

B . BEN ME COC DRAINAGE STATION.

1 . STRUCTURE OF THE BASE SOIL.

Based on in-situ survey, drilling documents and the results obtained from the soil tests, we have noticed that basic soil on the surveying site (up to 50.0m deep) was composed by Holocene deposits of 36m thick, and Pleistocene deposits which the thickness has not been determined yet (boreholes of 50.0m depth did not exceed these deposits), and there is made ground on the surface with the thickness 1.0m. From the surface downwards there are the following layers:

1.1 . Layer 1: Made ground - Soft, blackish grey SANDY CLAY

This layer lies right on the surface, with the thickness 1.0 m.

1.2 . Layer 2: Very soft, high plasticity blackish grey ORGANIC CLAY (OH).

It is covered by layer 1 with thickness 14.0m and the bottom is 15.0m deep. Standard penetration resistance N from 0 to 1. In total, 7 samples were taken from this layer, the obtained physical, mechanical properties of the samples have shown that, natural moisture is from 69.31% to 107.67%, wet density from 1.406 to 1.551g/cm³, liquid limit from 70.4 to 95.5%, plasticity index from 30.1 to 50.1%, high compressibility (see average value of the physico-mechanical properties - table 1b). The main characteristics of the layer are as follows :

Wet density	γ_w	=	1,471 g/cm ³
Unconfined compressive strength	q_u	=	0.112 Kg/cm ²
Compression index	Cc	=	1.327 cm ² /kg
Coefficient of consolidation	Cv	=	3.64 x 10 ⁻⁴ cm ² /s
Coefficient of volume compressibility	mv	=	1.13 x 10 ⁻⁴ cm ² /g

1.3 . Layer 3: Soft, high plasticity blackish grey ORGANIC CLAY (OH).

It is covered by layer 2. Thickness is 21.0m and bottom is 36.0m depth. Standard penetration resistance N from 2 to 3. In total, 8 samples were taken from this layer, the obtained physical, mechanical properties of the samples have shown that, natural moisture is from 51.87% to 79.12%, wet density from 1.509 to 1.663g/cm³, liquid limit from 56.8 to 79.5%, plasticity index from 21.4 to 39.3%, high compressibility (see average value of the physico-mechanical properties - table 2b). The main characteristics of the layer are as follows :

Wet density	γ_w	=	1,582 g/cm ³
Unconfined compressive strength	q_u	=	0.235 Kg/cm ²
Compression index	Cc	=	1.251 cm ² /kg
Coefficient of consolidation	Cv	=	3.04 x 10 ⁻⁴ cm ² /s
Coefficient of volume compressibility	mv	=	7.59 x 10 ⁻⁵ cm ² /g

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1.4 . Layer 3a: Soft, low plasticity blackish grey SANDY CLAY (CL).

It is covered by layer 3. Thickness is 3.6m and bottom is 39.6m depth. Standard penetration resistance N from 2 to 4. One sample was taken from this layer, the obtained physico-mechanical properties of the samples have shown that, natural moisture is 19.94%, wet density is 1.647g/cm^3 , liquid limit 36.3%, plasticity index is 18.2%, high compressibility (see average value of the physico-mechanical properties - table 3d). The main characteristics of the layer are as follows :

$$\text{Wet density} \quad \gamma_w = 1,647 \text{ g/cm}^3$$

1.5 . Layer 4: Loose, whitish grey SILTY SAND (SM)

It is covered by layer 3a. Thickness is 4.0m and bottom is 43.6m depth. Standard penetration resistance N from 8 to 9. In total, 2 sample was taken from this layer, the obtained physico-mechanical properties of the samples have shown that, natural moisture are 15.70% to 15.77%, wet density are from 2.048g/cm^3 to 2.053g/cm^3 , liquid limit 20.2%, plasticity index is 2.3%, high compressibility (see average value of the physico-mechanical properties - table 4b). The main characteristics of the layer are as follows :

$$\text{Wet density} \quad \gamma_w = 2,051 \text{ g/cm}^3$$

1.6 . Layer 4a: Medium dense, reddish yellow CLAYEY SAND (SC)

It is covered by layer 4. Thickness is 3.4m and bottom is 47.0m depth. Standard penetration resistance N from 11 to 15. In total, One sample was taken from this layer, the obtained physico-mechanical properties of the samples have shown that, natural moisture is 14.81%, wet density is 2.064g/cm^3 , liquid limit 26.5%, plasticity index is 10.4%, high compressibility (see average value of the physico-mechanical properties - table 5b). The main characteristics of the layer are as follows :

$$\text{Wet density} \quad \gamma_w = 2,064 \text{ g/cm}^3$$

1.7 . Layer 5: Very stiff, low plasticity reddish yellow SANDY CLAY (CL)

It is covered by layer 4a. At borehole with 50.0m depth, its thickness has not been determined yet. Standard penetration resistance N from 25 to 29. One sample was taken from this layer, the obtained physical, mechanical properties of the samples have shown that, natural moisture is 18.33%, wet density 2.086g/cm^3 , liquid limit 37.3%, plasticity index is 18.2%, (see average value of the physico-mechanical properties - table 6b).

Hydrogeological conditions

At the surveying area, the groundwater level is affected by the tide and changeable according to seasons. The groundwater level in the boreholes during the investigation time is from -0.5m to -1.0m. (The underground water level measured from ground surface).

AVERAGE VALUE OF PHYSICA - MECHANICAL PROPERTIES
Layer 2 : Very soft, high plasticity blackish grey ORGANIC CLAY (OH).

Table : 1b

No	Properties	Sign	Average value.	Maximum value	Minimum value	Number of test
1	Sieve Analysis, % Passing					
	3/4" (19 mm)					
	1/2" (12.5 mm)					
	3/8" (9.5 mm)					
	#4 (4.75 mm)					
	#8 (2.36 mm)		100.0	100.0	100.0	7
	#16 (1.18 mm)		99.5	100.0	98.9	7
	#30 (0.6 mm)		99.0	100.0	98.0	7
	#50 (0.3 mm)		98.2	100.0	96.3	7
	#100 (0.15 mm)		97.1	100.0	94.2	7
	#200 (0.075 mm)		95.5	98.4	93.0	7
	< 0.005 mm		61.8	70.4	47.0	7
2	Natural moisture content (%)	w	88.04	107.67	69.31	7
3	Natural unit weight (g/cm ³)	γ	1.471	1.551	1.406	7
4	Dry unit weight (g/cm ³)	γ _d	0.788	0.916	0.677	7
5	Specific gravity	G _s	2.572	2.602	2.534	7
6	Porosity	n	0.690	0.730	0.640	7
7	Void ratio	e _v	2.298	2.743	1.777	7
8	Degree saturation (%)	S	98.60	99.50	97.50	7
9	Liquid limit (%)	LL	86.5	95.4	70.4	7
10	Plastic limit (%)	LP	44.6	51.9	40.3	7
11	Plastic index (%)	PI	41.9	43.5	30.1	7
12	Water plasticity ratio (%)	B	1.04	1.24	0.60	7
13	Unconfined compression (Kg/cm ²)	qu	0.112	0.172	0.061	3
14	Compression index (cm ² /kg)	C _c	1.3270	1.9020	0.8800	3
15	Coefficient of consolidation (cm ² /s)	C _v	3.64E-04	4.15E-04	2.98E-04	3
16	Preconsolidation pressure (kg/cm ²)	P _c	0.628	0.796	0.435	3
17	Coefficient of volumn compressibility (cm ² /g)	M _v	1.13E-04	1.33E-04	9.60E-05	3
18	Permeability (cm/sec)	k ₂₀	3.06E-08	3.49E-08	2.71E-08	3

AVERAGE VALUE OF PHYSICA - MECHANICAL PROPERTIES
Layer 3 : Soft, high plasticity blackish grey ORGANIC CLAY (OH).

Table : 2b

No	Properties	Sign	Average value.	Maximum value	Minimum value	Number of test
1	Sieve Analysis, % Passing					
	3/4" (19 mm)					
	1/2" (12.5 mm)					
	3/8" (9.5 mm)					
	#4 (4.75 mm)					
	#8 (2.36 mm)		100.0	100.0	100.0	8
	#16 (1.18 mm)		99.4	100.0	98.7	8
	#30 (0.6 mm)		99.1	100.0	98.0	8
	#50 (0.3 mm)		98.4	100.0	96.4	8
	#100 (0.15 mm)		96.8	100.0	93.1	8
	#200 (0.075 mm)		89.7	98.6	76.2	8
	< 0.005 mm		65.6	80.5	54.5	8
2	Natural moisture content (%)	w	63.99	79.12	51.87	8
3	Natural unit weight (g/cm ³)	γ	1.582	1.663	1.509	8
4	Dry unit weight (g/cm ³)	γ _d	0.971	1.095	0.842	8
5	Specific gravity	G _s	2.581	2.601	2.564	8
6	Porosity	n	0.620	0.670	0.580	8
7	Void ratio	e _v	1.685	2.054	1.353	8
8	Degree saturation (%)	S	98.00	99.90	94.30	8
9	Liquid limit (%)	LL	69.6	79.5	56.8	8
10	Plastic limit (%)	LP	39.9	42.6	35.4	8
11	Plastic index (%)	PI	29.7	36.9	21.4	8
12	Water plasticity ratio (%)	B	0.80	1.04	0.50	8
13	Unconfined compression (Kg/cm ²)	qu	0.235	0.246	0.223	2
14	Compression index (cm ² /kg)	C _c	1.2510	1.7140	0.7780	2
15	Coefficient of consolidation (cm ² /s)	C _v	3.04E-04	3.34E-04	2.73E-04	2
16	Preconsolidation pressure (kg/cm ²)	P _c	1.850	2.165	1.534	2
17	Coefficient of volumn compressibility (cm ² /g)	M _v	7.59E-05	7.65E-05	7.52E-05	2
18	Permeability (cm/sec)	k ₂₀	1.96E-08	2.14E-08	1.78E-08	2