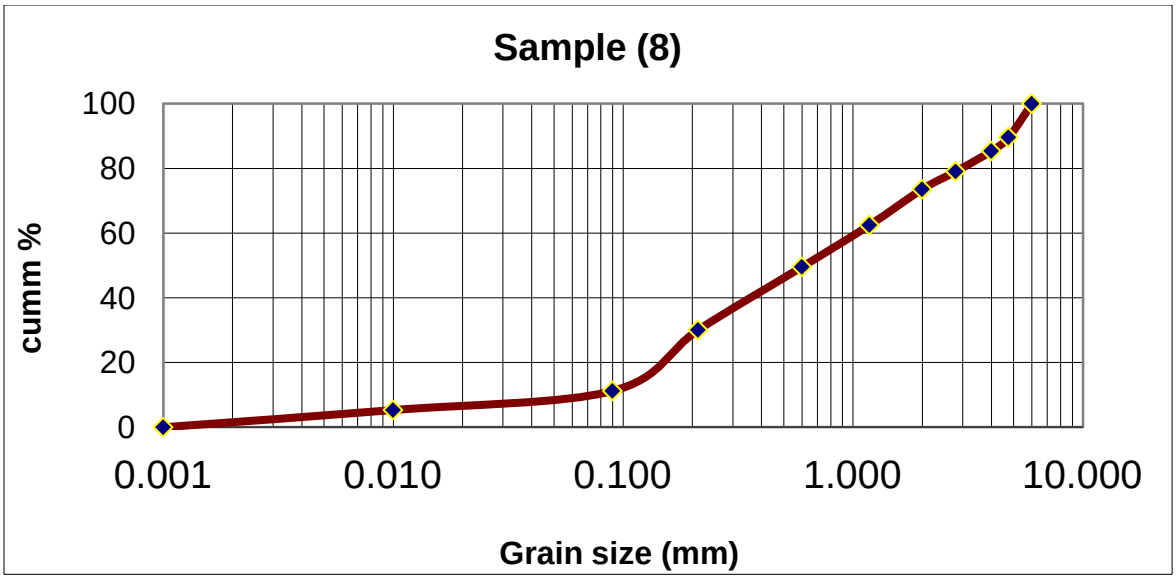


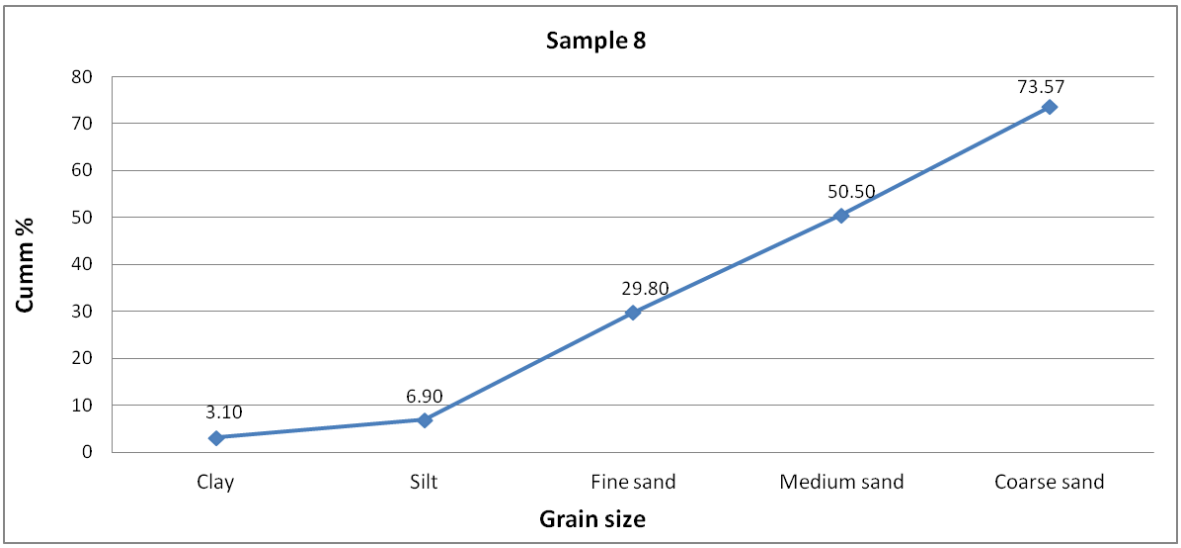
Sample 6	
Grain size (mm)	Cum %
0.001	0.00
0.010	0.31
0.075	0.53
0.125	1.70
0.250	3.22
0.500	5.06
1.000	7.91
2.000	13.34
2.800	16.88
4.000	17.51
4.750	19.47
19.000	59.22
37.500	100.00



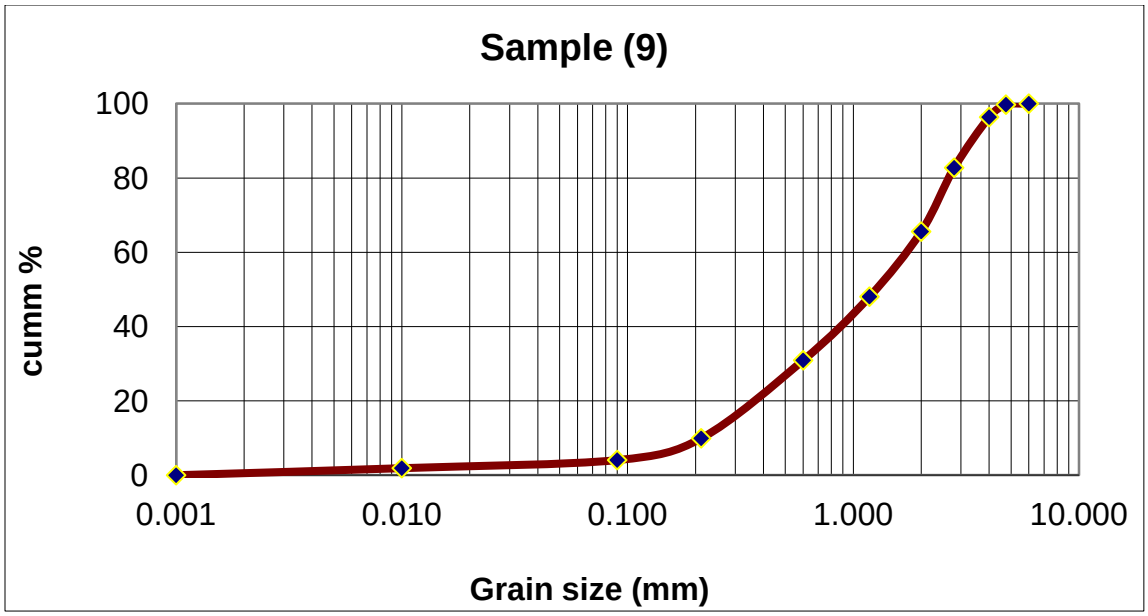


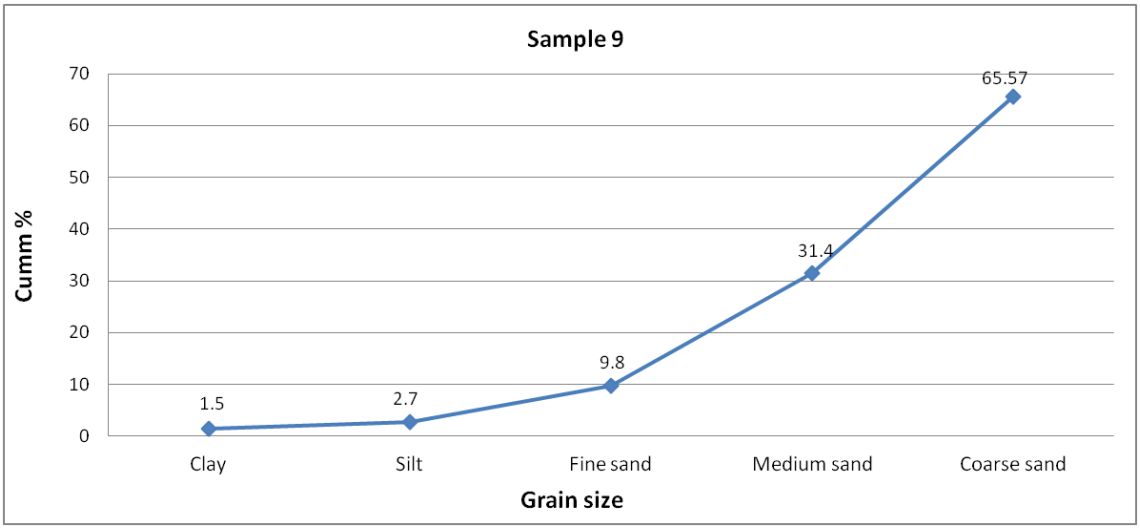
Sample 7	
Grain size (mm)	Cum %
0.001	0.00
0.01	4.00
0.09	9.84
0.212	25.94
0.6	41.49
1.18	53.25
2.00	66.97
2.8	79.31
4	88.76
4.75	92.64
6	100.00



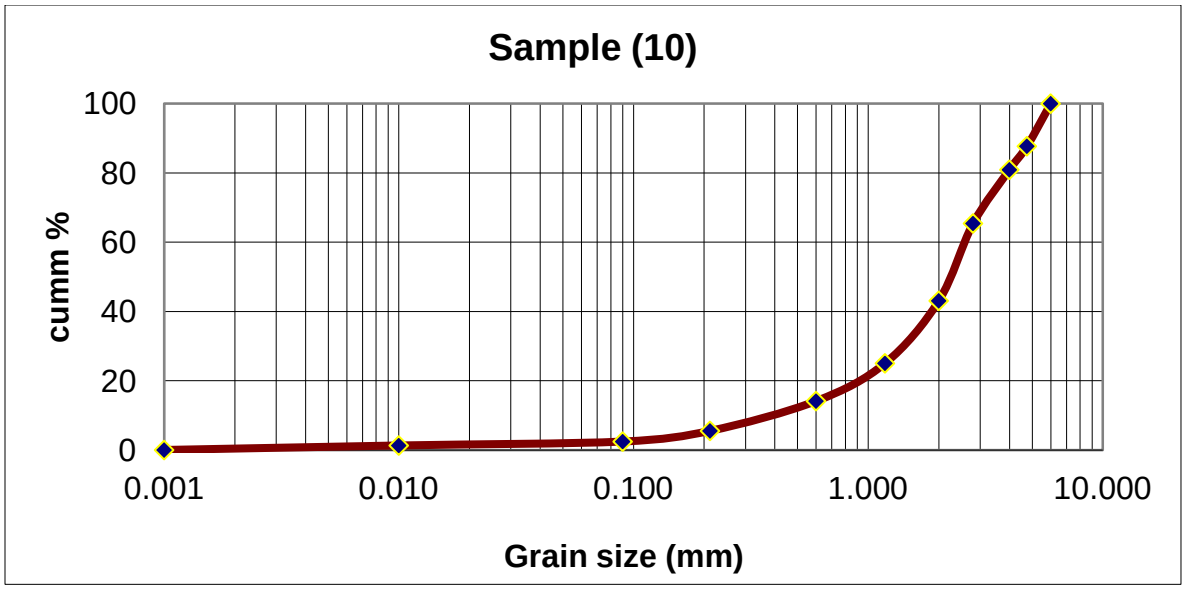


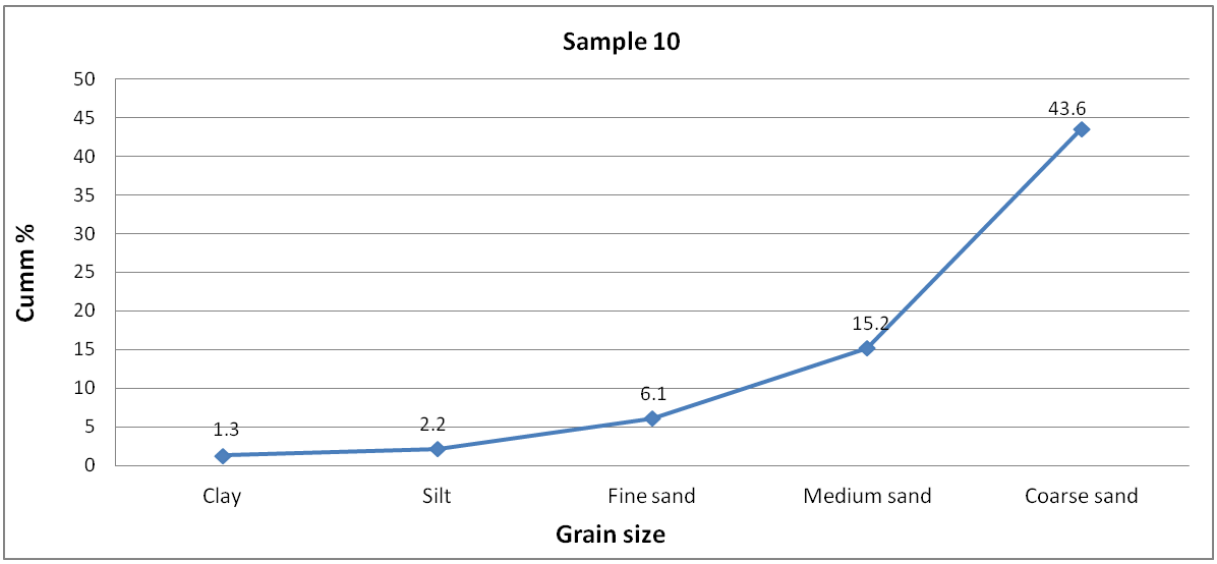
Sample.8	
Grain size (mm)	Cum %
0.001	0.00
0.010	5.31
0.090	11.23
0.212	30.07
0.600	49.56
1.180	62.48
2.000	73.57
2.800	79.06
4.000	85.38
4.750	89.62
6.000	100.00



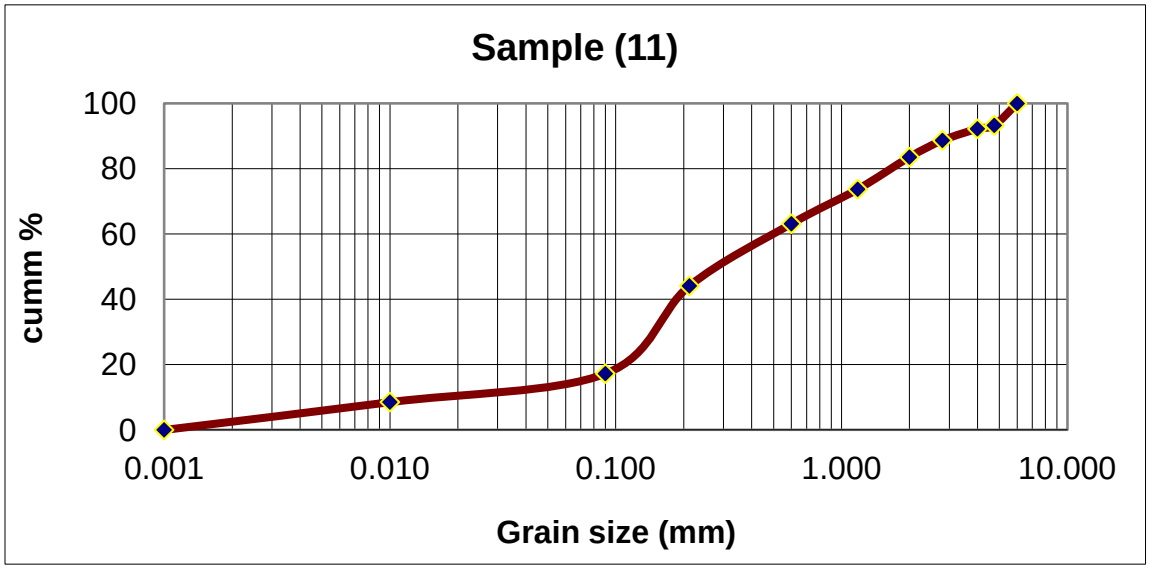


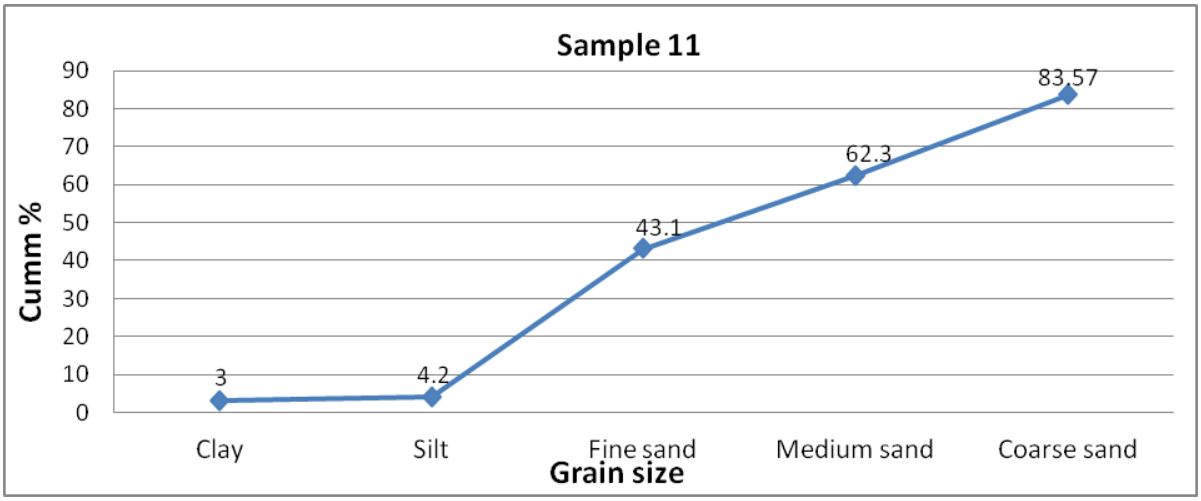
Samp.9	
Grain size (mm)	Cum %
0.001	0.00
0.010	1.90
0.090	4.08
0.212	9.93
0.600	30.93
1.180	48.05
2.000	65.57
2.800	82.75
4.000	96.38
4.750	99.73
6.000	100.00



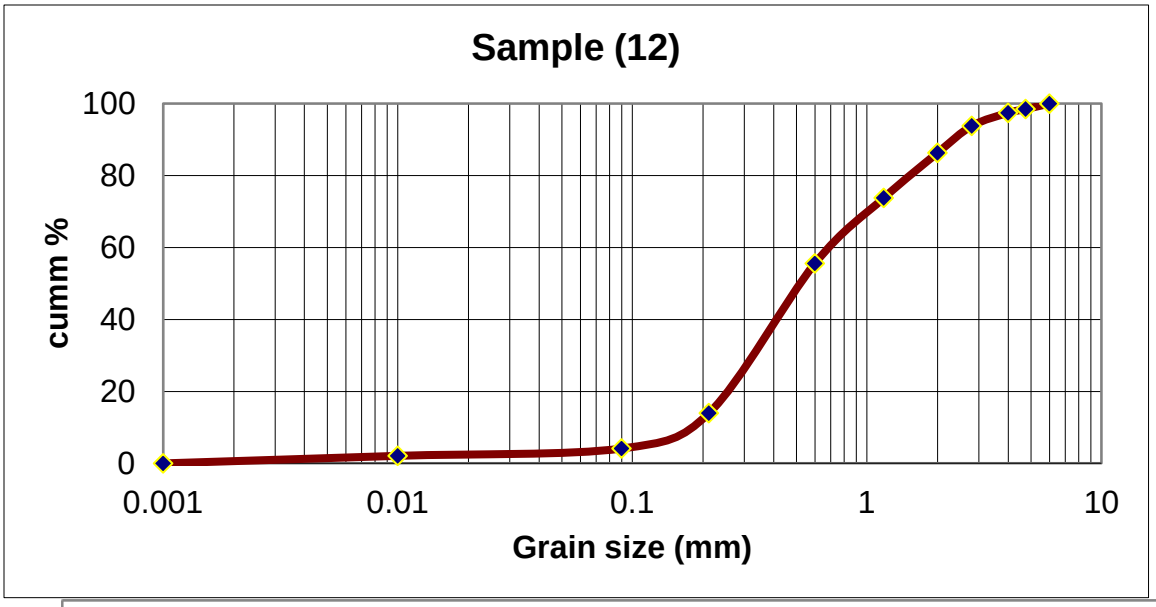


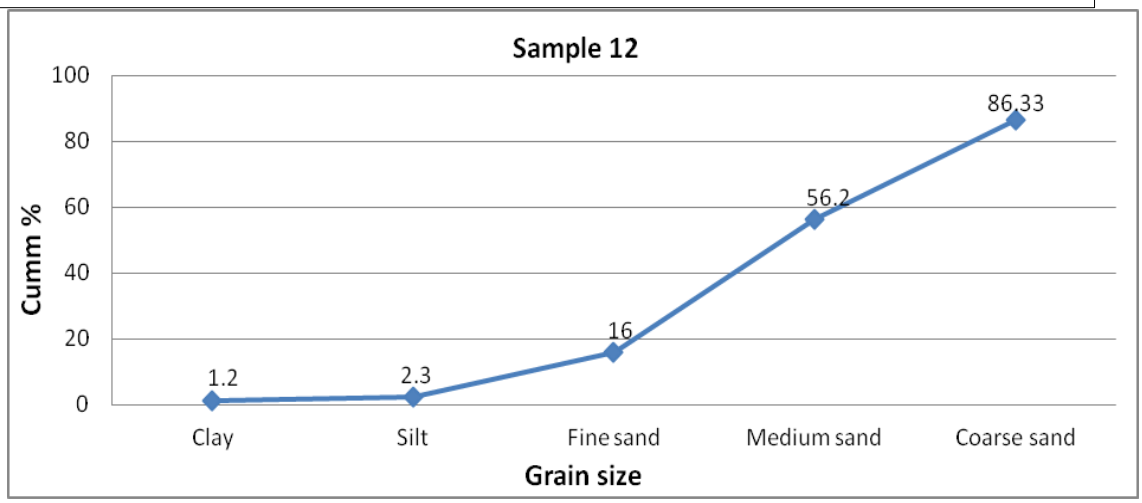
Samp.10	
Grain size (mm)	Cum %
0.001	0.00
0.010	1.30
0.090	2.43
0.212	5.52
0.600	14.12
1.180	25.03
2.000	43.08
2.800	65.41
4.000	80.90
4.750	87.71
6.000	100.00



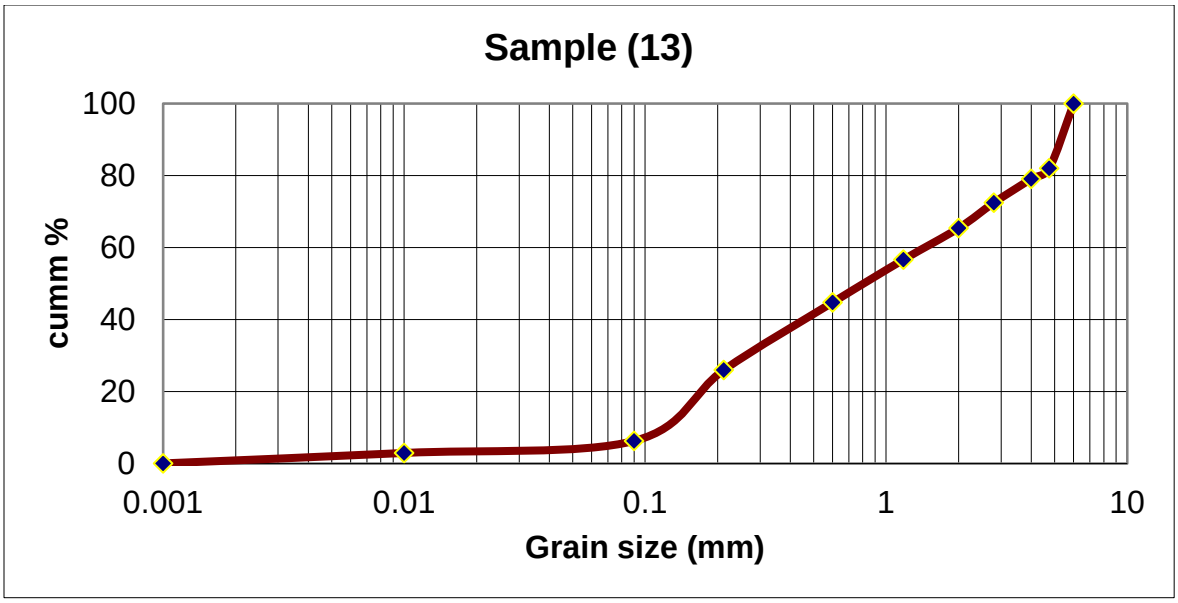


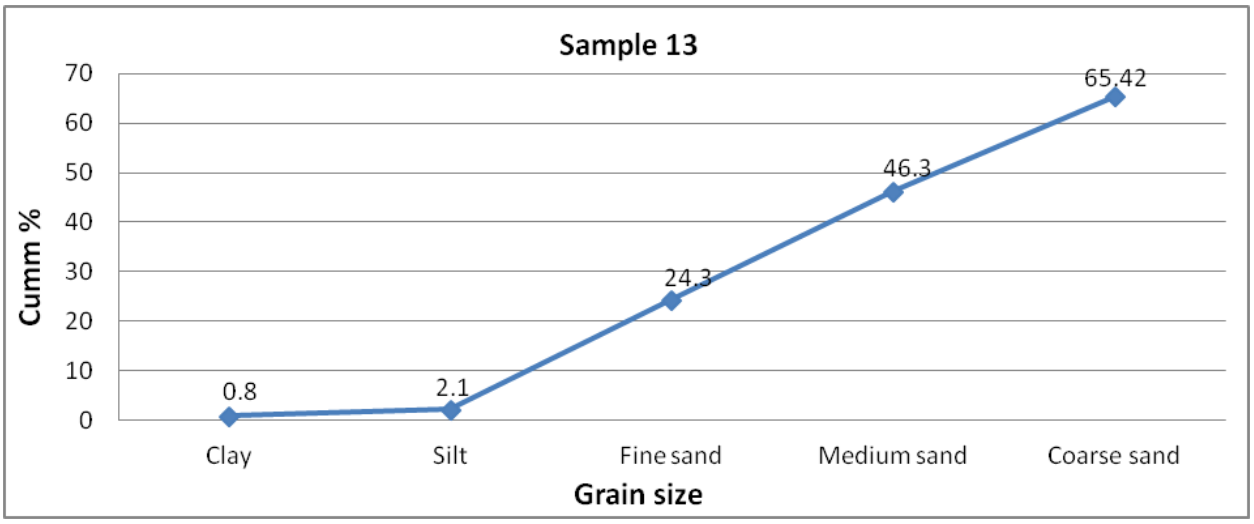
Sample11	
Grain size (mm)	Cum %
0.001	0.00
0.010	8.51
0.090	17.23
0.212	44.11
0.600	63.16
1.180	73.73
2.000	83.57
2.800	88.70
4.000	92.24
4.750	93.30
6.000	100.00



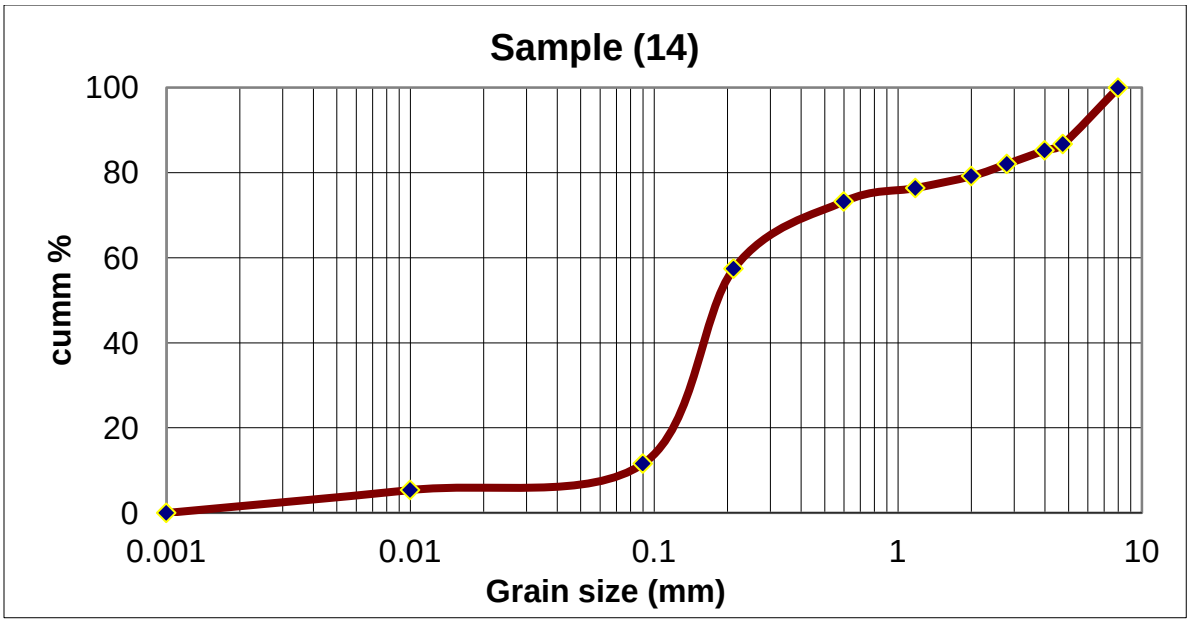


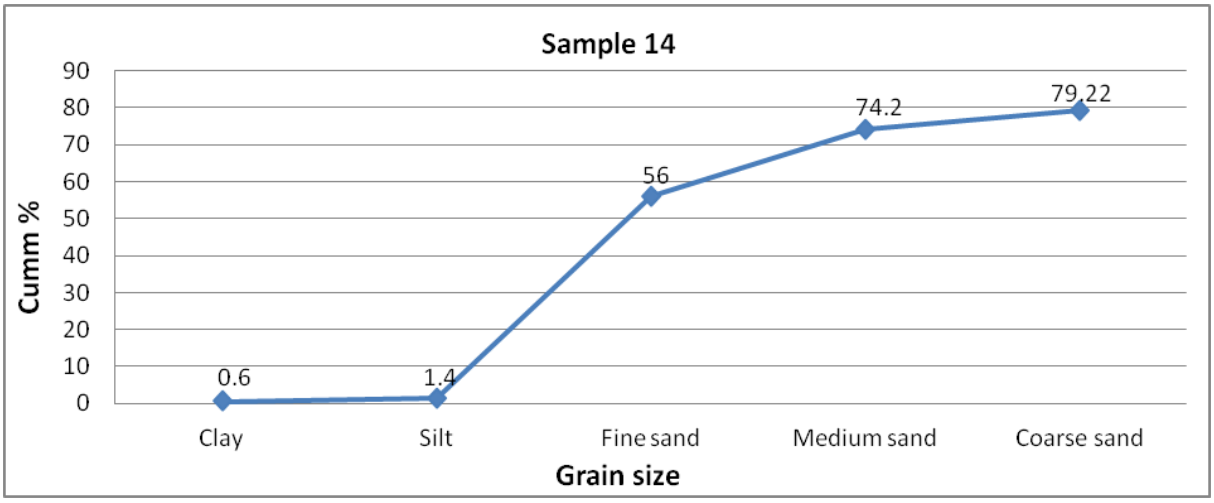
Sample 12	
Grain size (mm)	Cum %
0.001	0.00
0.01	2.10
0.09	4.14
0.212	13.97
0.6	55.59
1.18	73.80
2.00	86.33
2.8	93.82
4	97.45
4.75	98.51
6	100.00



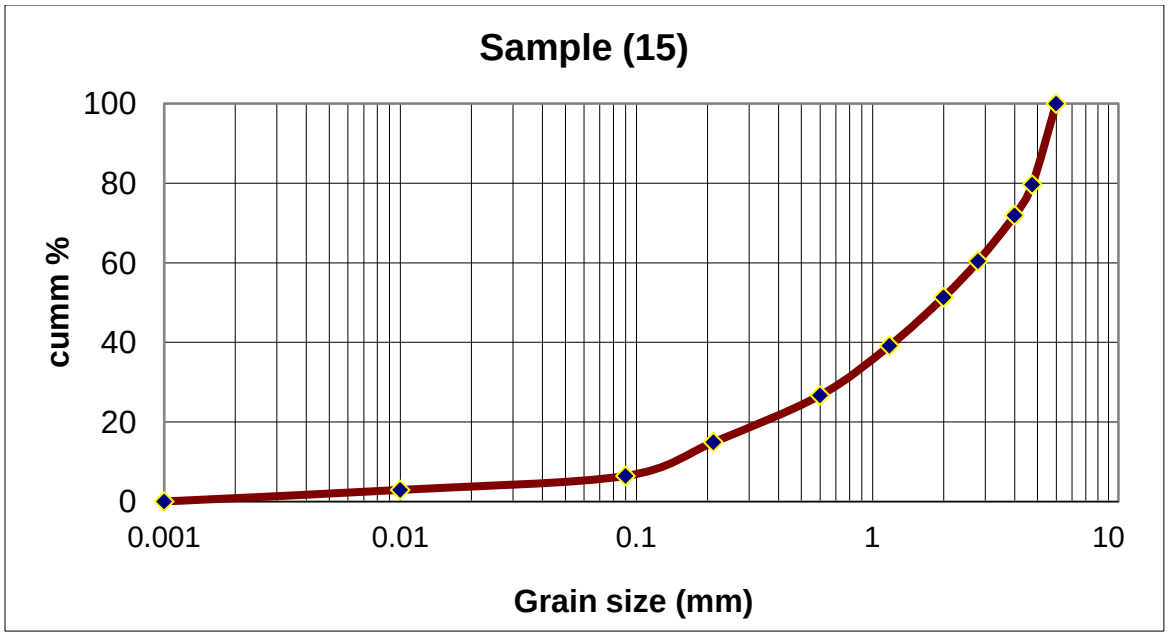


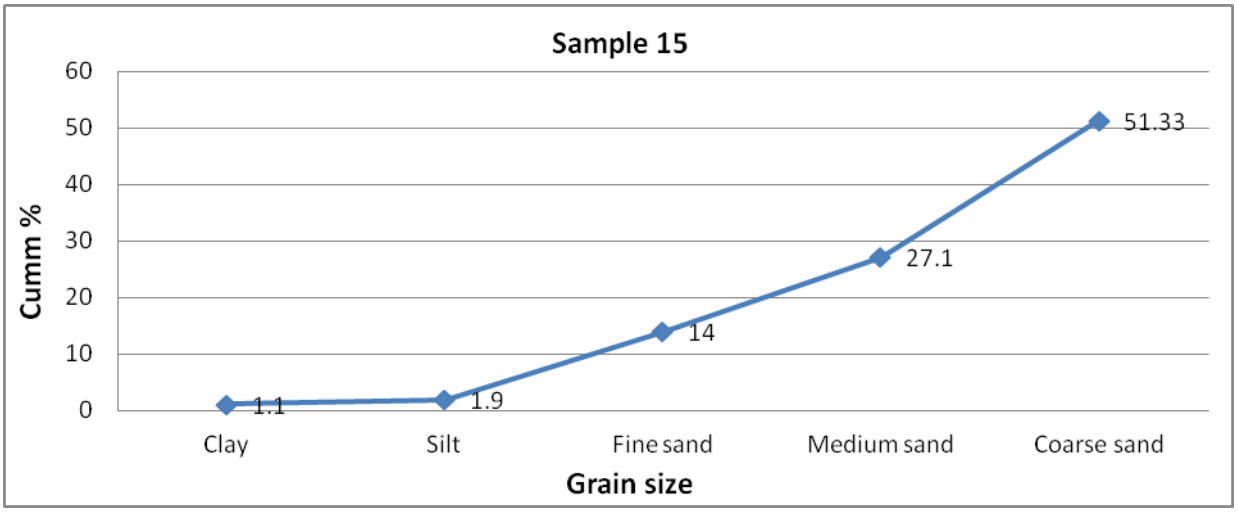
Sample 13	
Grain size (mm)	Cum %
0.001	0.00
0.01	2.9
0.09	6.25
0.212	25.97
0.6	44.76
1.18	56.65
2.00	65.42
2.8	72.47
4	79.10
4.75	82.04
6	100.00



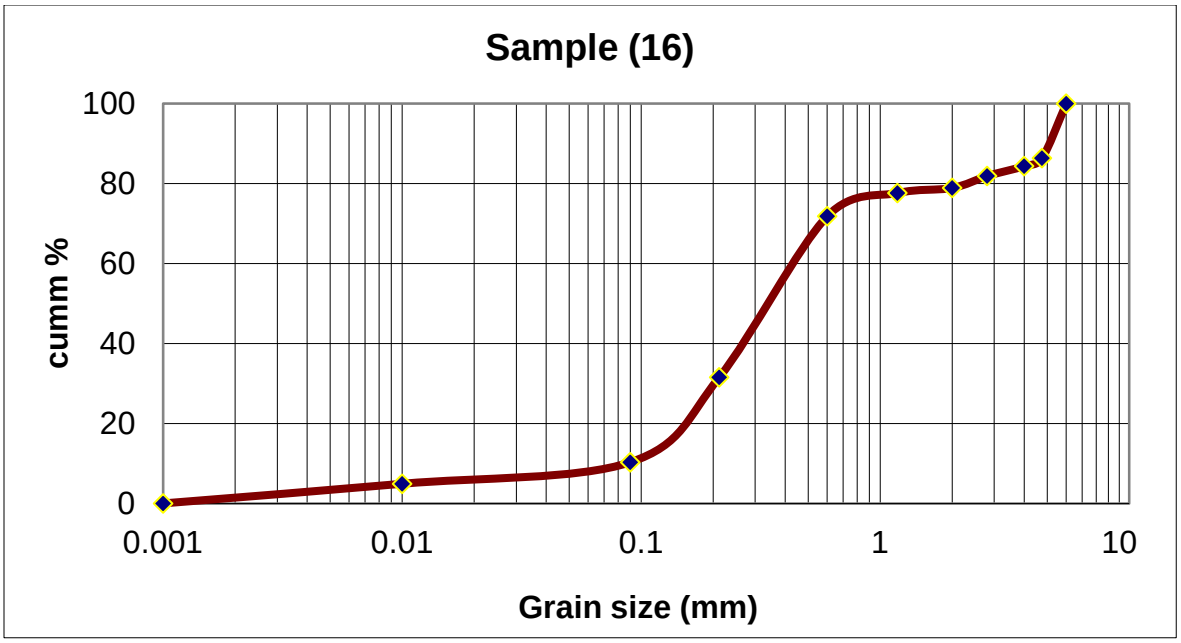


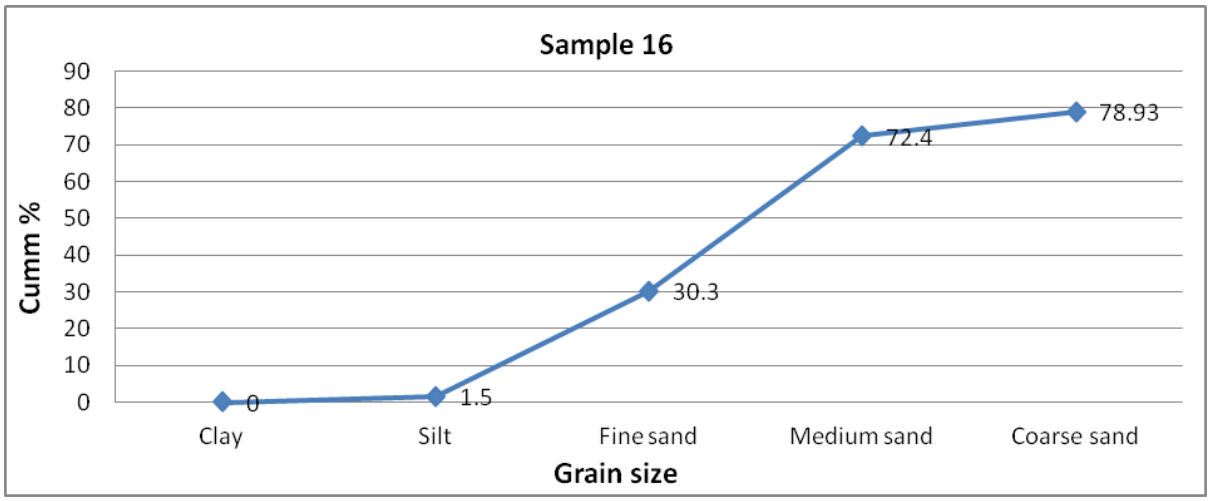
Sample 14	
Grain size (mm)	Cum %
0.001	0.00
0.01	5.39
0.09	11.59
0.212	57.44
0.6	73.24
1.18	76.41
2.00	79.22
2.8	82.07
4	85.28
4.75	86.75
8	100.00



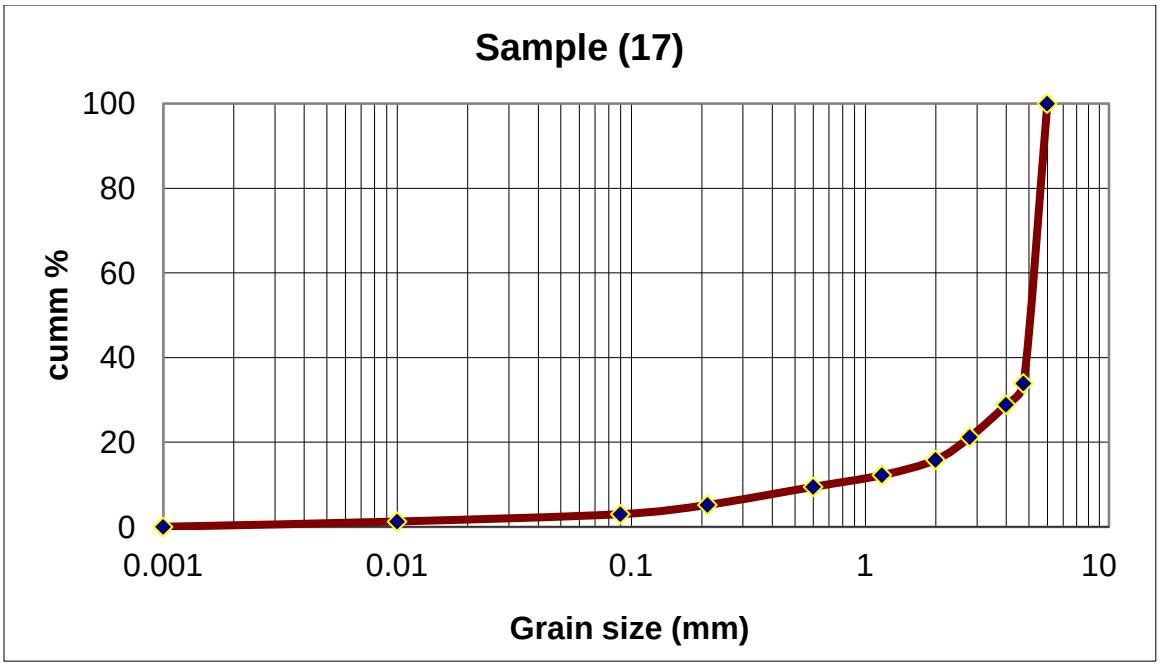


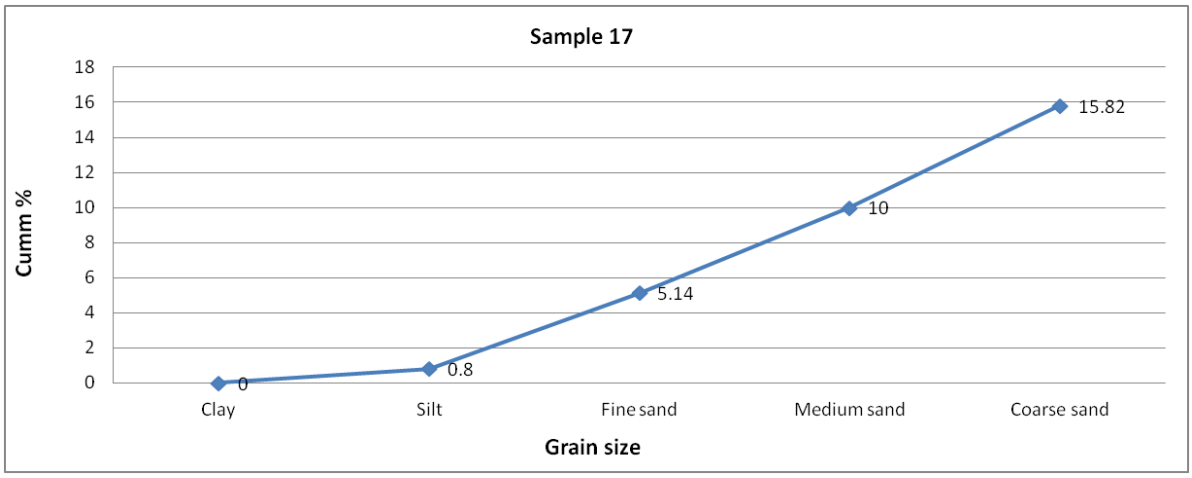
Sample 15	
Grain size (mm)	Cum %
0.001	0.00
0.01	2.91
0.09	6.42
0.212	14.90
0.6	26.68
1.18	39.14
2.00	51.33
2.8	60.42
4	71.93
4.75	79.66
6	100.00



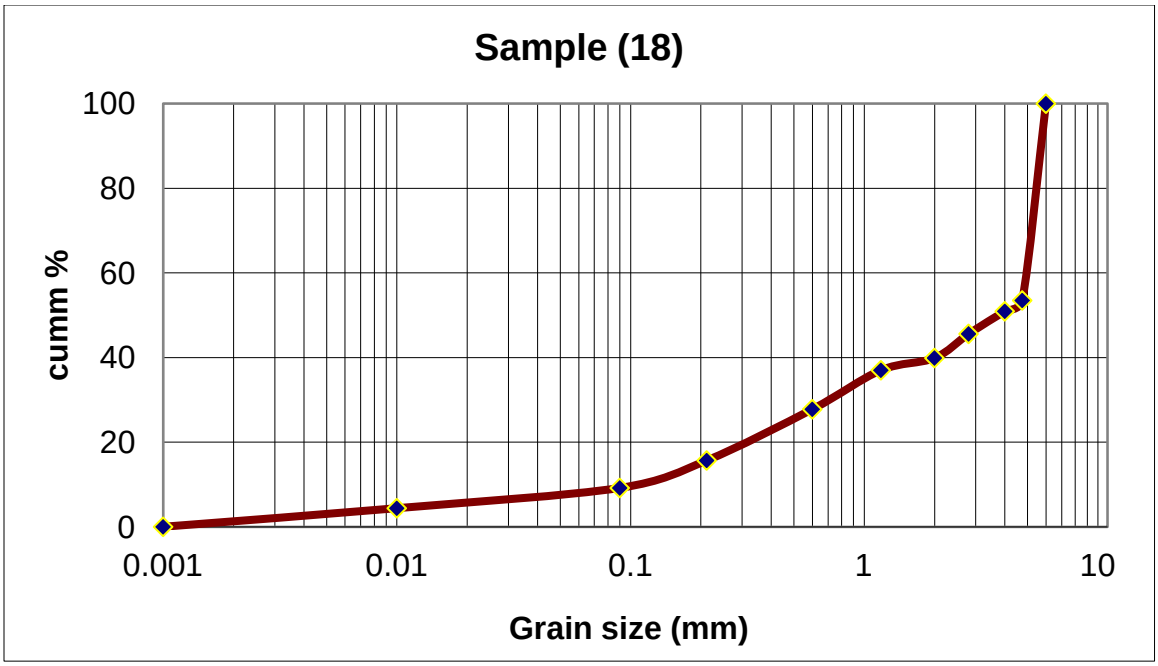


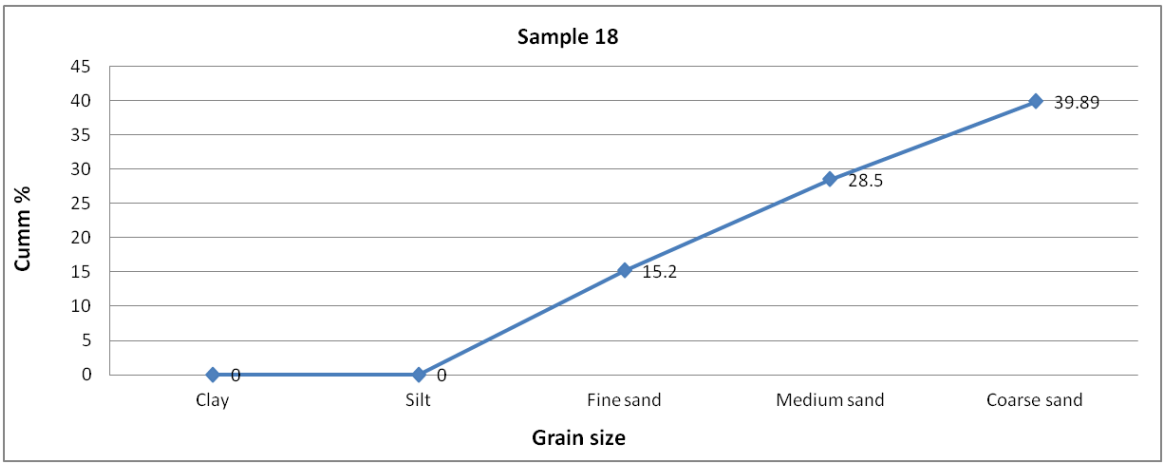
Sample 16	
Grain size (mm)	Cum %
0.001	0.00
0.01	4.91
0.09	10.30
0.212	31.56
0.6	71.85
1.18	77.65
2.00	78.93
2.8	81.91
4	84.38
4.75	86.38
6	100.00



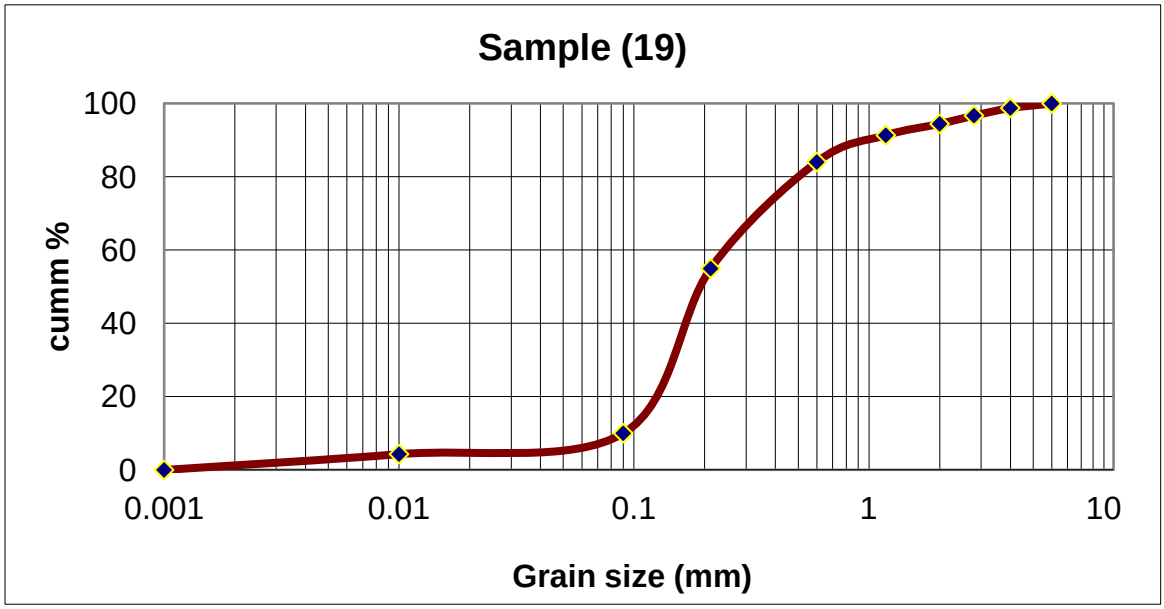


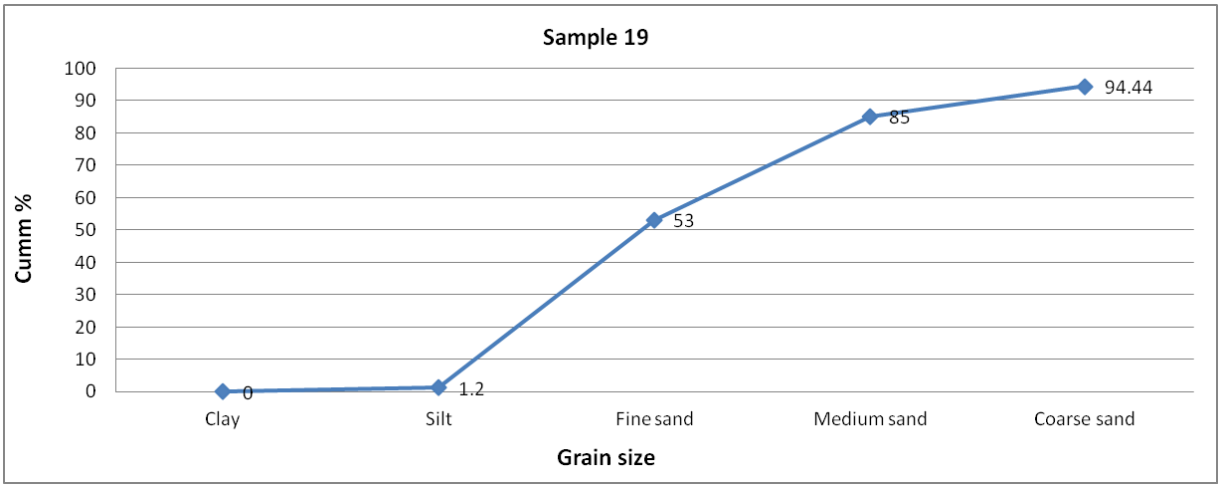
Sample 17	
Grain size (mm)	Cum %
0.001	0.00
0.01	1.24
0.09	2.99
0.212	5.18
0.6	9.44
1.18	12.21
2.00	15.82
2.8	21.20
4	28.85
4.75	33.88
6	100.00



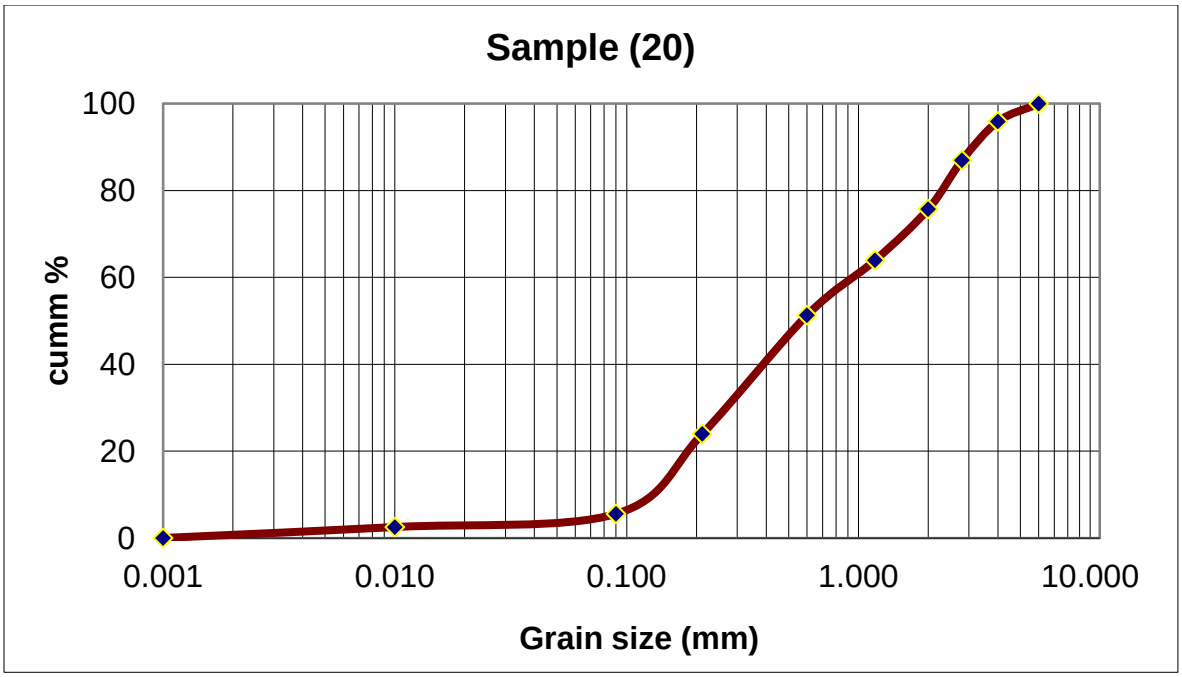


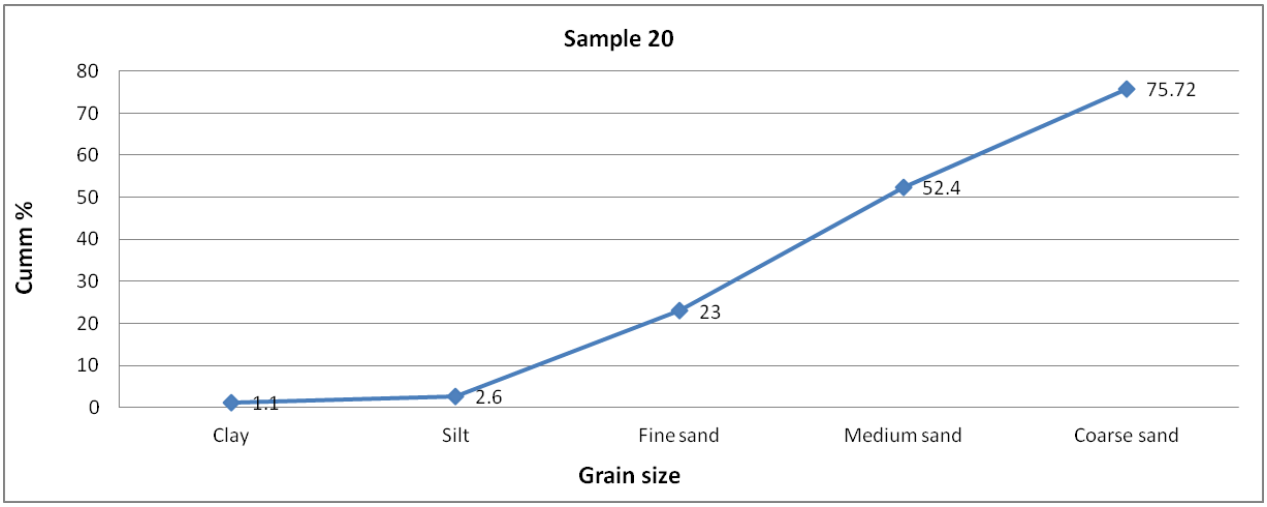
Sample 18	
Grain size (mm)	Cum %
0.001	0.00
0.01	4.39
0.09	9.18
0.212	15.68
0.6	27.78
1.18	37.00
2.00	39.89
2.8	45.59
4	50.93
4.75	53.50
6	100.00



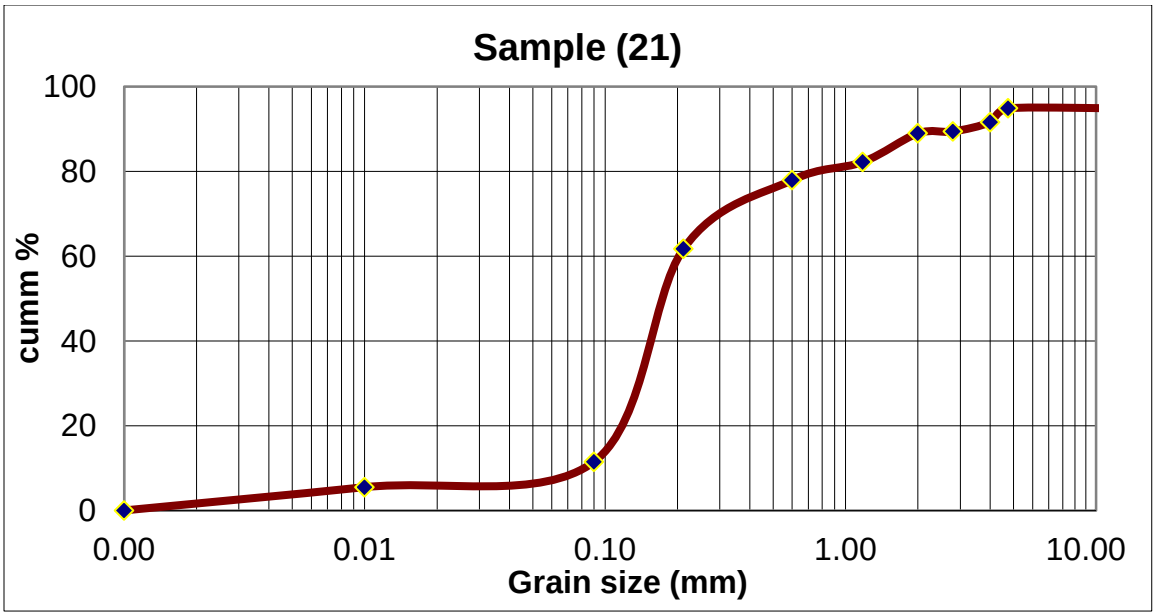


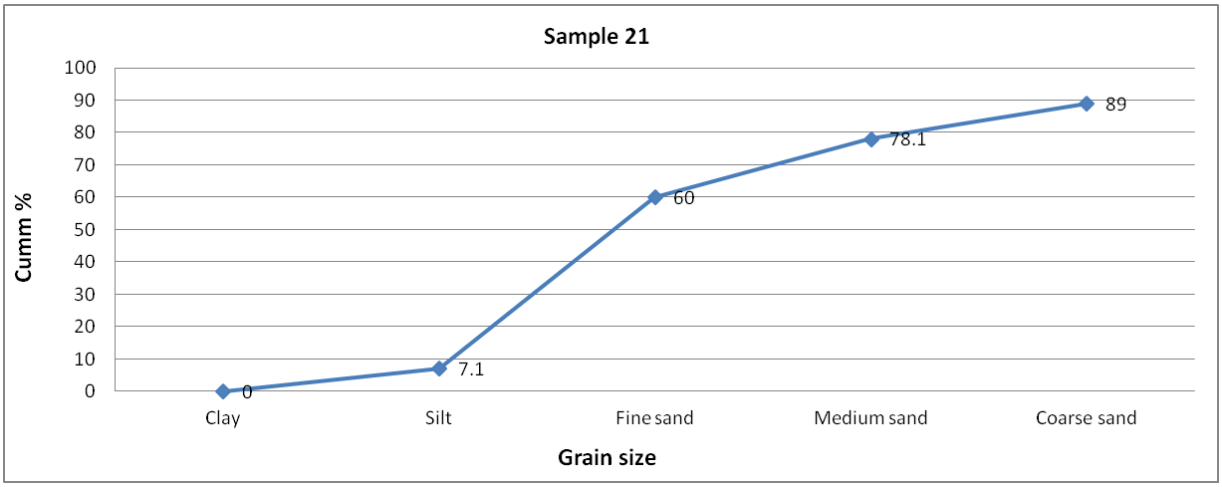
Sample19	
Grain size (mm)	Cum %
0.001	0.00
0.01	4.31
0.09	10.01
0.212	54.96
0.6	84.03
1.18	91.34
2.00	94.44
2.8	96.70
4	98.76
6	100.00



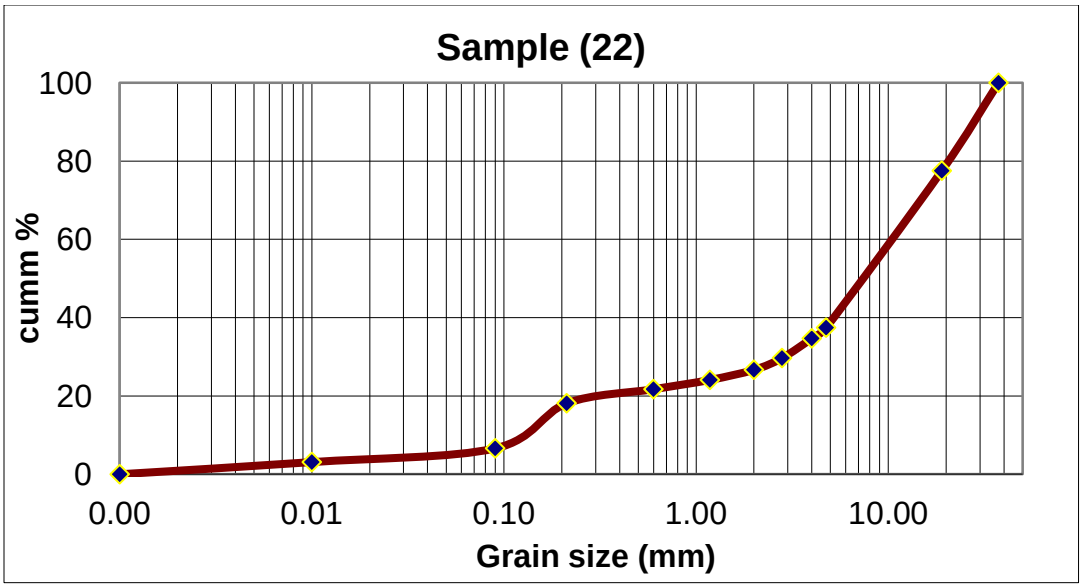


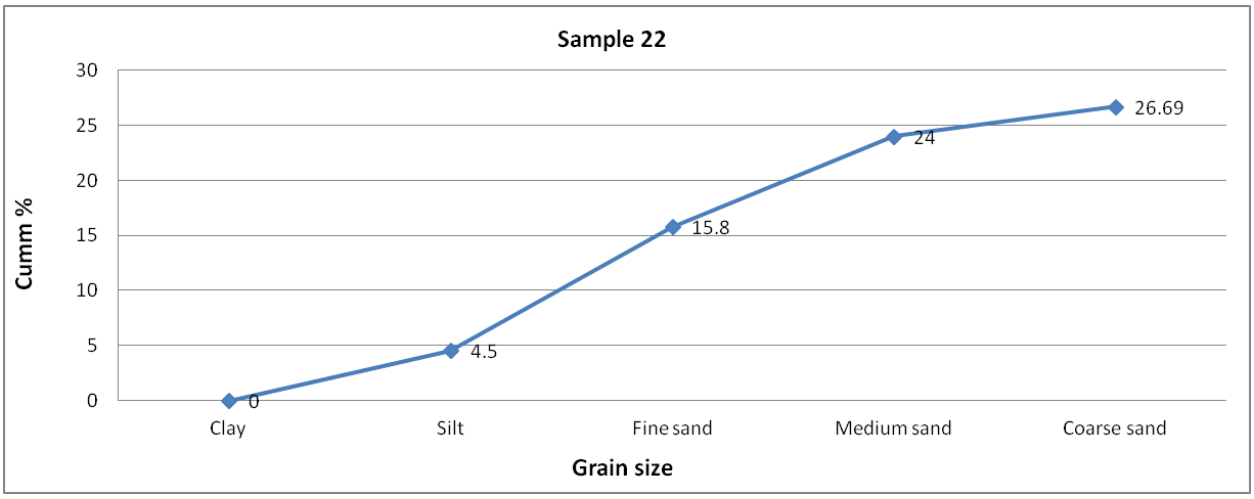
Sample 20	
Grain size (mm)	Cum %
0.001	0.00
0.010	2.51
0.090	5.56
0.212	23.98
0.600	51.29
1.180	63.96
2.000	75.72
2.800	86.97
4.000	95.90
6.000	100.00



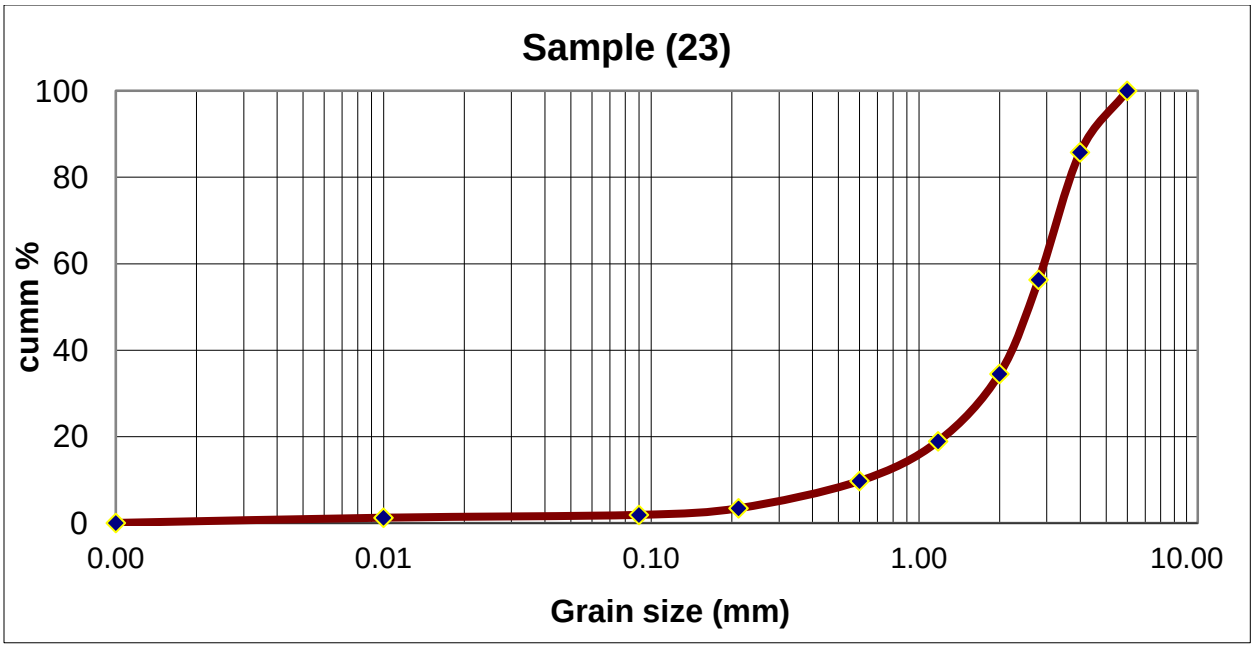


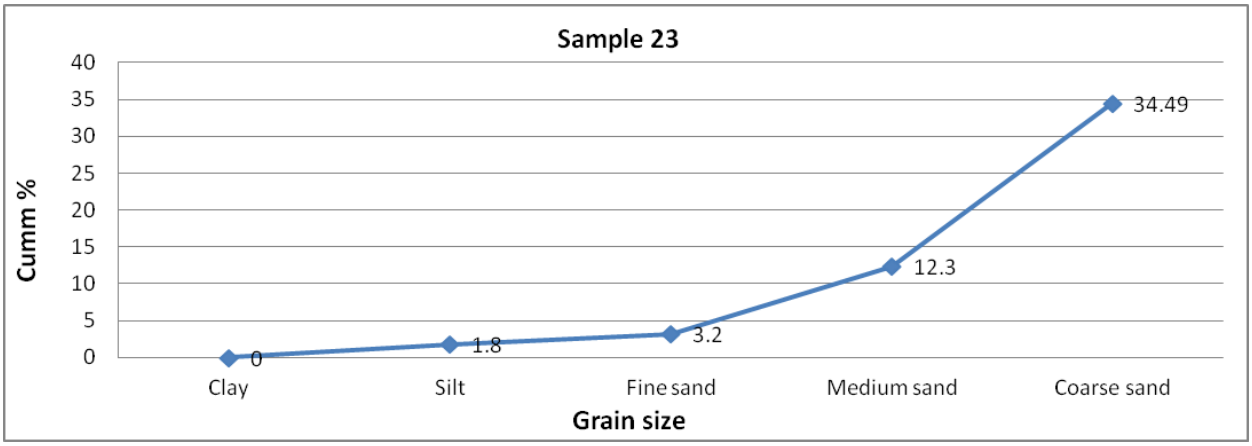
Sample 21	
Grain size(mm)	Cum %
0.00	0.00
0.01	5.49
0.09	11.49
0.21	61.73
0.60	77.95
1.18	82.23
2.00	89.00
2.80	89.43
4.00	91.61
4.75	94.90
19.00	95.30
37.50	100.00



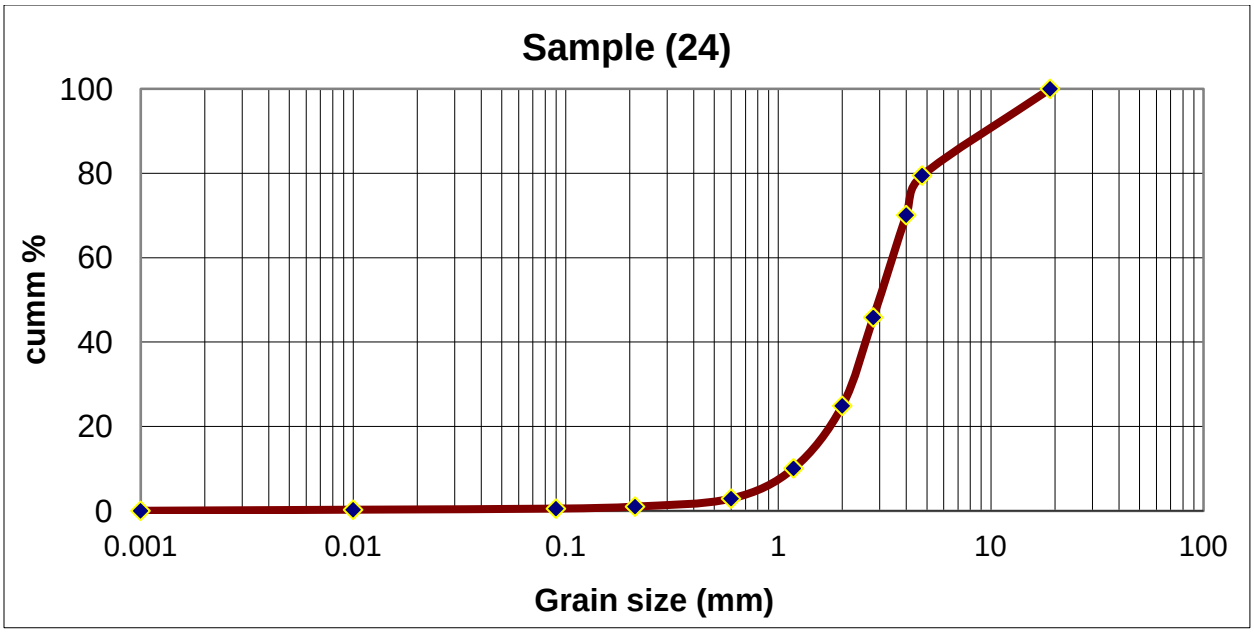


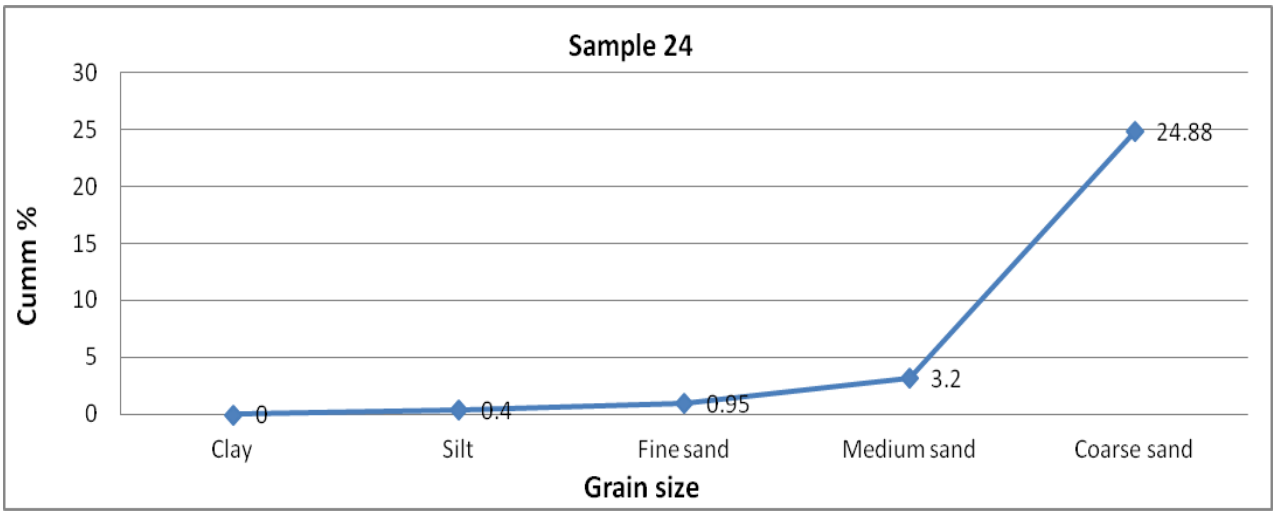
Sample 22	
Grain size (mm)	Cum %
0.00	0.00
0.01	3.11
0.09	6.62
0.21	18.13
0.60	21.73
1.18	24.10
2.00	26.69
2.80	29.68
4.00	34.70
4.75	37.45
19.00	77.53
37.50	100.00



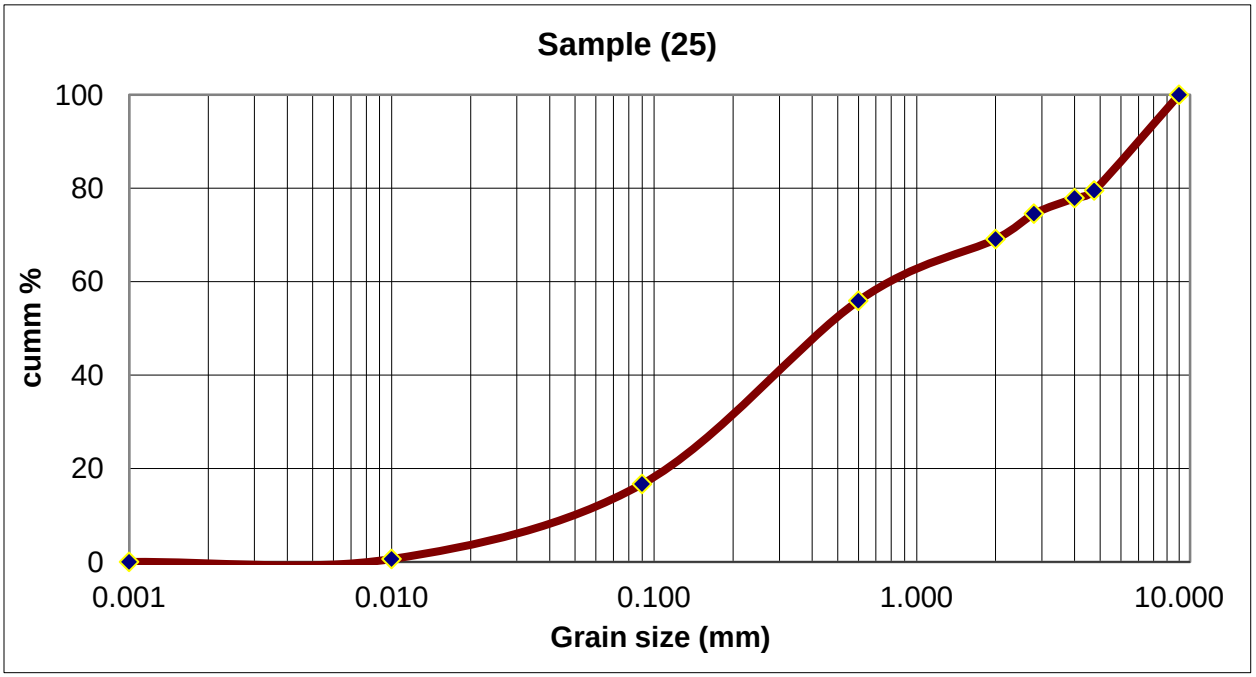


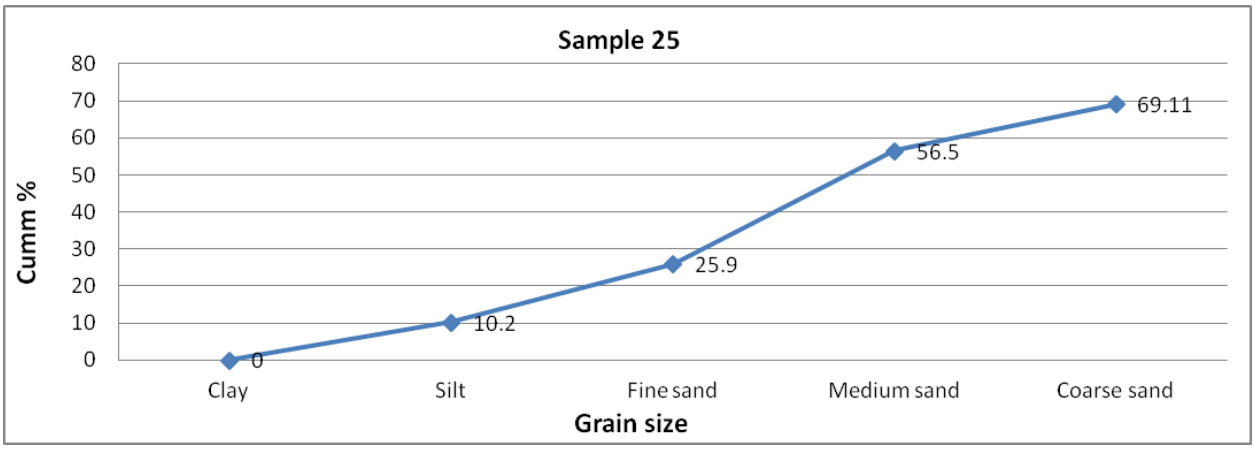
Sample 23	
Grain size (mm)	Cum %
0.00	0.00
0.01	1.21
0.09	1.86
0.21	3.40
0.60	9.71
1.18	18.90
2.00	34.49
2.80	56.28
4.00	85.76
6.00	100.00



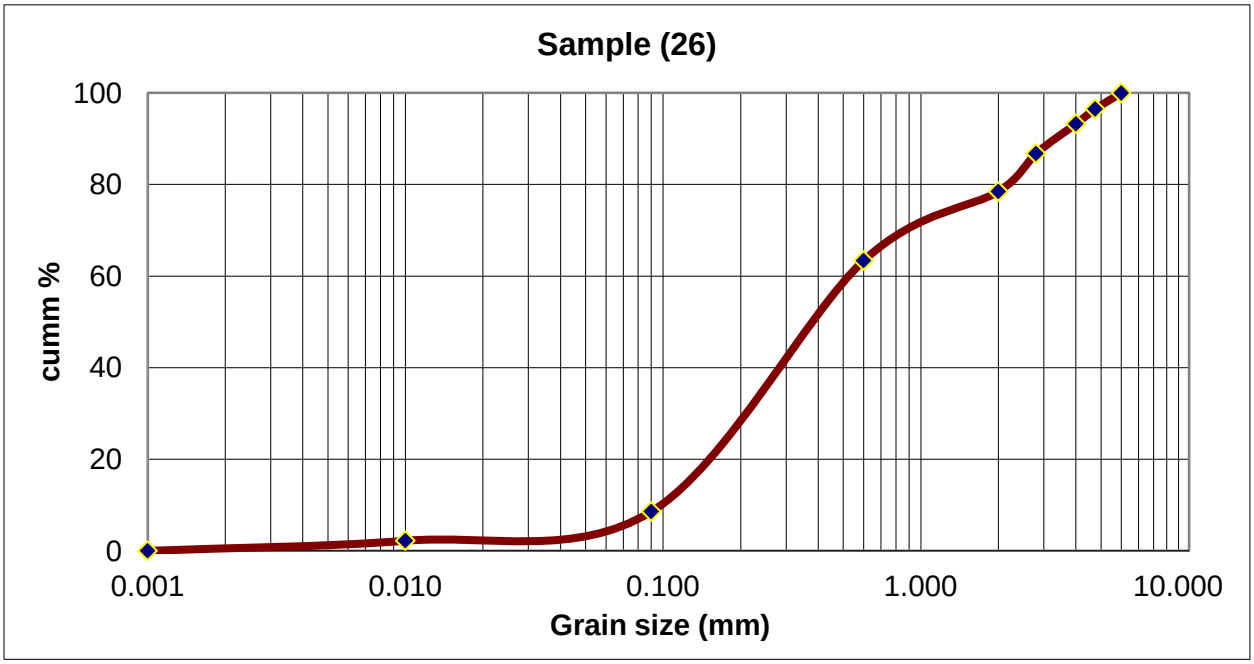


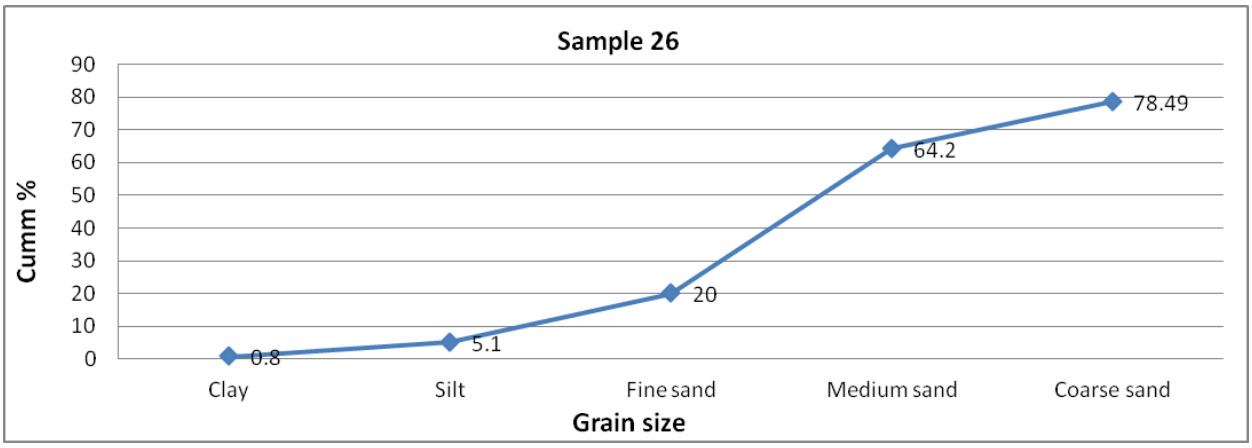
Sample 24	
Grain size (mm)	Cum %
0.001	0.00
0.01	0.25
0.09	0.51
0.212	0.99
0.6	2.88
1.18	10.06
2.00	24.88
2.8	45.83
4	70.07
4.75	79.45
19	100.00



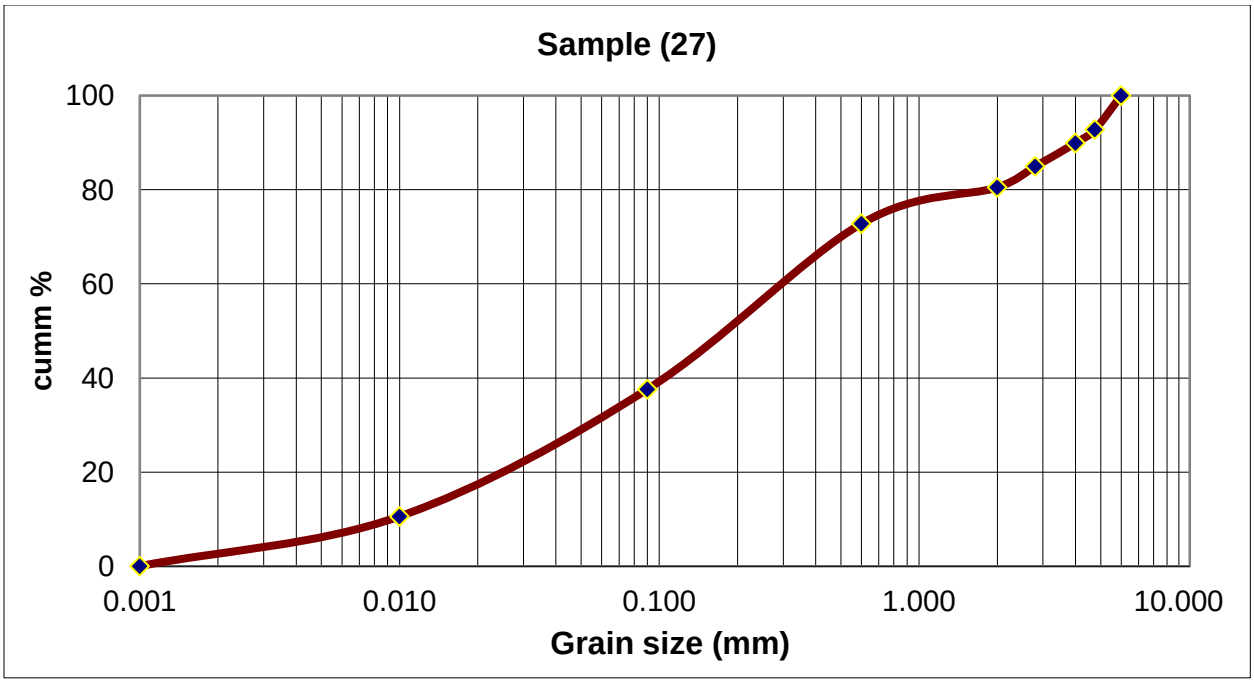


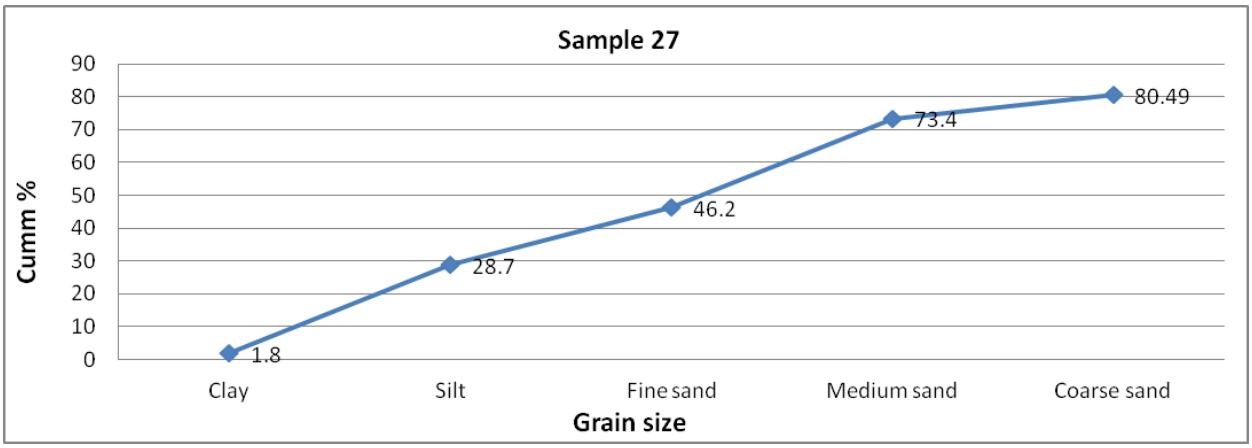
Sample 25	
Grain size (mm)	Cum %
0.001	0.00
0.010	0.62
0.090	16.67
0.600	55.90
2.000	69.11
2.800	74.55
4.000	77.89
4.750	79.51
10.000	100.00



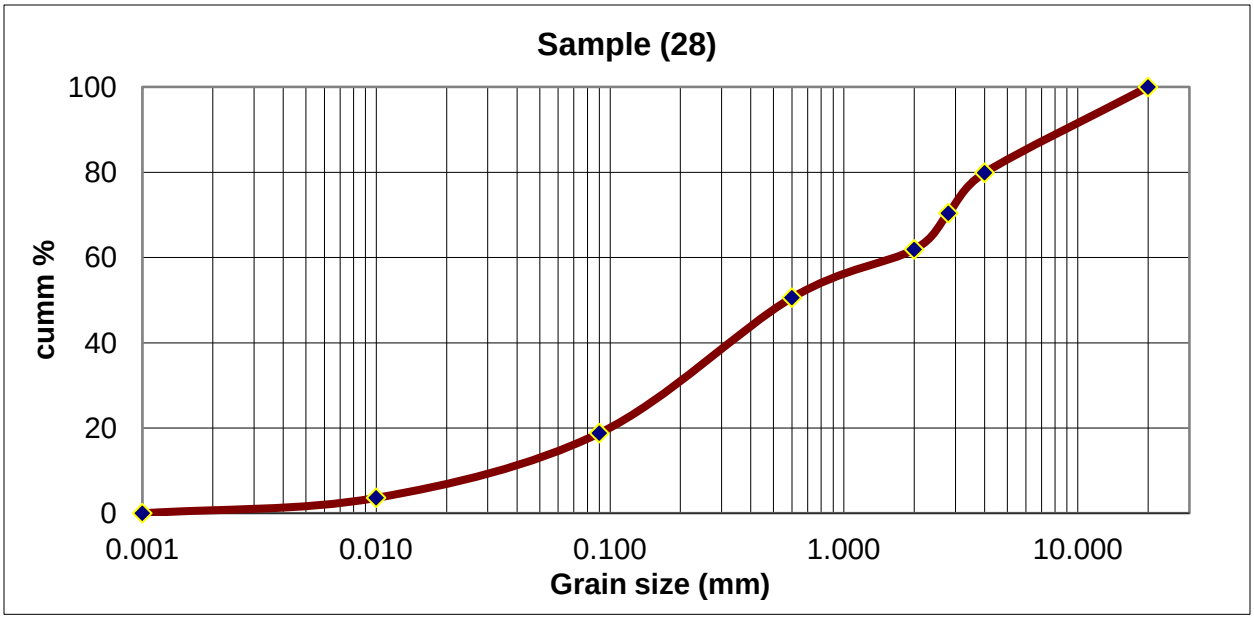


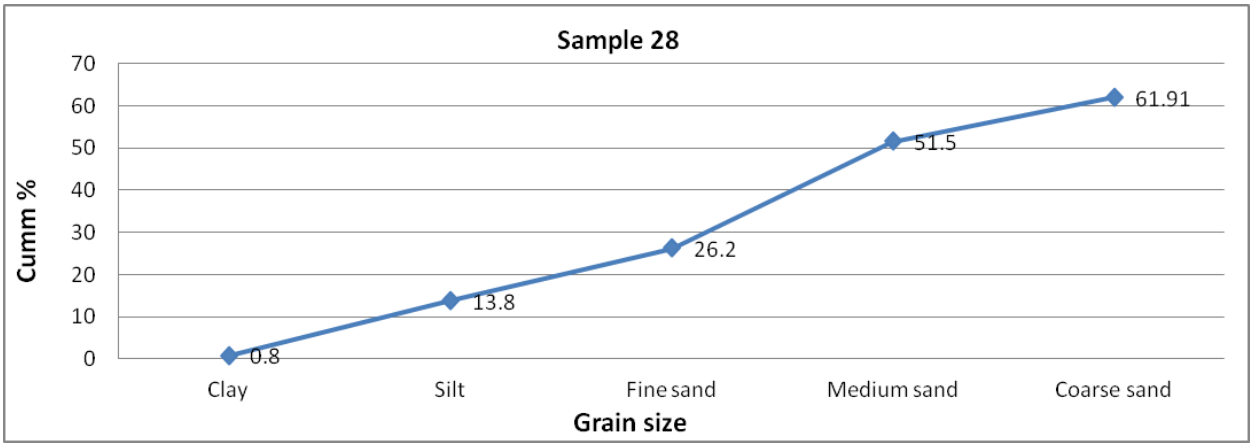
Sample 26	
Grain size	cum. wt. %
0.001	0.00
0.010	2.21
0.090	8.58
0.600	63.39
2.000	78.49
2.800	86.78
4.000	93.27
4.750	96.51
6.000	100.00



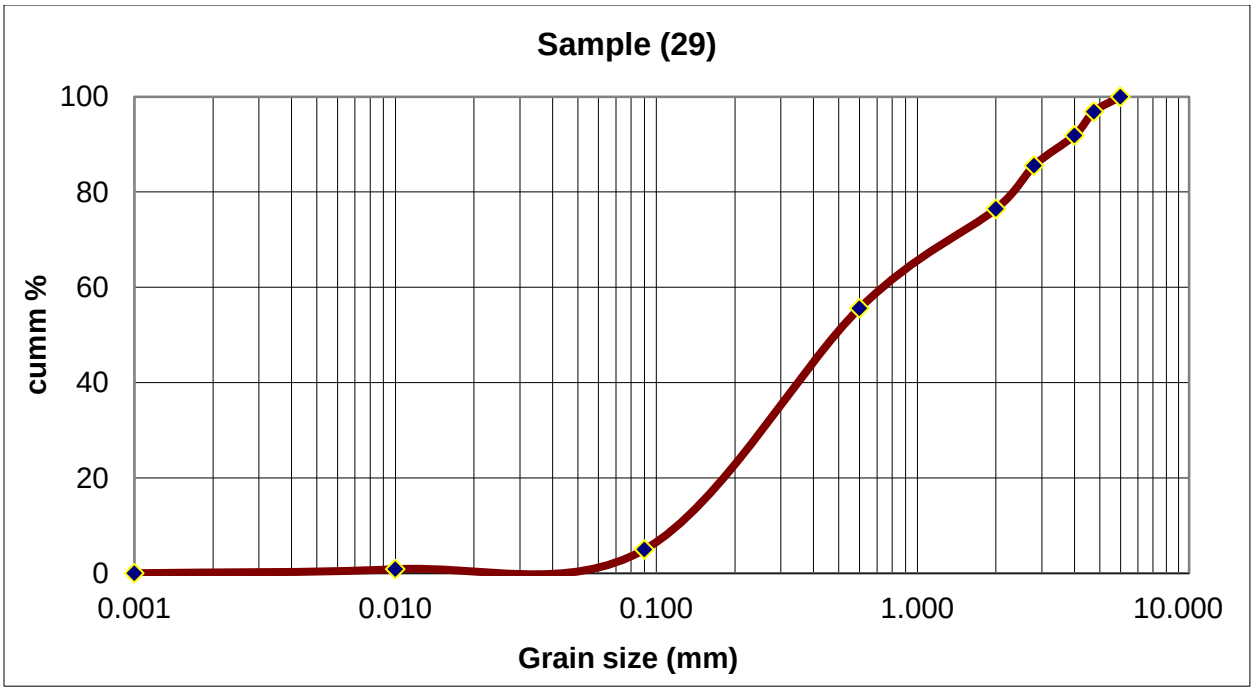


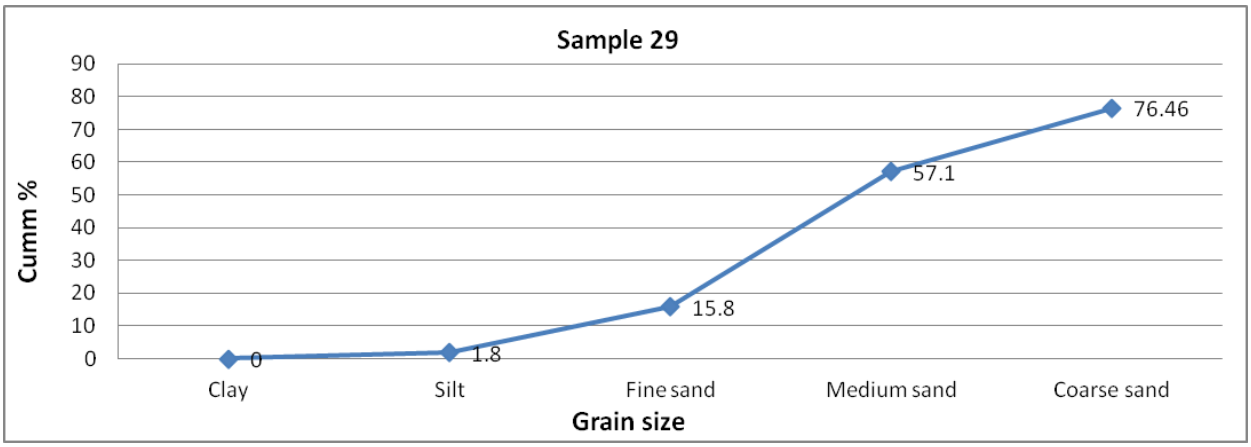
Sample 27	
Grain size	cum. wt. %
0.001	0.000
0.010	10.56
0.090	37.59
0.600	72.79
2.000	80.49
2.800	84.97
4.000	89.92
4.750	92.79
6.000	100.00



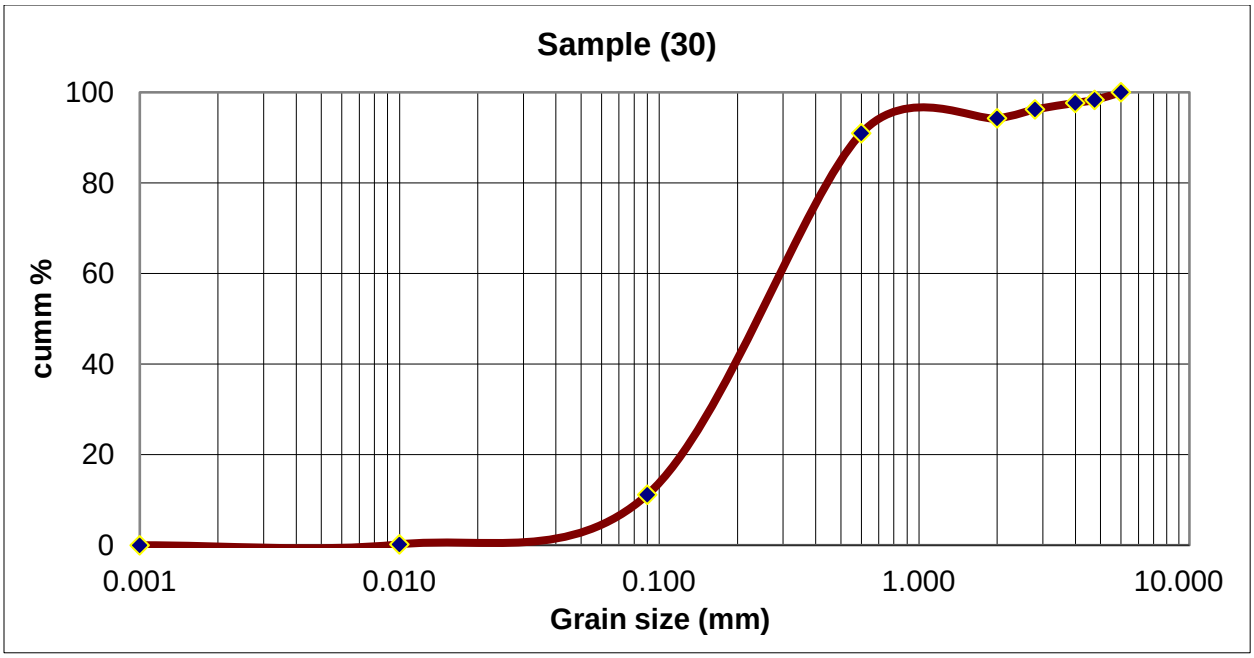


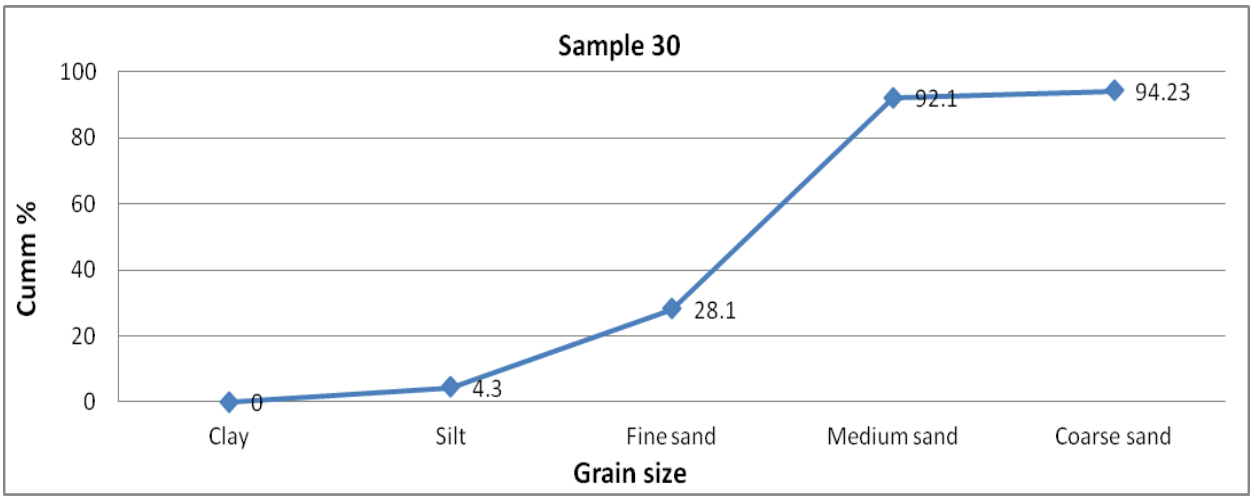
Sample 28	
Grain size (mm)	cum. wt. %
0.001	0.00
0.010	3.62
0.090	18.80
0.600	50.58
2.000	61.91
2.800	70.39
4.000	79.89
20.000	100.00





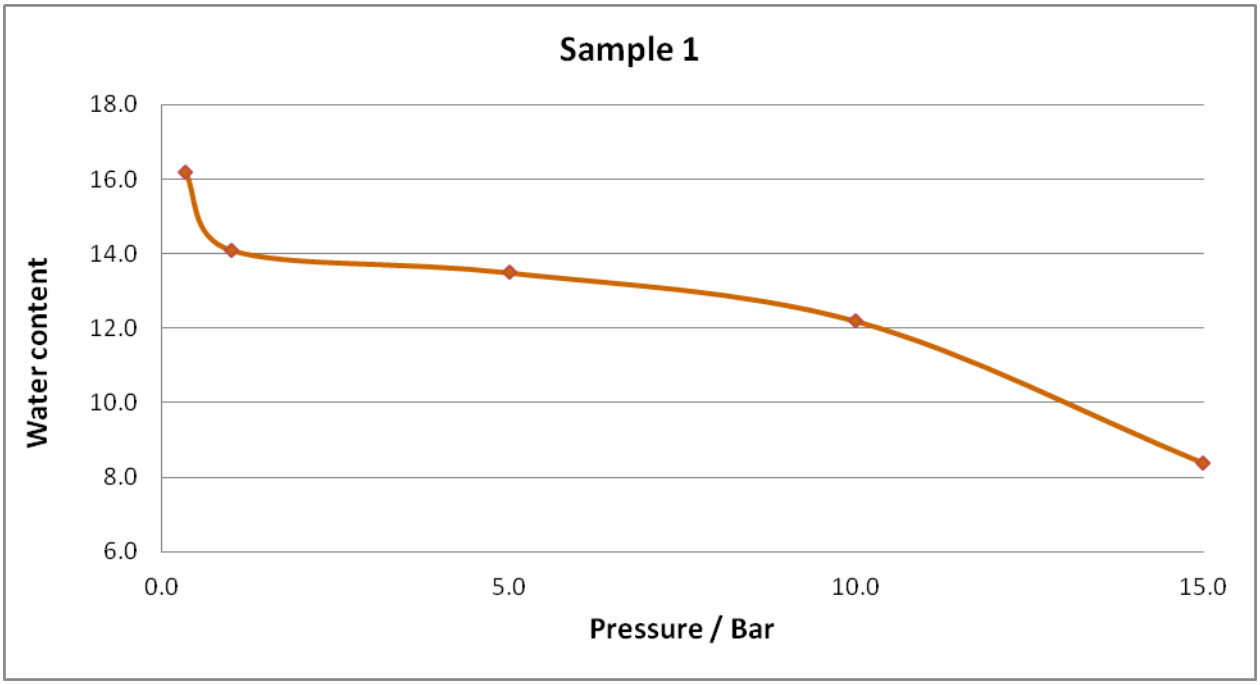
Samp.29	
Grain size (mm)	cum. wt. %
0.001	0.00
0.010	0.85
0.090	4.98
0.600	55.60
2.000	76.46
2.800	85.54
4.000	91.88
4.750	96.86
6.000	100.00

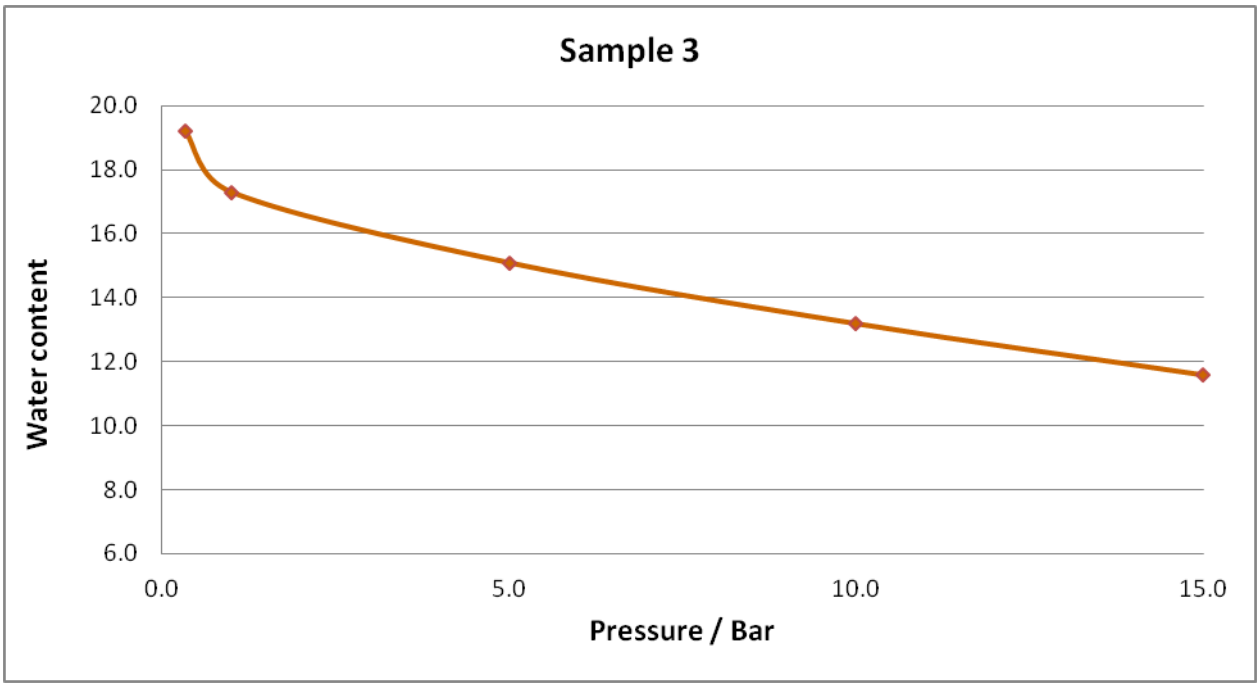


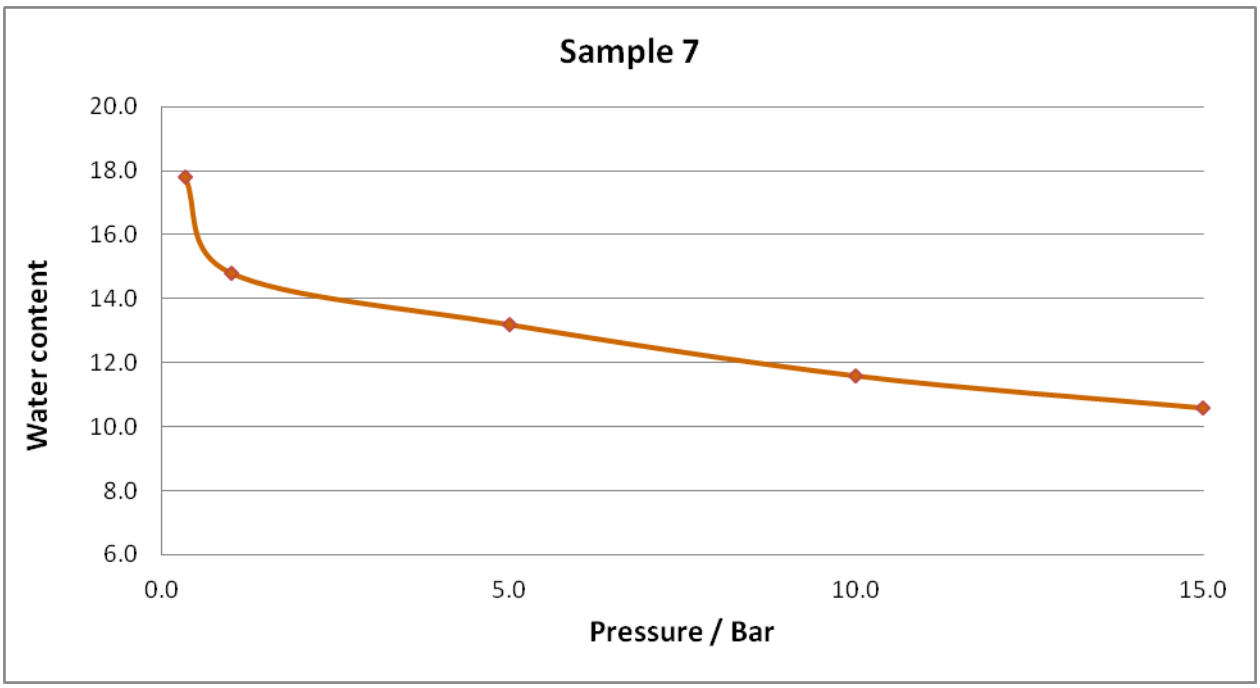


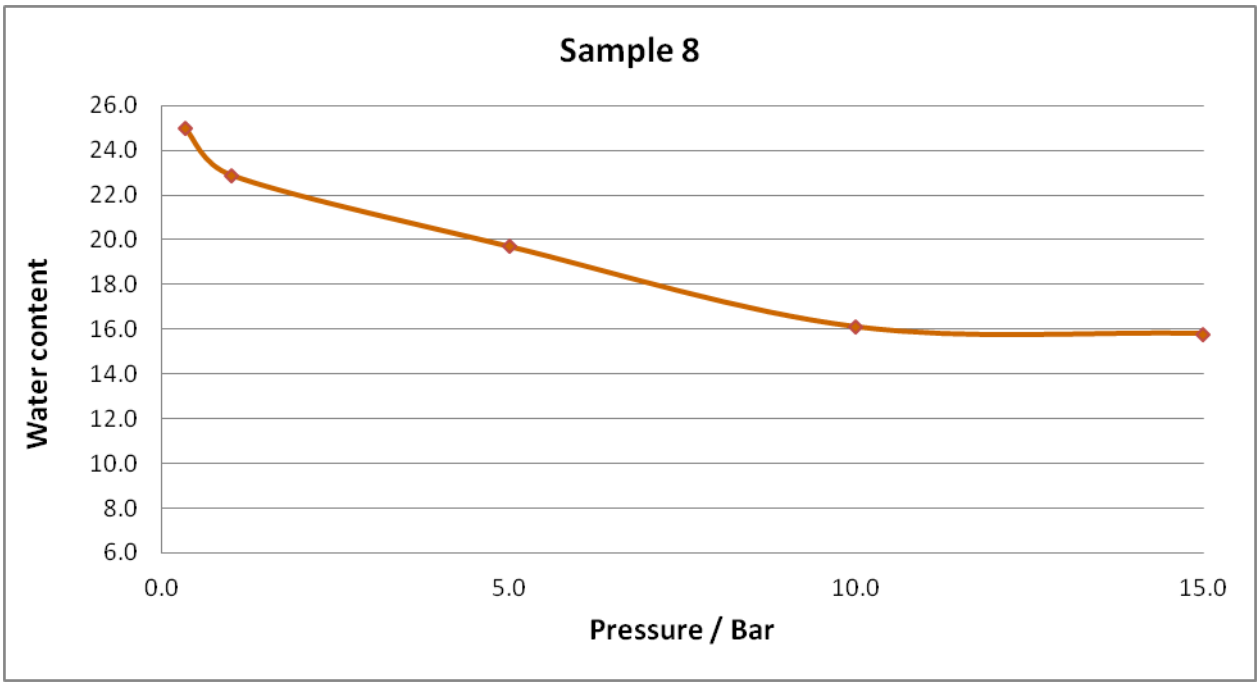
Samp.30	
Grain size (mm)	cum. wt. %
0.001	0.00
0.010	0.20
0.090	11.16
0.600	90.94
2.000	94.23
2.800	96.21
4.000	97.63
4.750	98.31
6.000	100.00

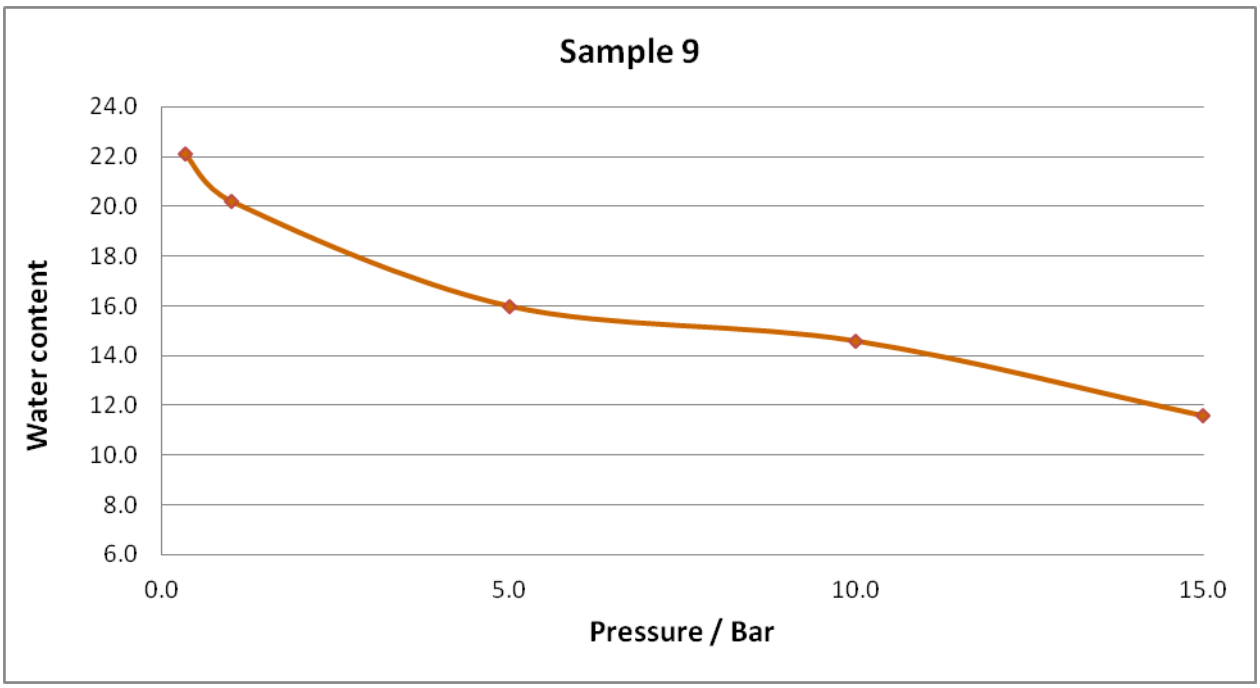
Appendices 31-50: Soil PF curves:

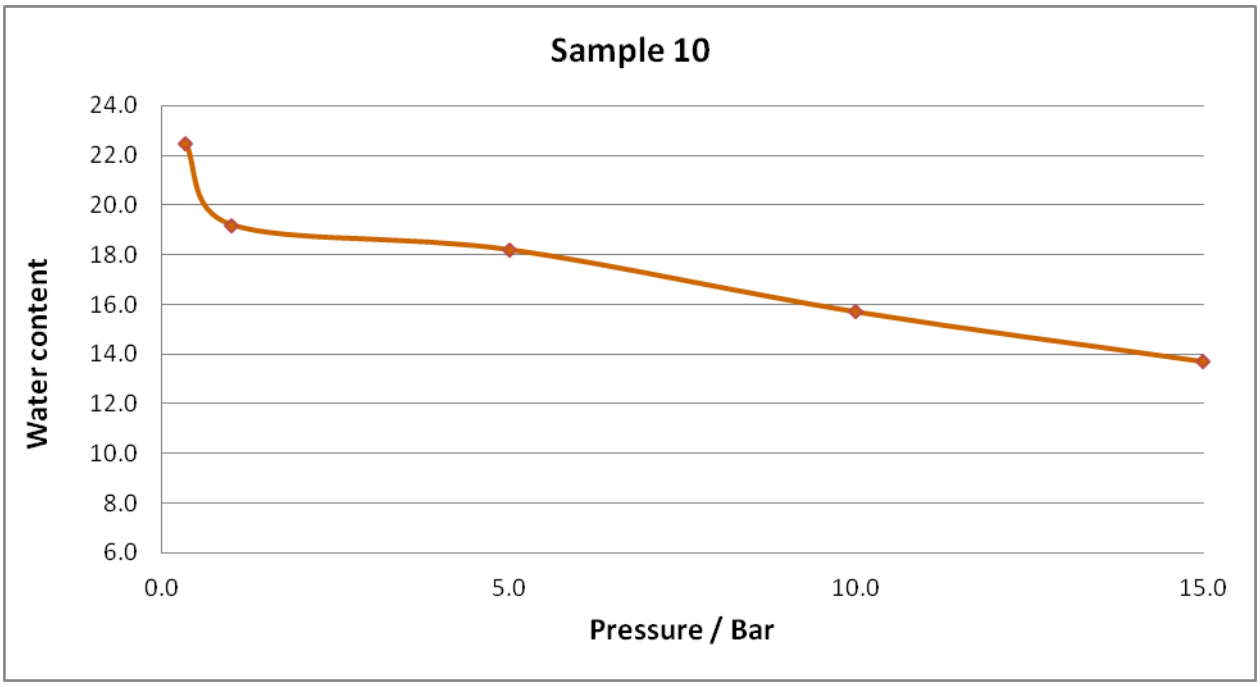


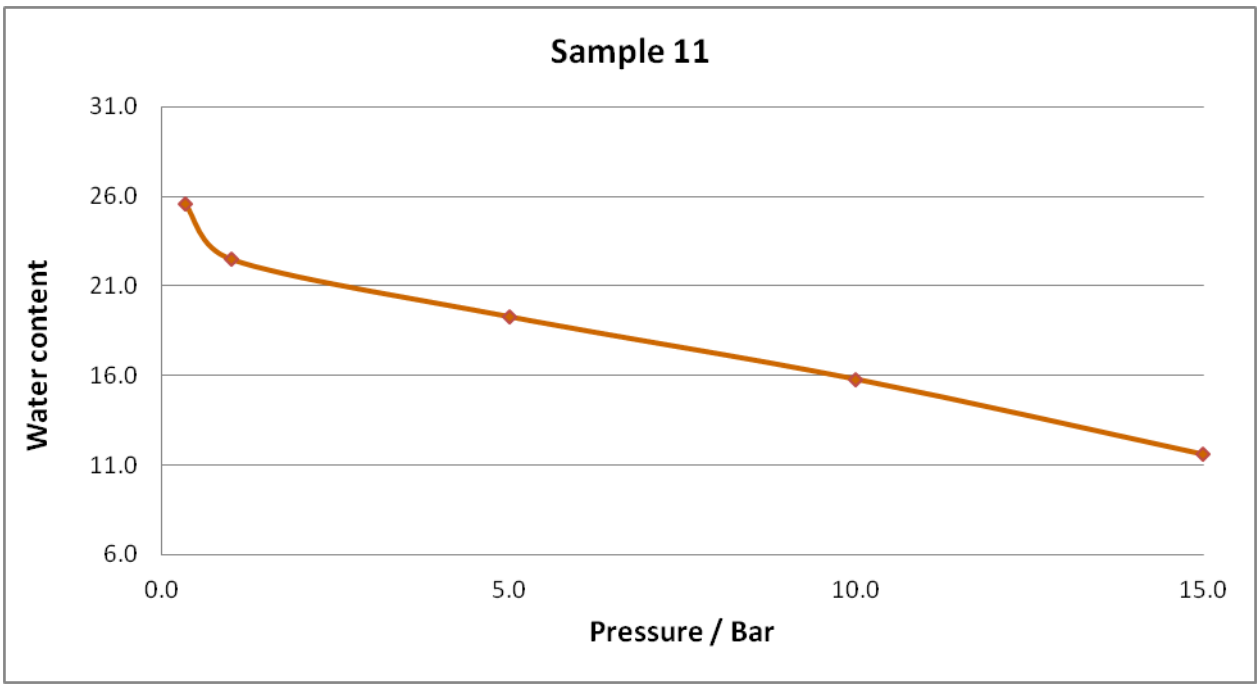


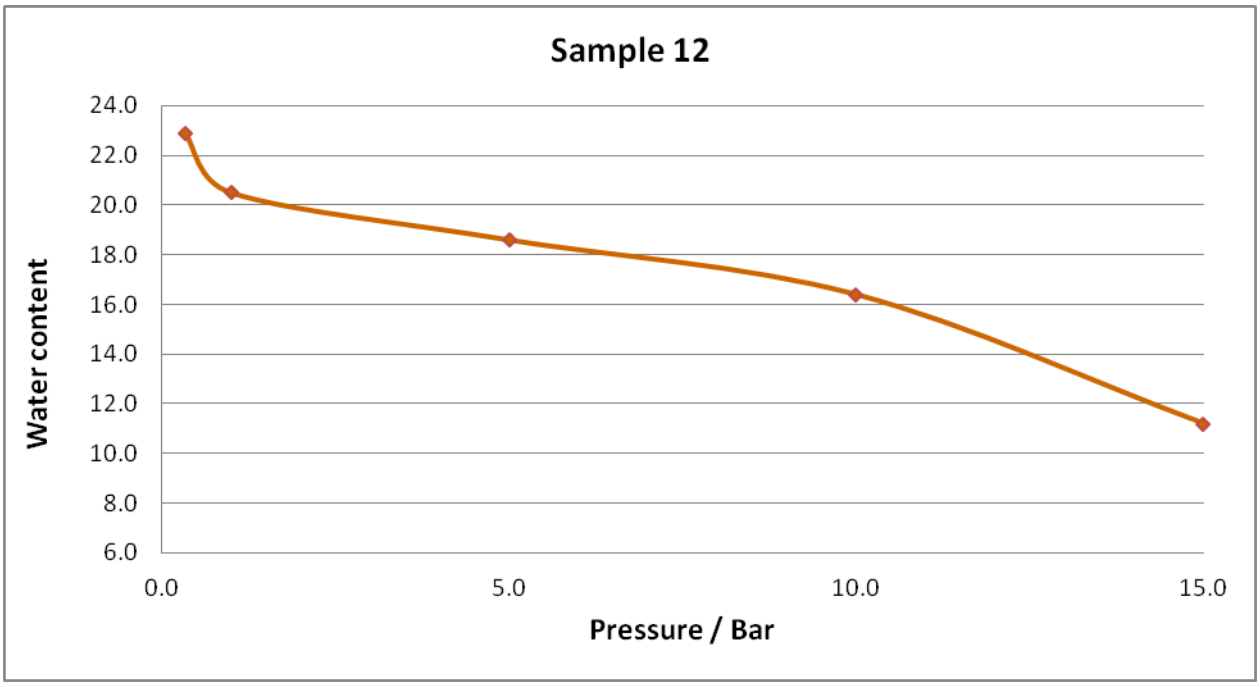

Sample 7
Water content
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
0.0
5.0
10.0
15.0
Pressure / Bar

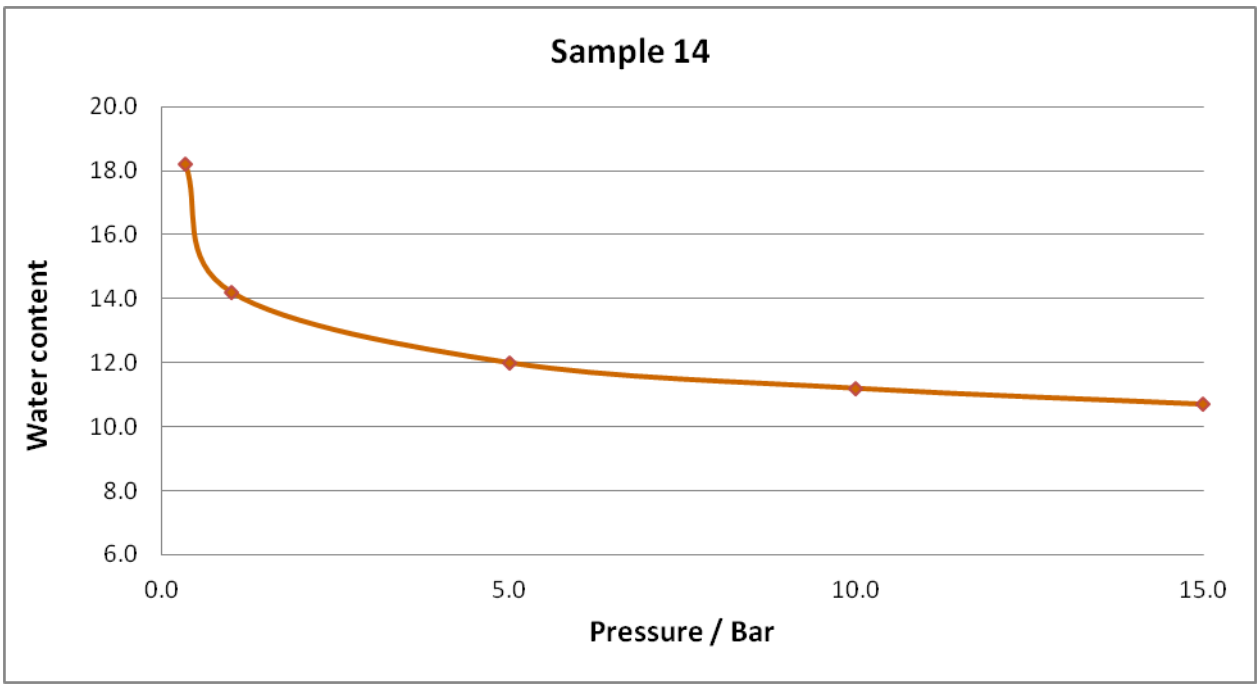

Sample 8
Water content
26.0
24.0
22.0
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
0.0
5.0
10.0
15.0
Pressure / Bar

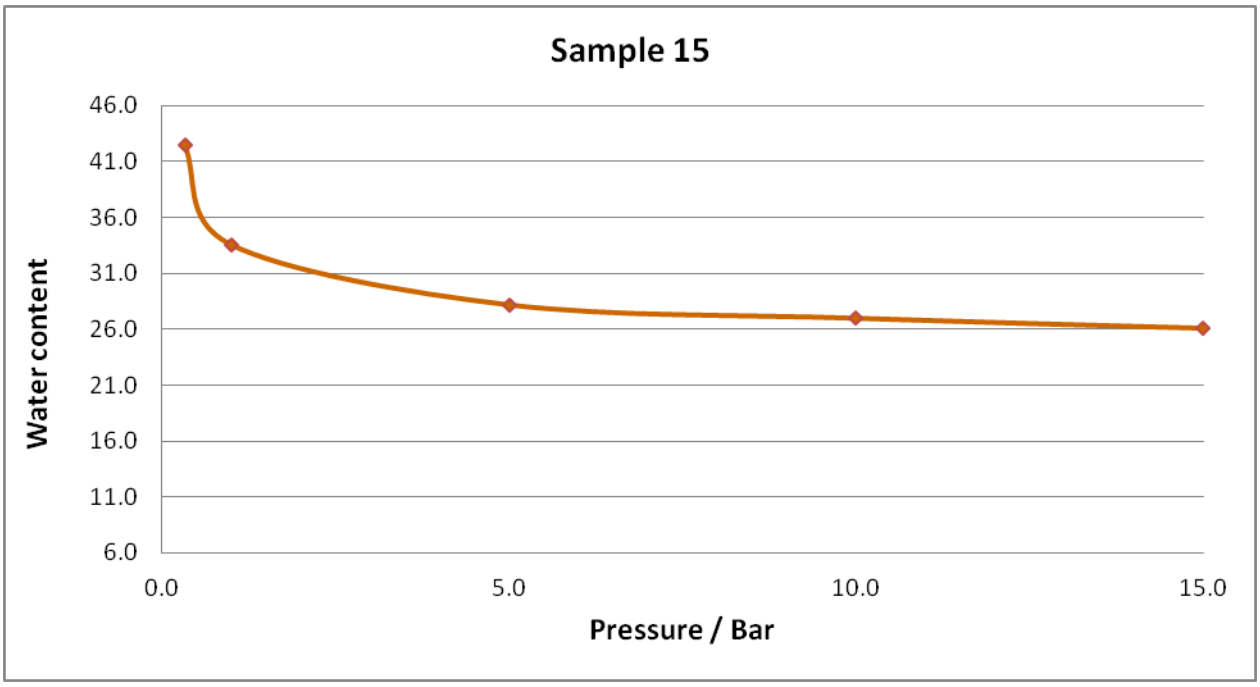

Sample 9
Water content
24.0
22.0
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
0.0
5.0
10.0
15.0
Pressure / Bar

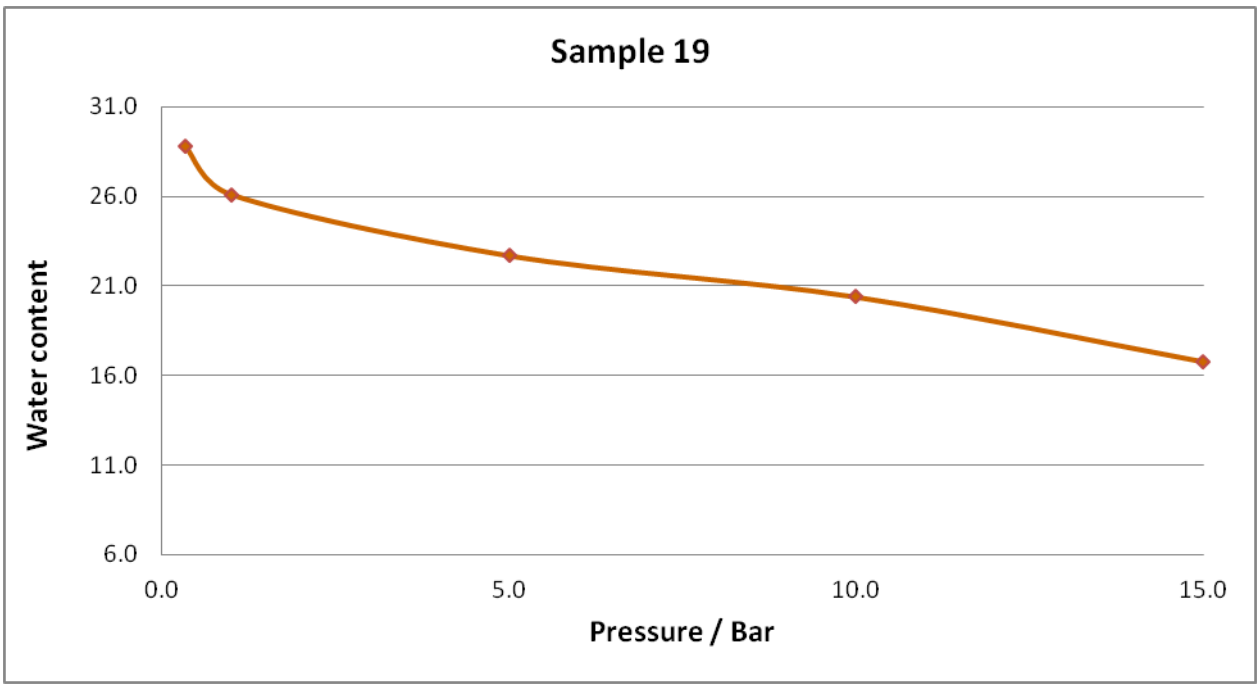

Sample 10
Water content
24.0
22.0
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
0.0
5.0
10.0
15.0
Pressure / Bar

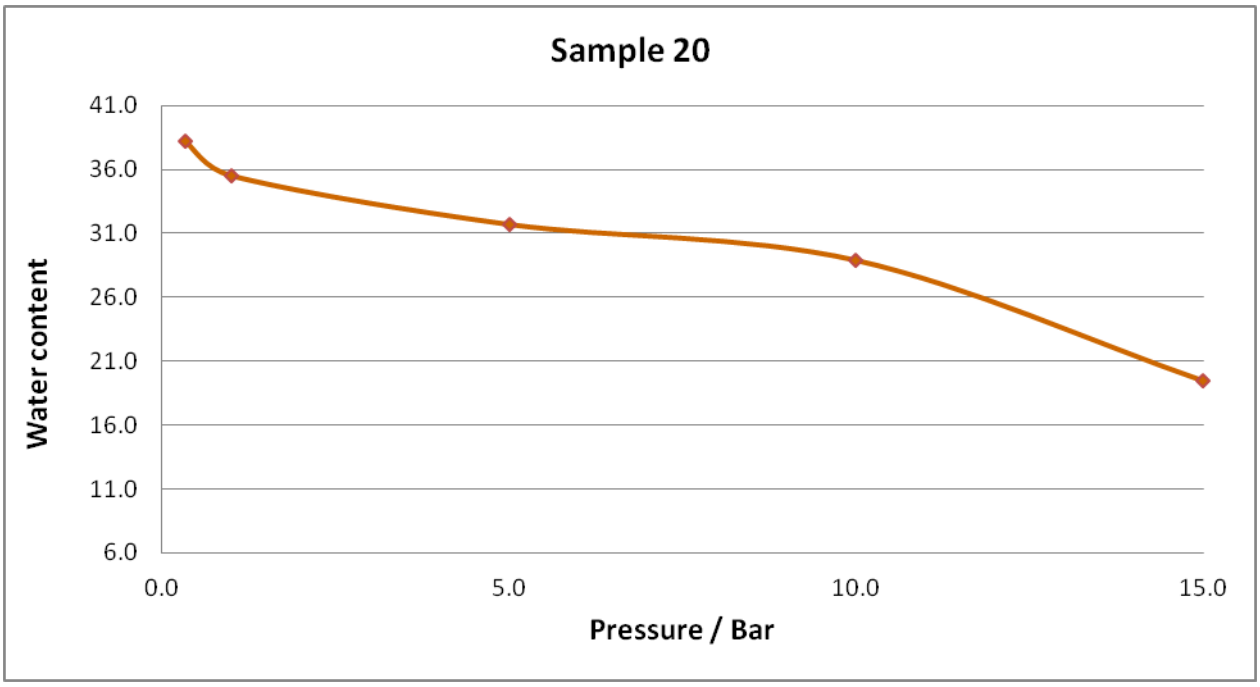

Sample 11
Water content
31.0
26.0
21.0
16.0
11.0
6.0
0.0
5.0
10.0
15.0
Pressure / Bar

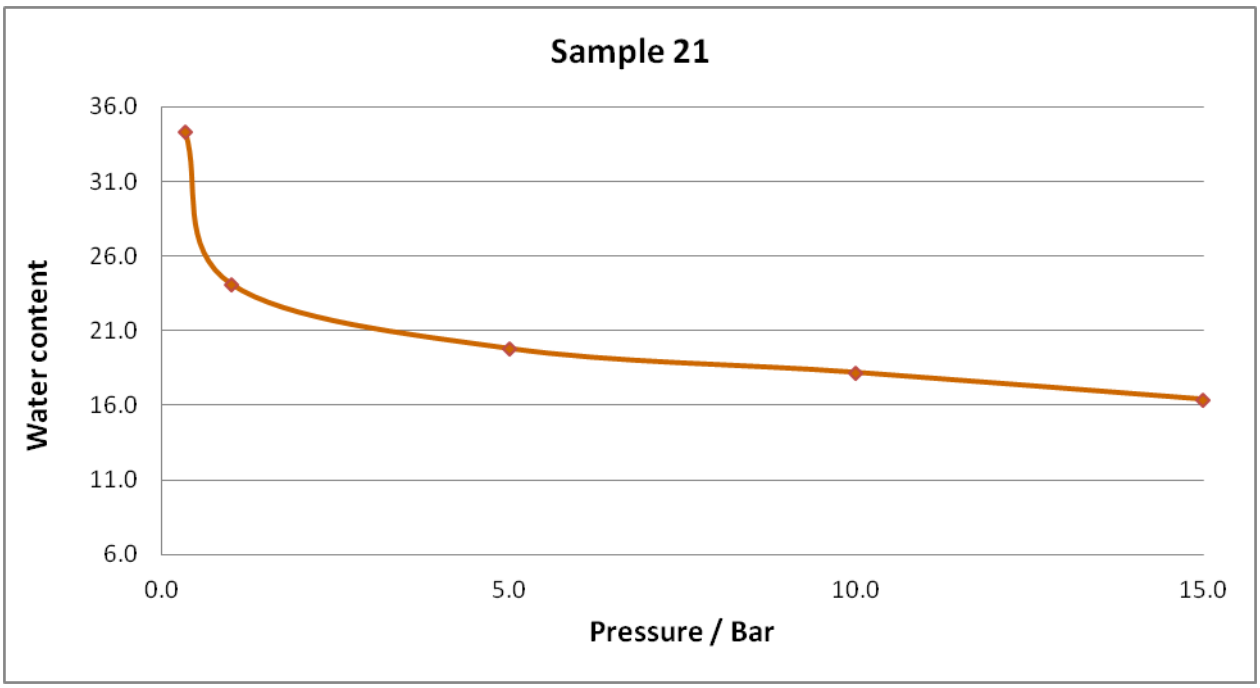

Sample 12
Water content
24.0
22.0
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
0.0
5.0
10.0
15.0
Pressure / Bar

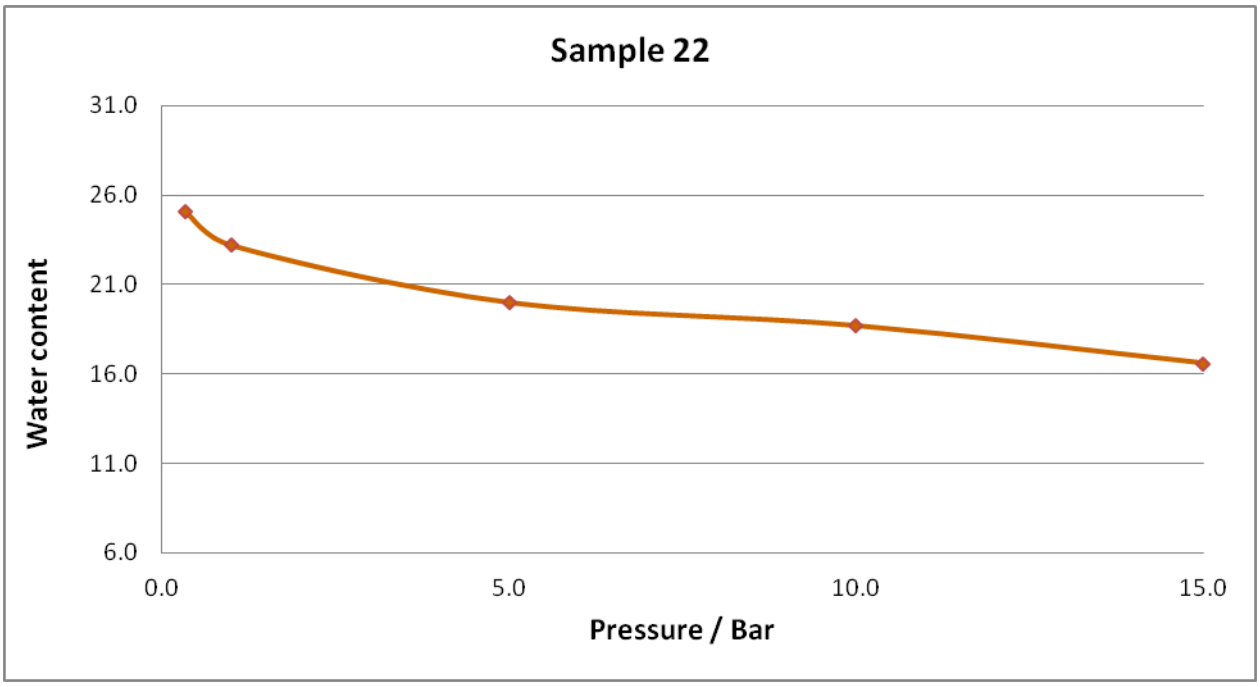

Sample 14
Water content
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
0.0
5.0
10.0
15.0
Pressure / Bar

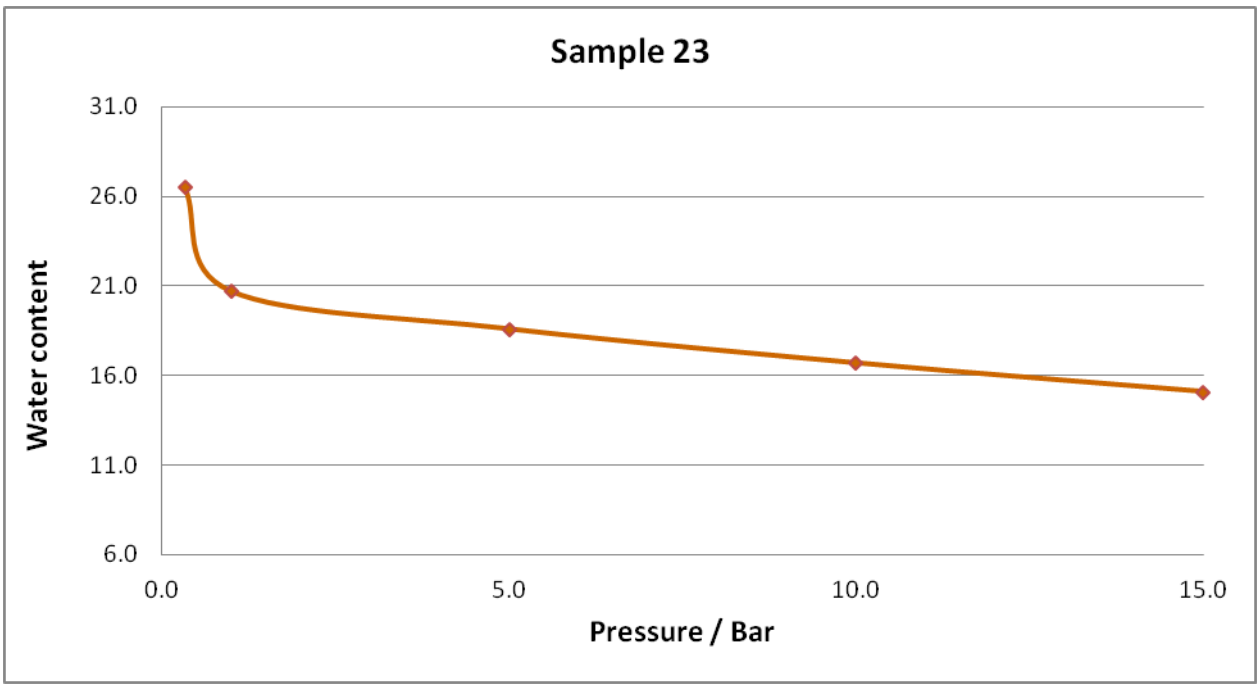

Sample 15
Water content
46.0
41.0
36.0
31.0
26.0
21.0
16.0
11.0
6.0
0.0
5.0
10.0
15.0
Pressure / Bar

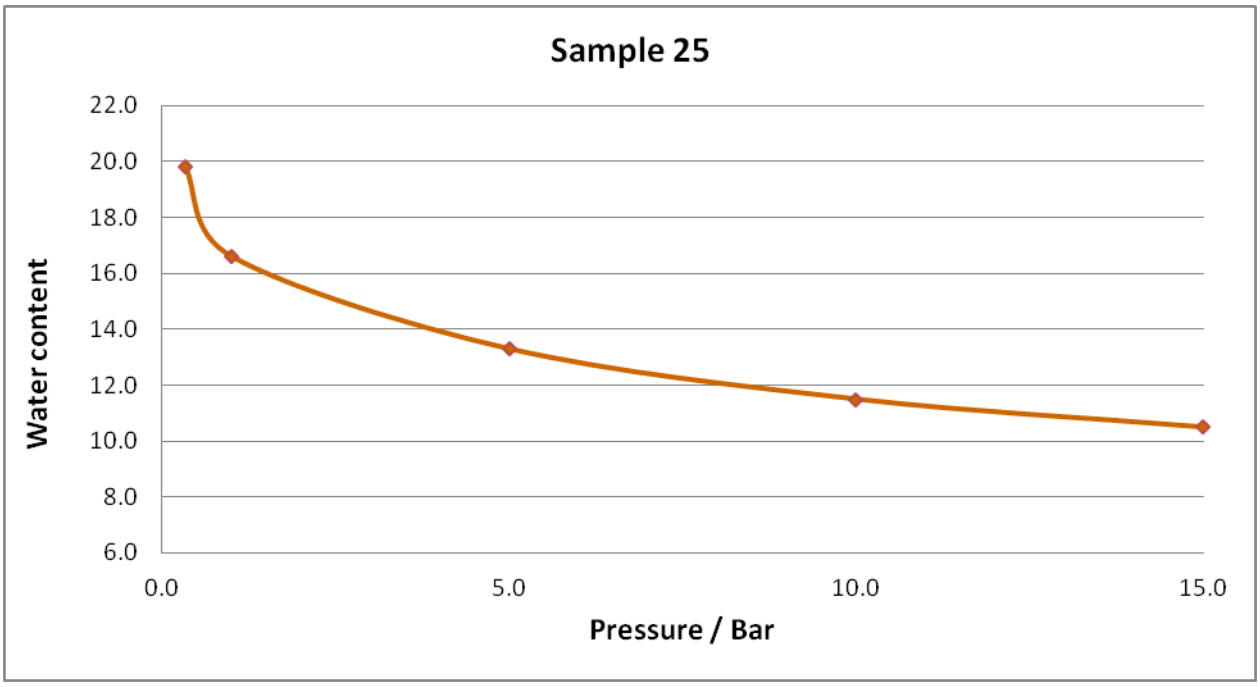

Sample 19
Water content
31.0
26.0
21.0
16.0
11.0
6.0
0.0
5.0
10.0
15.0
Pressure / Bar

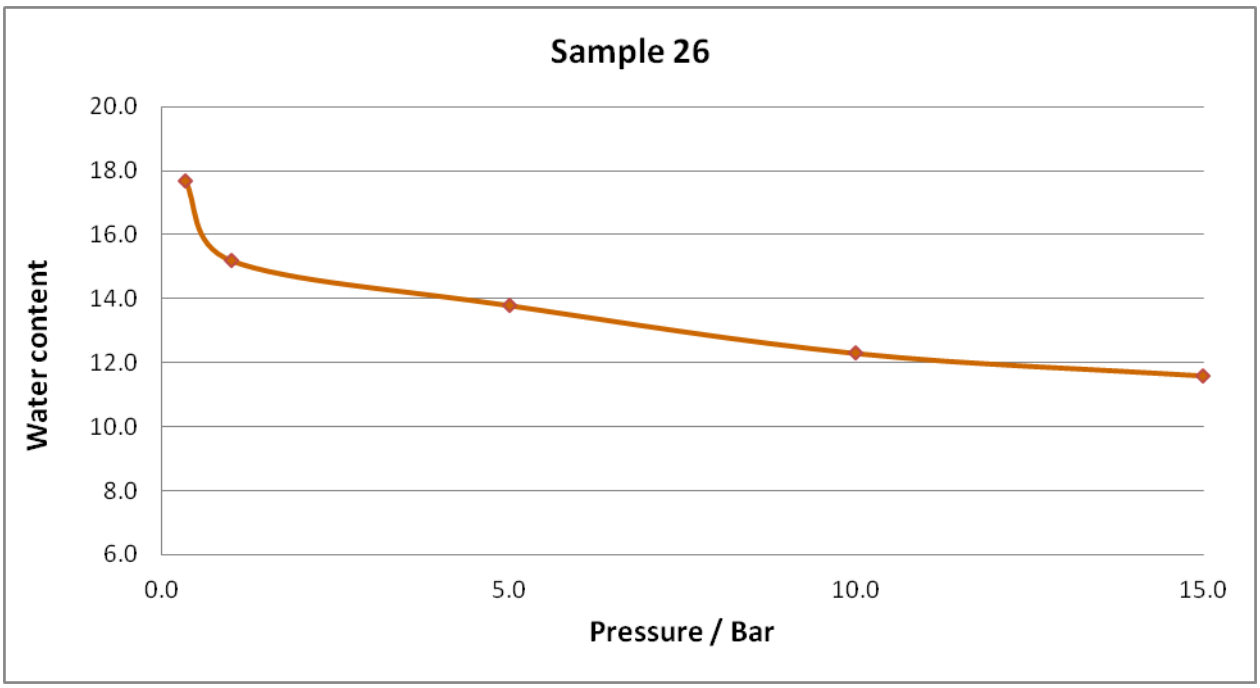

Sample 20
Water content
41.0
36.0
31.0
26.0
21.0
16.0
11.0
6.0
0.0
5.0
10.0
15.0
Pressure / Bar

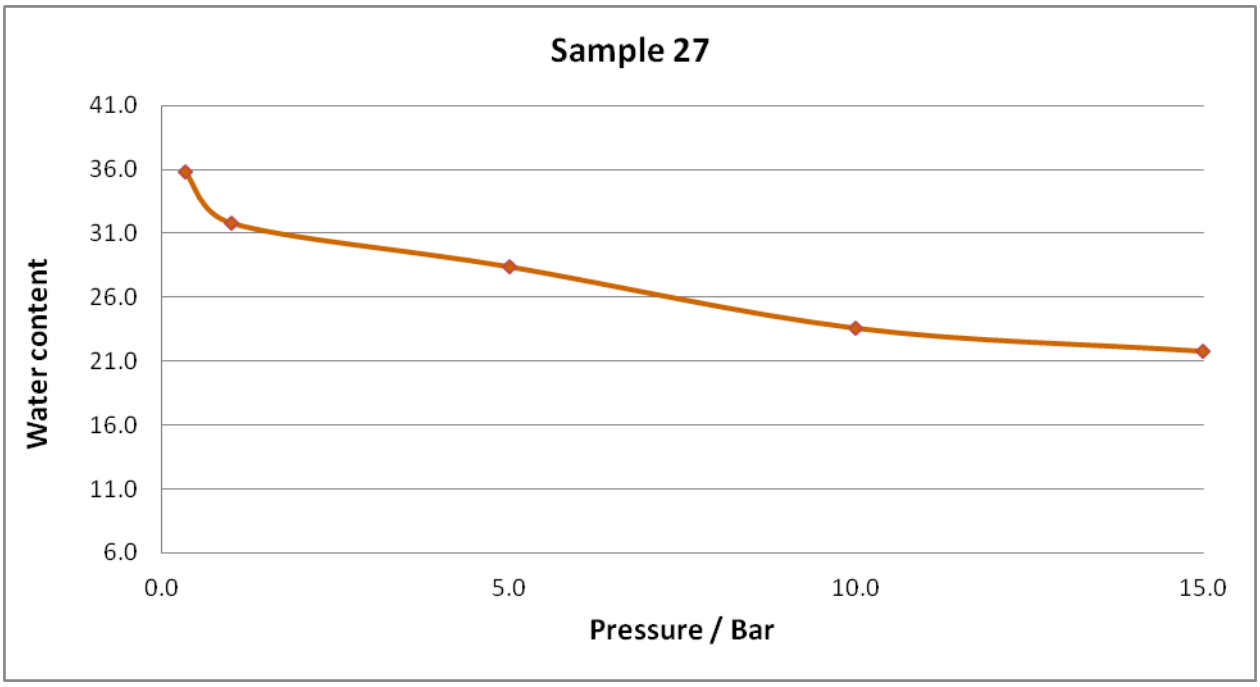

Sample 21
Water content
36.0
31.0
26.0
21.0
16.0
11.0
6.0
0.0
5.0
10.0
15.0
Pressure / Bar

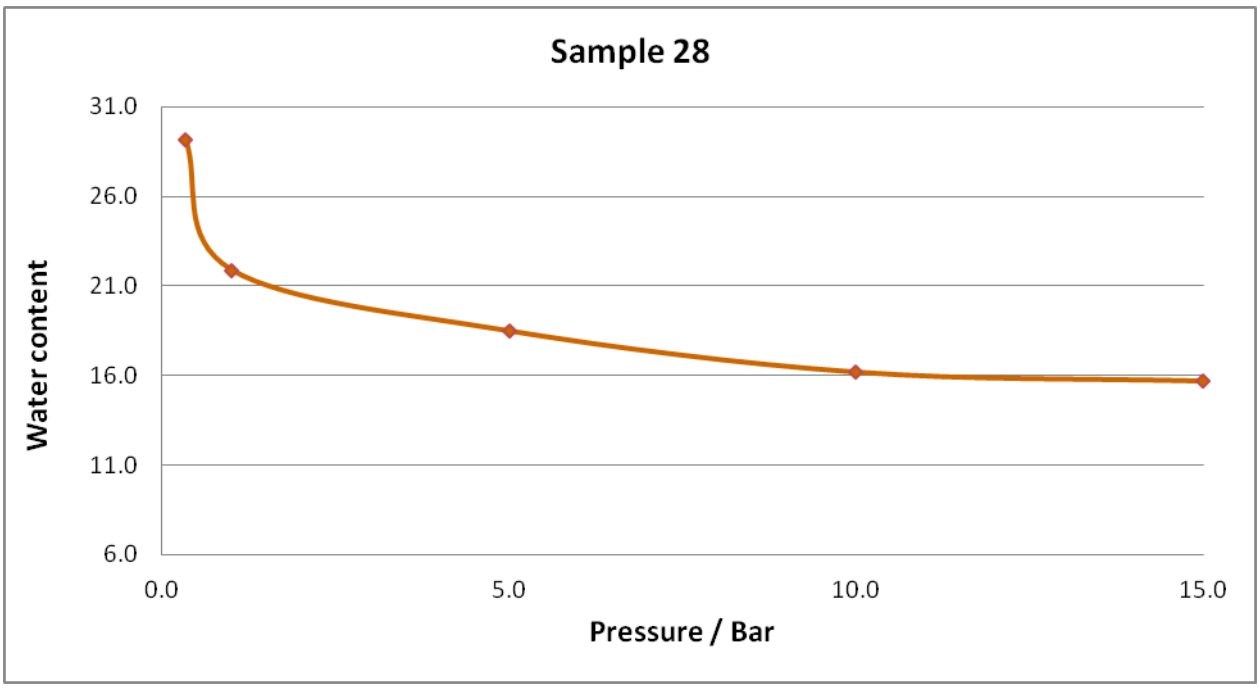

Sample 22
Water content
31.0
26.0
21.0
16.0
11.0
6.0
0.0
5.0
10.0
15.0
Pressure / Bar

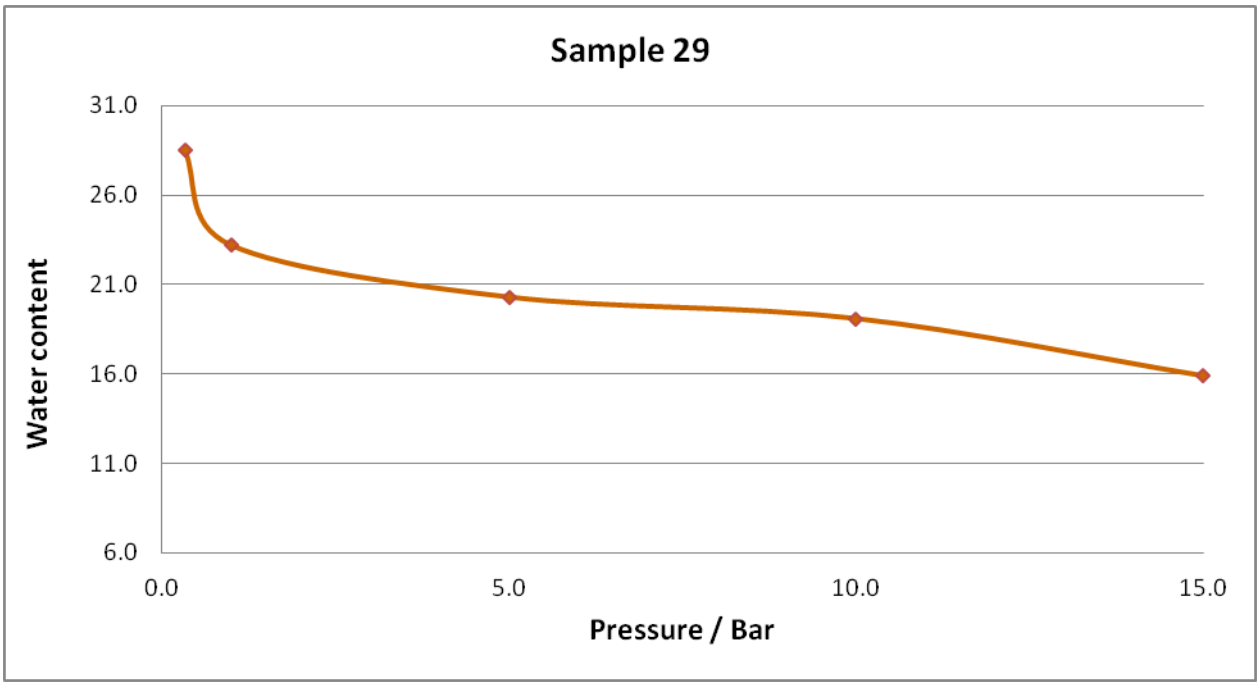

Sample 23
31.0
26.0
21.0
16.0
11.0
6.0
Water content
0.0
5.0
10.0
15.0
Pressure / Bar


Sample 25
22.0
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
Water content
0.0
5.0
10.0
15.0
Pressure / Bar


Sample 26
Water content
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
0.0
5.0
10.0
15.0
Pressure / Bar


Sample 27
Water content
41.0
36.0
31.0
26.0
21.0
16.0
11.0
6.0
0.0
5.0
10.0
15.0
Pressure / Bar


Sample 28
31.0
26.0
21.0
16.0
11.0
6.0
Water content
0.0
5.0
10.0
15.0
Pressure / Bar


Sample 29
31.0
26.0
21.0
16.0
11.0
6.0
Water content
0.0
5.0
10.0
15.0
Pressure / Bar