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Geological and Geological Engineering Studies for EL-Burullus Power Plant Area, Kafr EL-Sheikh-Egypt

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THIS WORK aims to evaluate the geological engineering characteristics and hazards for the EL-Burullus Power Plant area. The values of effective diameter (D_{10}) are between 0.059m and 0.206mm, the coefficient of uniformity (C_u) is between 2.509mm and 8.417mm, the coefficient of curvature (Cc) is between 0.920mm and 3.901mm; friction angle ranged from 34° to 35.5°, bearing capacity is between 3.59 1Kg/cm² and 4.5 Kg/cm², the moisture content is between 30.22% and 57.20%, L.L is between 37.85% and 79.51%, P.L conclusions are between 19.55% and 28.25%, S.L is between 8.52% and 10.39% and free swelling conclusions are between 70% to 105%. Chemical analysis for samples reveals that the average of sulfate (So3) is 7526.5 ppm, the average of chlorides C (Cl) is 74900.5 ppm and the average of PH is 7.65. Most of the samples are highly aggressive. The calculated data of radioactivity reveal that, the values of the Raeq varied from 102.296 to 27.255 Bqkg-1with an average of 64.775 Bq kg-1. The highest limits eff. is 56.599 µSvyr-1, and the lowest is 17.245 µSvyr-1 with a mean average of 36.922 µSvyr-1. The results are less than the worldwide average. The average of the external hazard is 0.174. All conclusions are less than Unity recommends. So that the study area is safe from radiation.

Keywords: Atterberg limits, Free swell, Stiffness, Radioactivity.

Introduction

This study aims to gather data on the foundation beds and identify potential hazards at the site of the EL-Burullus Power Plant area in Egypt using engineering methods, geoenvironmental hazards, and radiometric characteristics. The studied site is located at the following coordinates: Longitudes 30° 48' 7.27" to 30°49' 3.66" E and latitudes 31° 31' 23.84" to 31° 32' 5.62" N. (Fig. 1). The soil's engineering geological characteristics were determined through the collection and analysis of multiple field samples. The soil was classified according to the unified soil classification system suggested by the International Association of Engineering Geologists (IAEG, 1981). This test is according to the behavior of the soil. Brackish water at a depth of 100 m. at Abu-Madi oil field (RIGW, 1992). Quaternary sediments, fluvio-marine sand and clay with gravels are divided into three Formations: Bilqas FM., Mit Ghamr FM and El-Wastani (Said, 1981).

Methodology

Ensuring the safety and health of the environment is of utmost importance to us, and we take this responsibility seriously. To accomplish this, we have collected soil samples that represent the various soil types in the study area and have diligently addressed any issues we discovered with appropriate solutions. We conducted several experiments on the soil, including sieving tests, direct shear, tri-axial, chemical analysis, Atterberg testing, free swelling, and shrinkage limit, to ensure its safety and health.

Understanding the critical role of the El-Burullus Power Plant in the community, we have taken great care in ensuring the foundation layers made up of sand and clay are secure and safe. We conducted lab experiments on both sand and clay to ensure they met the highest standards, taking into account vital factors such as moisture content, plastic limit, and shrinkage.

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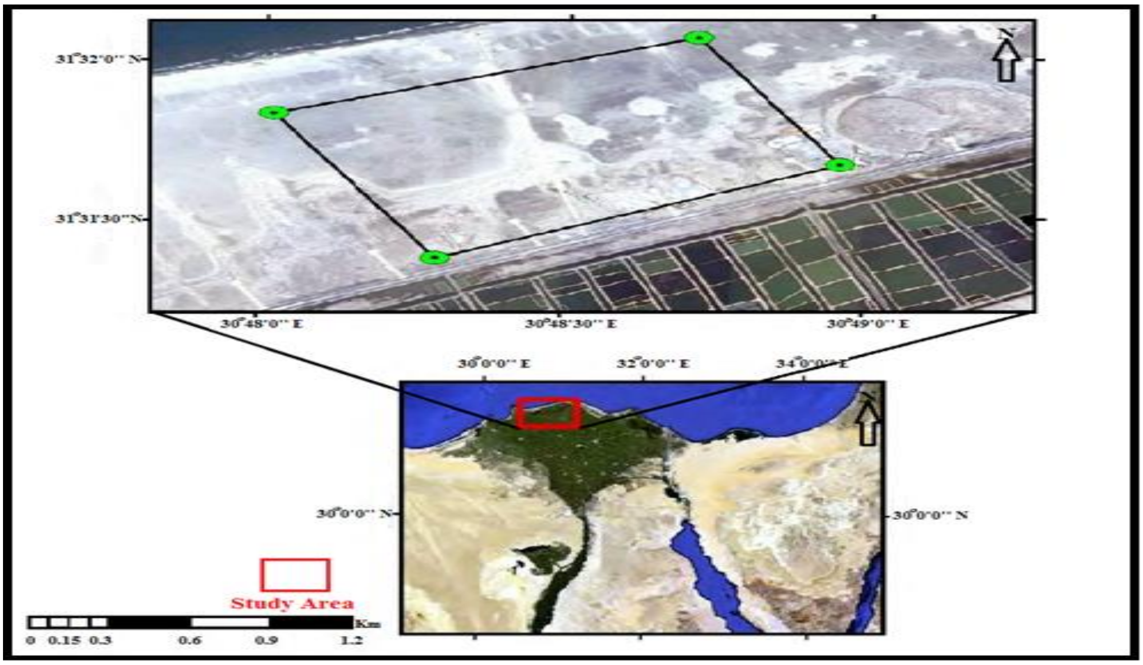

Fig. 1. Location map of EL -Burullus power plant.

Our commitment to consistency and free swelling in the soil led us to conduct necessary experiments to make informed decisions for the environment's safety and health. We understand the significance of radioactivity and have taken every precaution to ensure that radioactive elements do not harm the environment. We care deeply about the environment and remain committed to doing everything in our power to keep it safe and healthy.

Sieving Test

For engineers, understanding the mechanical properties and qualities of materials is crucial. Tables 1a and 1b contain the findings of a recent test, which involved the sieving of soil in accordance with ASTM D – 422. Figure 2 depicts the resulting data. It is worth noting that fine soil usually has a lower bearing capacity, whereas soil with coarse grains generally has a higher bearing capacity.

TABLE 1a. Results of Sieving analysis of samples.

Sieve Size (mm) / Sample No.	Finer weight (%)							Statistical parameters				
	4	**2**	**1**	**0.5**	**0.25**	**0.125**	**0.063**	**D_{10}**	**D_{30}**	**D_{60}**	**C_U**	**C_C**
1,1	99.6	99.2	99.2	98.5	84.0	20.0	10.0	0.077	0.160	0.207	2.688	1.606
2,1	100	100	97.9	65.0	30.2	12.6	8.0	0.100	0.246	0.398	3.980	1.521
3,1	99.6	98.4	93.7	61.7	29.5	11.7	8.6	0.100	0.252	0.421	4.210	1.508
4,1	100	99.5	99.1	95.6	76.7	19.0	8.3	0.082	0.160	0.212	2.585	1.473
4,2	100	100	92.0	43.6	20.7	9.1	6.7	0.160	0.308	0.531	3.319	1.117
5,1	100	100	94.3	46.6	19.4	11.3	7.7	0.125	0.300	0.507	4.056	1.420
6,1	100	99.9	95.1	36.6	17.8	9.3	6.4	0.158	0.364	0.595	3.767	1.408
8,1	100	100	99.8	86.0	68.2	21.0	9.9	0.075	0.163	0.385	5.133	0.920
9,1	100	100	99.0	37.0	12.8	6.5	4.8	0.206	0.374	0.583	2.832	1.169
9,2	100	100	96.4	56.9	24.8	11.9	8.9	0.103	0.278	0.442	4.288	1.700
1,1	100	100	98.7	51.1	28.9	11.4	8.5	0.100	0.253	0.495	4.950	1.293
10,2	100	99.9	96.1	48.6	27.0	11.6	8.7	0.100	0.260	0.500	5.000	1.352
11,1	100	100	93.9	43.0	24.7	14.0	9.3	0.080	0.298	0.525	6.563	2.114
12,1	100	100	97.0	60.0	28.1	13.0	8.9	0.088	0.255	0.455	5.170	1.624
13,1	99.7	99.3	99.0	97.0	79.8	16.6	9.3	0.081	0.160	0.210	2.593	1.505
13,2	100	100	92.1	24.7	11.5	8.0	4.8	0.200	0.442	0.605	3.025	1.615
14,1	100	99.9	95.9	32.0	13.4	9.1	5.9	0.160	0.400	0.590	3.688	1.695
15,1	100	99.6	91.3	41.8	23.0	11.8	8.6	0.107	0.313	0.580	5.410	1.569
16,1	100	100	99.9	99.0	83.3	16.9	8.9	0.086	0.170	0.215	2.509	1.565
17,1	100	100	99.9	96.1	83.4	18.0	9.1	0.083	0.168	0.214	2.595	1.602
17,2	100	100	89.6	29.0	14.2	9.5	7.2	0.162	0.432	0.600	3.713	1.925
18,1	99.5	99.2	98.4	80.8	30.0	18.1	9.9	0.080	0.245	0.347	4.338	2.162

TABLE 1b. Results of Sieving analysis of samples.

S. No. - Sieve Size	4	2	1	0. 5	0. 25	0. 125	0. 063	D_{10}	D_{30}	D_{60}	C_U	C_C
18,2	100	100	92.8	48.0	20.5	9.2	6.5	0.157	0.300	0.505	3.217	1.135
19,1	100	100	99.8	45.4	25.1	9.9	6.7	0.155	0.295	0.503	3.245	1.116
19,2	100	100	96.1	34.6	17.6	7.9	5.3	0.160	0.390	0.588	3.675	1.617
20,1	100	100	96.3	67.0	26.0	9.7	6.6	0.155	0.255	0.395	2.548	1.062
21,1	100	99.7	99.1	75.9	44.4	12.0	6.5	0.125	0.200	0.318	2.544	1.006
22,1	100	100	100	99.4	82.9	20.0	8.8	0.081	0.160	0.210	2.593	1.505
22,2	91.5	89.6	84.2	54.4	29.3	12.7	9.1	0.090	0.252	0.492	5.467	1.434
24,1	100	100	99.9	98.6	77.7	18.1	9.4	0.080	0.170	0.220	2.747	1.636
25,1	100	100	90.0	34.7	14.0	9.1	7.1	0.169	0.386	0.620	3.672	1.421
27,1	99.0	98.0	85.9	46.3	21.8	11.8	9.3	0.096	0.309	0.523	5.422	1.889
28,1	100	100	97.6	53.2	20.9	9.1	7.9	0.160	0.294	0.490	3.063	1.103
29,1	100	100	97.5	49.7	21.6	12.1	8.5	0.100	0.295	0.500	5.000	1.741
30,1	100	100	95.7	47.9	19.2	10.8	8.2	0.147	0.300	0.502	3.415	1.220
31,1	100	100	91.4	47.0	24.7	9.1	7.5	0.155	0.290	0.505	3.258	1.074
32,1	100	100	95.9	45.2	19.9	11.1	8.3	0.125	0.300	0.500	4.000	1.440
33,1	100	100	94.6	47.5	22.1	12.7	10.7	0.060	0.295	0.505	8.417	2.872
34,1	98.5	98.0	93.3	48.3	20.4	10.3	9.3	0.100	0.300	0.500	5.000	1.800
35,1	100	100	95.7	51.0	21.0	12.9	9.9	0.080	0.395	0.500	6.250	3.901
36,1	100	100	99.5	80.1	51.2	13.8	10.9	0.059	0.190	0.295	5.000	2.074
37,1	100	99.9	91.9	41.7	24.5	14.1	9.9	0.080	0.300	0.550	6.875	2.045
39,1	100	100	95.3	59.5	32.6	12.2	9.8	0.080	0.240	0.427	5.338	1.686
40,1	100	100	100	99.6	96.9	21.9	10.0	0.077	0.165	0.195	2.532	1.813
40,2	100	100	95.8	62.0	33.6	10.6	8.6	0.140	0.295	0.415	2.964	1.498
41,1	100	100	94.7	58.1	31.7	12.9	9.9	0.080	0.240	0.427	5.338	1.686
42,1	100	100	99.9	99.3	78.9	18.7	10.0	0.077	0.160	0.210	2.727	1.583
43,1	100	100	90.9	40	18.1	8.9	7.4	0.160	0.330	0.580	3.625	1.173

From (Table 1a and Table 1b), the results of Cc are showing that, study area descripted by a range poorly graded and well graded type. The definition of different particles diameter on distribution curve of particle size and some types of samples gradations was after (DAS 2010).

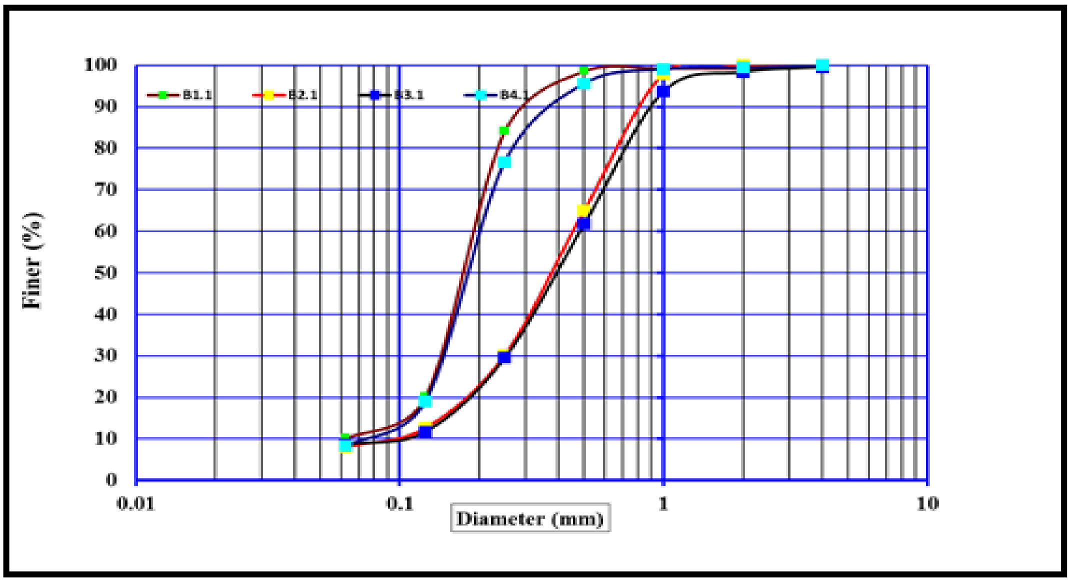

Fig. 2. Distribution curve of some samples.

Geologic Setting

Results of geological studies confirm stratigraphic features of sedimentary layers in the study site and structural features that affected the area during the geological time. The study area is located within the Nile Delta, which was formed by the River Nile in recent geological Times. Paleo-Nile started to advance across a marine embayment in the Late Pliocene, which advanced in the Pleistocene during major sea–level differences with glacial ages. During the low sea level stage, many amounts of clay and sand moved towards the Mediterranean (Fig. 3).

Bilqas Formation is at top plurality part of Delta Nile sediments which includes clays and some of plants remains with sand (Said, 1981).

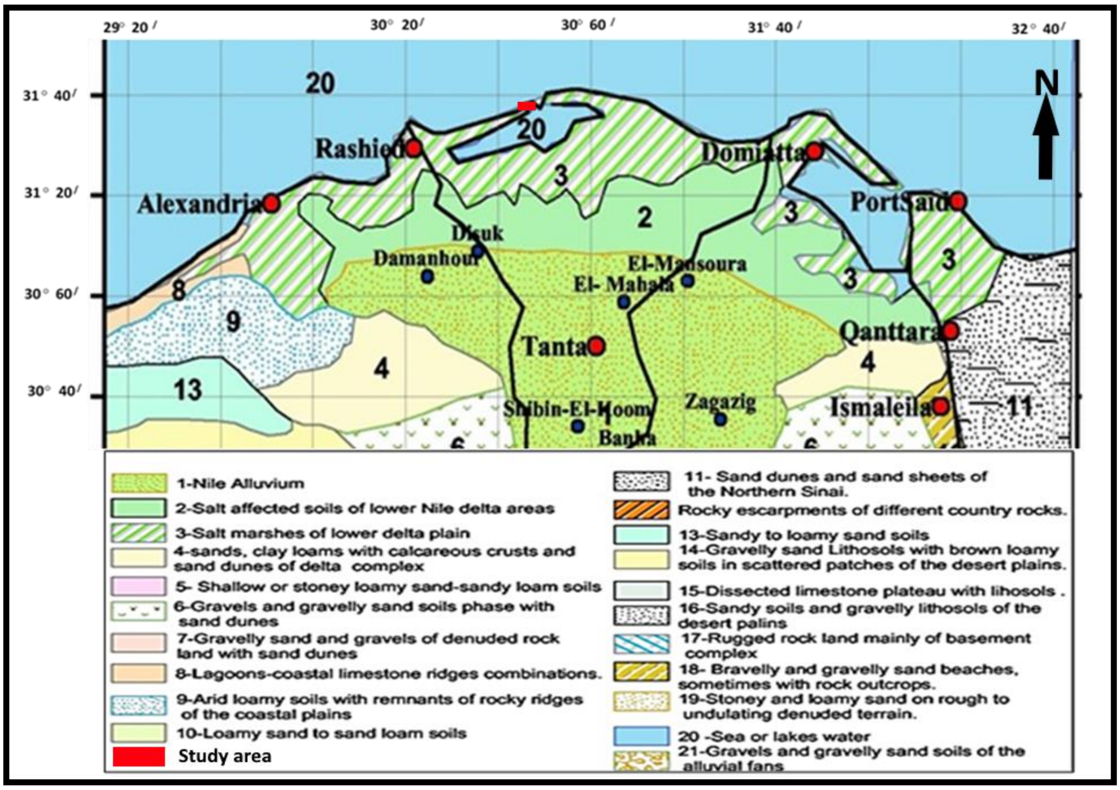

Fig. 3. Geologic map of EL - Burullus power plant (after CONCO - Coral, 1987).

General Stratigraphy

A brief description will be given to describe the different litho-stratigraphic units that exposed in the surface and encountered in the sub-surface.

Surface Stratigraphic Units

The coastal plain of the Nile Delta characterize by the occurrences of the following stratigraphic units referring to the Pliocene –Quaternary ages. These units are:

Quaternary Stratigraphic Units

Coastal Sand Dunes

Coastal Dunes are spread along the plain of the Nile Delta at disconnected localities. They appear to the West, North and South of Lake Burullus at some of the islands on the lagoon and between Rosetta and Damietta Branches.

Salt Marshes and Sabkha

A belt of salt and marshy flat covered with aquatic vegetation extends along the Southern margins of the lagoons.

Pleistocene Stratigraphic Units

Bilqas Formation

Bilqas Formation represents the top most part of the Nile Delta sediments. It consists of sands and clays with plant remains. The average thickness is about 50 m.

Sub-Surface Stratigraphic Units

According to Said, (1981), Zaghloul E., (1984) and El-Heiny and Morsi, (1992), the sub-surface lithostratigraphic units can be described from younger to older formation as follows :

Mit Ghamr Formation

The depositional environment of this formation is probably shallow marine to fluvial. It is a typical fill-up of basin with shelly sands, Coqina beds, clay and peat.

El-Wastani Formation

It consists of thick quartzose sands with argillaceous interbred. The thickness ranges from 120 to 300 m.

Kafr EL -Sheikh Formation

The formation ranges in age from Lower to Middle Pliocene. The sequence consists of soft clays with inter-bedded poorly consolidated sands with a clayey matrix. The clays are composed in equal proportions of Kaolinite and Montmorillonite with very little Illite.

Abu-Madi Formation

The formation is represented by a series of thick sand bodies inter-bedded with thin shales. The sand is cross-bedded and overlies the Rosetta Anhydrite in Abu-Madi, El-Wastani and Abu-Qir fields while in the study area, the formation unconformable overlies the Qawasim Formation. Abu-Madi Formation was deposited in a deltaic environment and grades up into shallow marine environment.

Qawasim Formation

This formation overlies the Sidi Salem Formation and underlies the Abu-Madi Formation with unconformity surface due to the missing of Rosetta Formation (Anhydrite section of Upper Messinian). It comprises a thick section of sand and conglomeratic series of Middle to Upper Miocene. In any case, the development of the section marks a change in the depositional environment from fluvial- deltaic to marine.

Sidi Salem Formation

It is consisting of predominant shale's with few interbedded dolomitic marls and rare sandstone.

Results and Discussion

Direct Shear Test

Accurate determination of bearing capacities for buildings located near the surface is crucial, particularly with respect to firmness issues. Based on recorded data, the average friction angle is 34.75°, and Figure 4 displays the relationship between normal stress and shear stress for a selection of samples. Scientists have concluded that finer grains offer better grading, which fills voids or pores formed by coarse particles that result from compacting materials and provides a greater degree of interconnection within the material than in pore soils. As per Hamidi et al. (2012), well-graded soils generally exhibit high shear strength. Table 2 contains data on the friction angle and cohesion of some of the samples.

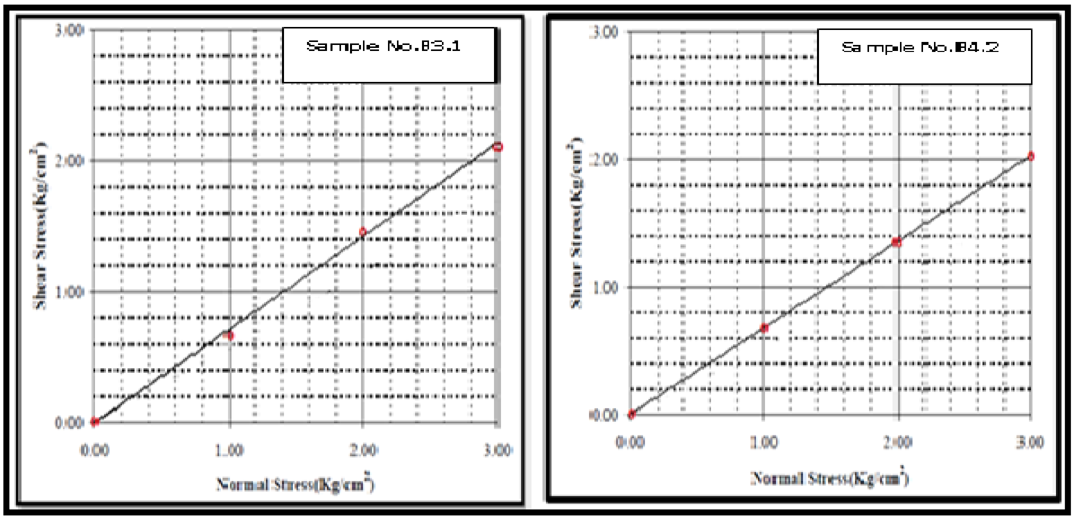

Fig. 4. Normal stress and shear stress of some samples.

TABLE 2. Results of Direct Shear.

S. No.	N. Stress (Kg/cm^2)	Sh. Stress (Kg/cm^2)	(Ø)	Cohesion C(KN/m^2)
	1.00	0.67		
B3.1	2.00	1.46	35.5°	0.00
	3.00	2.18		
	1.00	0.65		
B4.2	2.00	1.38	34°	0.00
	3.00	2.01		
	1.00	0.65		
B6.1	2.00	1.41	35°	0.00
	3.00	2.04		
	1.00	0.66		
B9.2	2.00	1.28	34°	0.00
	3.00	2.03		
	1.00	0.67		
B11.1	2.00	1.40	34.5°	0.00
	3.00	2.09		
	1.00	0.65		
B12.1	2.00	1.38	34.5°	0.00
	3.00	2.05		
	1.00	0.66		
B15.1	2.00	1.40	34.5°	0.00
	3.00	2.03		
	1.00	0.62		
B16.1	2.00	1.37	34.5°	0.00
	3.00	2.00		
	1.00	0.67		
B17.2	2.00	1.37	34°	0.00
	3.00	2.02		
	1.00	0.65		
B42.1	2.00	1.40	34.5°	0.00
	3.00	2.03		

Square foundation = 1.5 * 1.5 m, unit weight = 18 KN/m^3, foundation depth = 1.5 m. Results of bearing capacities are tabulated in (Table 3). Conclusions are between 3.59 Kg/cm^2 and 4.5 Kg/cm^2. The study area has a river sedimentary environment and some of it is beach sedimentary environment. The study area has a sands which has a very high bearing capacities.

TABLE 3. Results of Allowable bearing capacities.

S. No.	Friction Angle(Φ)	(C) (KN/m^2)	N_C	N_q	N_γ	q_{all} (Kg/cm^2)
B3.1	35.5°	0.00	48.4	34.6	24.6	3.98
B4.2	34°	0.00	42.4	29.8	19.8	4.5
B6.1	35°	0.00	46	33	23	3.79
B9.2	34°	0.00	42.4	29.8	19.8	4.5
B11.1	34.5°	0.00	44.2	31.4	21.4	3.59
B12.1	34.5°	0.00	44.2	31.4	21.4	3.59
B15.1	34.5°	0.00	44.2	31.4	21.4	3.59
B16.1	34.5°	0.00	44.2	31.4	21.4	3.59
B17.2	34°	0.00	42.4	29.8	19.8	4.5
B18.2	34.5°	0.00	44.2	31.4	21.4	3.59
B20.1	34.5°	0.00	44.2	31.4	21.4	3.59
B22.2	34.5°	0.00	44.2	31.4	21.4	3.59
B28.1	34.5°	0.00	44.2	31.4	21.4	3.59
B29.1	34.5°	0.00	44.2	31.4	21.4	3.59
B30.1	34.5°	0.00	44.2	31.4	21.4	3.59
B32.1	34.5°	0.00	44.2	31.4	21.4	3.59
B34.1	35.5°	0.00	48.4	34.6	24.6	3.98
B39.1	35°	0.00	46	33	23	3.79
B41.1	34°	0.00	42.4	29.8	19.8	4.5
B42.1	34.5°	0.00	44.2	31.4	21.4	3.59

Chemical Analysis

This test is according to ASTM D516 – 02. Conclusions are tabulated in (Table 4).

TABLE 4. Results of Chemical analysis for the samples.

S. No.	T.D.S.	SO_3		pH	Cl^-	
	ppm	ppm	%		ppm	%
BH2.2	146190	5493	3.7	7.60	85195	58.2
BH6.3	140320	7812	5.5	7.60	80225	57.1
BH9.4	113620	7436	6.5	7.59	64251	56.5
BH11.2	136020	7009	5.1	7.70	78095	57.4
BH14.3	144040	9772	6.7	7.70	81290	56.4
BH18.3	142080	7285	5.1	7.70	81645	57.4
BH21.3	135980	7606	5.5	7.60	77740	56.4
BH22.4	139970	5735	4.09	7.60	81290	57.1
BH23.2	138360	8209	5.9	7.60	78805	58.07
BH25.3	143320	9715	6.7	7.60	80935	56.9
BH26.2	122900	6730	5.4	7.60	70286	56.4
BH27.3	146060	6463	4.4	7.60	84485	57.1
BH28.4	149220	8016	5.3	7.60	85550	57.8
BH29.3	147630	6349	4.3	7.59	85550	57.3
BH30.3	149930	8630	5.7	7.60	85550	57.9
BH31.2	150530	10460	6.9	7.60	84840	57.05
BH32.3	148000	7820	5.2	7.60	84840	56.3
BH33.2	147510	8522	5.7	7.60	84130	57.3
BH35.3	147100	7606	5.1	7.61	84485	57.03
BH36.2	141410	6584	4.6	7.59	81645	57.4
BH37.2	137290	7626	5.5	7.62	78450	57.7
BH39.3	135520	6531	4.8	7.60	78095	57.1
BH41.3	143250	6654	4.6	7.59	82710	57.7
BH42.3	132510	7572	5.7	7.60	75610	57.05

pH of samples results are between 7.60 (Non - aggressive) and 7.70 (Non - aggressive) av. = 7.65 (Non - aggressive). Sulfate between 5493 ppm and 10460 ppm with an average 7976.5 ppm (Highly

Aggressive). The values of chlorides are ranging from 64251 ppm (Highly aggressive) to 85550 ppm (Highly aggressive) with an average 74900.5 ppm (Highly aggr.). According to Egypt code (2001), most of results are highly aggressive.

Finer Soil Results

Water Content

The conclusions of it are shown in (Table 5). Which is from 30.22% to 57.20%.

Limits of Atterberg

These conclusions were determined according to ASTM D4318-05. When more plastic soil is equal with more pressure will increase the dumping of the swelling - shrinkage and reduce the permeability (Abramson et. al., 1996).

Liquid Limit (L.L)

This test is according to ASTM D – 4318. Conclusions are tabulated in (Table 5). This ranged between37.85% and 79.51%. We use these results to draw relation for L.L and P.I.

Plastic Limit (P.L)

This test is according to ASTM D – 4318. Conclusions of it are tabulated in (Table 5). Values of it are ranging between19.55% to 28.25%.

Shrinkage Limit (S.L)

This test is according to ASTM D – 427. Conclusions of it are tabulated in (Table 5). It is between 8.52 and 10.39.

Plasticity Index (P.I)

This term mean the description of the ability of soil to undergo unrecoverable deformation at fixed size without stopped, and this character is assigned to presence of the minerals which in clay (Craig, 1982). If soil has been used as problems (if P.I is great) when the residence and roads will occur, large engineering problems occur (Joseph, 1984). Conclusions of P.I are tabulated in (Table 6). P.I is between 18.30 and 51.40.

Liquidity Index (L.I)

The assesses of (L.I) are shown in (Table 6). L.I is between 0.08 and 0.83. L.I according to (Whitlow, 1983) is plastic.

TABLE 5. Results of Limits of Atterberg for some samples.

S. No.	(L.L.) %	(P.L.) %	(S.L.)%	Moisture Content %	Free Swell%
B3.2	52.00	25.64	8.63	42.12	70
B4.3	71.27	27.33	9.84	30.81	87
B5.2	65.69	26.75	9.24	41.28	70
B6.2	67.69	26.89	10.39	40.78	84
B7.3	71.48	27.33	9.29	48.12	87
B7.4	70.02	26.99	8.74	52.64	70
B9.3	37.85	19.55	10.23	30.55	87
B14.2	60.24	25.96	8.58	49.53	84
B15.2	79.51	28.11	9.79	49.88	70
B17.3	57.72	25.75	9.18	40.79	77
B17.4	68.21	27.01	8.69	53.60	105
B20.2	69.31	27.15	10.28	56.55	70
B21.2	55.34	25.75	8.58	42.77	87
B22.3	70.69	26.95	9.18	51.66	70
B23.1	66.12	26.88	9.07	43.80	73
B24.2	51.75	24.99	8.58	35.99	70
B26.1	77.26	27.88	9.79	54.37	70
B27.2	54.97	25.66	8.52	50.02	84
B28.2	62.41	26.44	8.58	49.50	80
B29.2	66.96	26.88	10.34	49.37	84
B39.2	66.24	26.87	9.07	42.82	73
B40.3	76.48	27.84	9.73	55.24	70
B41.2	79.14	28.25	9.79	57.20	70

TABLE 6. Results of Plasticity, Liquidity Index and Consistency Index of some samples.

S. No.	P.I %	L.I %	C.I %
B3.2	26.54	0.63	0.37
B4.3	43.94	0.08	0.92
B5.2	38.94	0.37	0.63
B6.2	40.80	0.34	0.66
B7.3	44.15	0.47	0.53
B7.4	43.03	0.60	0.40
B9.3	18.30	0.60	0.40
B14.2	34.27	0.69	0.31
B15.2	51.40	0.42	0.58
B17.3	31.97	0.47	0.53
B17.4	41.20	0.65	0.35
B20.2	42.16	0.70	0.30
B21.2	29.59	0.58	0.42
B22.3	43.74	0.56	0.44
B23.1	39.24	0.43	0.57
B24.2	26.76	0.41	0.59
B24.3	29.74	0.70	0.30
B24.4	48.78	0.46	0.54
B26.1	49.38	0.54	0.46
B27.2	29.31	0.83	0.17
B28.2	35.97	0.59	0.41
B28.3	40.08	0.56	0.44
B29.2	40.08	0.56	0.44
B35.2	25.92	0.20	0.80
B38.1	31.71	0.67	0.33
B39.2	39.38	0.41	0.59
B40.3	48.64	0.56	0.44
B41.2	50.89	0.57	0.43

Consistency Index (C.I)

The values of C.I are tabulated in (Table 6). C.I conclusions are between 0.17% and 0.92%. Samples are stiff.

Free Swelling Test

Soil have free swelling result as100% can causes great damage to light loading structure, while soil have free swelling result less than50% give noteworthy size difference equivalent under very simple loading (Bell, 1983). Sampling are written in (Table 5). Conclusions are between 70% and 105 %.

Triaxial Shear Test

This test is by ASTM D-2850. Stiffness and Shear Parameters of some studied clay samples showed in (Fig. 5). Conclusions are tabulated in (Table 7). This test is very important in all stability problems such as stability of slopes and bearing capacity of shallow foundation.

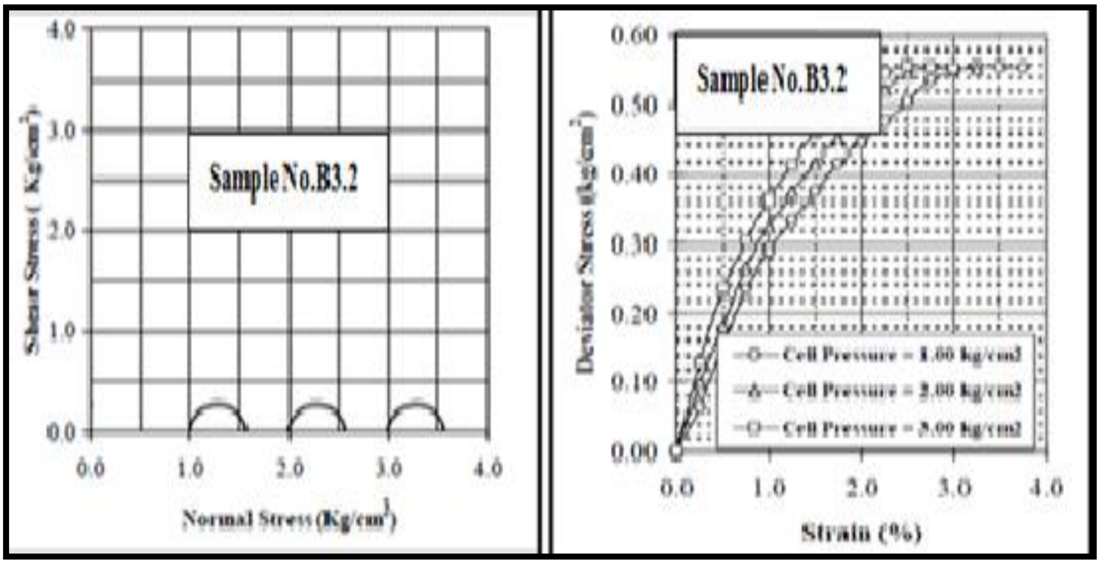

Fig. 5. Stiffness and shear strength parameters of some studied clay samples.

TABLE 7. Results of Stiffness and shear strength parameters of some studied samples.

Sample No.	Cell Stress (Kg/cm^2)	Deviator Stress (Kg/cm^2)	Major Stress (Kg/cm^2)	Cohesion Strength C_u (Kg/cm^2)	Internal Friction Angle ϕ (°)
	1.00	0.56	1.56		
BH3.2	2.00	0.56	2.56	0.28	0°
	3.00	0.56	3.56		
	1.00	5.32	6.32		
BH4.3	2.00	5.32	7.32	2.66	0°
	3.00	5.33	8.33		
	1.00	0.48	1.48		
BH6.2	2.00	0.49	2.49	0.24	0°
	3.00	0.49	3.49		
	1.00	0.48	1.08		
BH10.3	2.00	0.48	1.68	0.24	0°
	3.00	0.47	2.87		
	1.00	0.97	1.97		
BH15.2	2.00	0.98	2.98	0.49	0°
	3.00	0.98	3.98		
	1.00	5.22	6.22		
BH16.2	2.00	5.59	7.59	2.61	0°
	3.00	5.94	8.94		
	1.00	0.46	1.46		
BH17.3	2.00	0.46	2.46	0.23	0°
	3.00	0.46	3.46		
	1.00	3.42	4.42		
BH19.3	2.00	3.43	5.43	1.71	0°
	3.00	3.43	6.43		
	1.00	3.98	4.98		
BH39.2	2.00	3.99	5.99	1.99	0°
	3.00	3.99	6.99		
	1.00	0.40	1.40		
BH42.2	2.00	0.41	2.41	0.20	0°
	3.00	0.41	3.41		

Classification of Engineering Properties of Soil

Finer grains soil of our samples are divided by using A – Line chart (Casagrand, 1948). Fig. 6. Illustrate clay of EL – Burullus power plant that was described as inorganic clay with high and very high plastic.

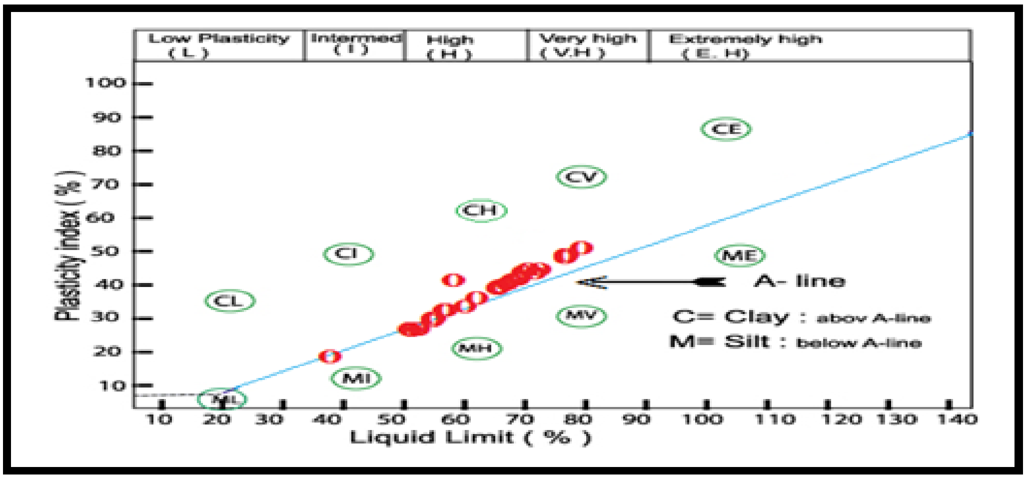

Fig. 6. Division of finer soil (after Casagrand, 1948).

Radioactivity

The Activity Concentration of Radionuclides "A"

The activity concentration of ^{232}Th, ^{238}U and ^{40}K detected by γ-ray technique for samples which tabulated in tables 8 and 9. Active concentrations of our samples in Bq / Kg was detected from photo - peak of γ - ray corresponding to ^{40}K, ^{238}U and ^{232}Th. Evaluation of count rates for each determined from photo - peak and radiologic concentrations of determined radionuclides depend on the establishment of secular equilibrium in sample. Since secular equilibrium was reached between ^{232}Th and ^{238}U and their decay products, ^{232}Th concentration was detected from average concentrations of (^{208}Tl, ^{212}Pb, ^{228}Ac) in samples, and that of ^{238}U (^{226}Ra) was detected from ^{214}Pb and ^{214}Bi decay products average concentrations. So, radionuclide concentration of ^{232}Th and ^{238}U was calculated, while the ^{40}K concentration was calculated from true calculations of its γ - ray line of 1460 Kev.

TABLE 8. Distribution conc. of natural radionuclide, ^{238}U, ^{232}Th, ^{226}Ra and ^{40}K in EL- Burullus power plant at depth 0.00 m.

Sample No.	^{238}U Concentration		^{226}Ra Concentration		^{232}Th Concentration		^{40}K Concentration	
	ppm	Bq/Kg	Ppm	Bq/Kg	ppm	Bq/Kg	%	Bq/Kg
0-1	ULD	ULD	ULD	ULD	8	32.48	2.00	626
0-2	1	2.35	ULD	ULD	4	16.24	1.21	378.73
0-3	ULD	ULD	ULD	ULD	1	4.06	0.89	278.57
0-4	ULD	ULD	ULD	ULD	6	24.36	1.81	566.53
Average	1	2.35	ULD	ULD	4.5	18.27	1.44	452.28

TABLE 9. Distribution concentrations of natural radionuclide, ^{238}U, ^{232}Th, ^{226}Ra and ^{40}K in EL- Burullus power plant at depth 1 m.

Sample No.	^{238}U Concentration		^{226}Ra Concentration		^{232}Th Concentration		^{40}K Concentration	
	ppm	Bq/Kg	ppm	Bq/Kg	ppm	Bq/Kg	%	Bq/Kg
1-1	ULD	ULD	ULD	ULD	1	4.06	1.26	394.38
1-2	ULD	ULD	ULD	ULD	4	16.24	1.04	325.52
1-3	ULD	ULD	ULD	ULD	3	12.18	0.78	244.14
1-4	ULD	ULD	ULD	ULD	5	20.3	3.04	951.52
Average	ULD	ULD	ULD	ULD	3	12.18	1.91	597.83

(Tables 8 and 9) showed that concentrations (Bq/kg) for the EL-Burullus power plant area samples, CTh ranged from 32.48 (No.0-1) to 4.06 (No.0-3) with an average value (18.27), while CRa ULD and for Ck ranged from 951.52 (No.1-4) to 244.14 (No.1-3) with an average value (597.83). Samples are in allowable limits.

TABLE 10. The Ra_{eq}, D. rate, D. eff. rate and H ex. of EL - Burullus power plant at 0.00 m.

Sample No.	Ra_{eq} (Bq/Kg)	Absorbed Dose, D_{rate} D(nGy/h^{-1})	Effective Dose, D_{eff} (µSv/yr^{-1})	External Hazard Index, 1H_{ex} (Bq/.Kg)
0-1	94.648	46.151	56.599	0.255
0-2	52.385	25.796	31.636	0.140
0-3	27.255	14.062	17.245	0.072
0-4	78.457	38.630	47.375	0.211
Average	60.951	30.106	36.922	0.163

TABLE 11. The Ra_{eq}, D. rate, D. eff. rate and H ex. of EL - Burullus power plant at depth 1 m.

Sample No.	Ra_{eq} (Bq/Kg)	Absorbed Dose, D_{rate} D(nGy/h^{-1})	Effective Dose, D_{eff} (µSv/yr^{-1})	External Hazard Index, 1H_{ex} (Bq/.Kg)
1-1	36.173	18.856	23.124	0.097
1-2	48.288	23.594	28.935	0.130
1-3	36.216	17.695	21.701	0.097
1-4	102.296	16.601	20.359	0.276
Average	69.234	20.097	24.647	0.186

Calculated data of Ra_{eq} is presented in (Tables 10 and 11). The values for soil samples varied from 102.296 to 27.255 Bqkg-1with average 64.775 Bqkg-1. Samples in allowable limits (370 Bqkg-1) as recommended by (IAEA, 1989). High observed annual eff. dose is 56.599 µSvyr-1 and the low is 17.245 µSvyr-1 with a mean average 36.922 µSvyr-1. It was less than international average that is 70 µSvyr-1 (Veiga et al., 2006). External hazard index is between 0.276 Bqkg-1 and 0.072 with av. (0.174). Results are lower than permitted limits which by (IAEA, 1989). So, no radiation effect on human activities in study area.

Conclusions

Sedimentological studies of EL-Burullus Power Plant involved with sieve analysis. Conclusions of sieve analysis confirmed that, EL -Burullus Power Plant is between poorly-grade and moderately-grade. Curves of distribution are near-symmetrical and lepto kurtic to meso kurtic. Limits of Atterberg show that, clay of EL-Burullus Power Plant can be classified as inorganic with high & very high plastic. Clay has moderate values of free swelling. The all values of radiological effects for soil samples are lower than permitted limits which by (IAEA, 1989), no radiation effect on human activities in study area. The soil of EL-Burullus Power Plant area is classified into two kinds: sand and clay. The first type is described as coarse grained sand which have very good bearing capacity. The first type is suitable for direct foundation above it. The second type is classified as clay which has moderate swelling property, but it has high and very high plasticity index, which has dangerous effect on the buildings, that are found their, this soil should be replaced by a soil of clean sand or good materials or constructing of piles before build many buildings. We will use sulfate attack cement within the foundations of study area, because the study area is highly aggressive for sulfate.

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الدراسات الجيولوجية والهندسية لمنطقة محطة كهرباء البرلس، كفر الشيخ، مصر

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في هذا البحث تم تحديد بعض النقاط الهامة والحساسة لمنطقة محطة كهرباء البرلس والتي تقع شمال محافظة كفر الشيخ بمصر وتم إجراء دراسات جيولوجية مع دراسات هندسية وبيئية، وتعتبر المنطقة من المناطق الساحلية الهامة ونجد أن هذه الدراسة تعتبرمحاولة لتقييم المنطقة من الناحية الجيولوجية والبيئية والهندسية والإشعاعية وذلك ليتثنى لنا معرفة خصائص طبقات الأساس، لكى يمكننا حل بعض المشاكل الهندسية بالمناطق العمرانية والصناعية والمشاريع الجديدة والحد من المخاطر الجيوبيئية بتلك المناطق، واتضح لنا بعد إجراء الاختبارات اللازمة على عينات من منطقة الدراسة أنها تنقسم إلى نوعين من التربة، بالنسبة للنوع الأول هوعبارة عن تربة رملية تسمح بإقامة المباني عليها مباشرة، أما النوع الثاني فهو عبارة عن تربة طينية وهي متوسطة الانتفاش وعالية اللدونة وخطيرة التأثير على المباني ، فيجب استبدال هذه التربة برمل نظيف أو مواد جيدة أو إقامة خوازيق عند إقامة المباني عليها، ونحن سوف نستخدم أسمنت مقاوم للكبريتات في منطقة الأساسات بمنطقة الدراسة لأن التربة شديدة العدوانية للكبريتات.