

#### 1.4 . Layer 4: Stiff, low plasticity, yellowish brownish grey SANDY CLAY (CL)

It was found at boreholes DSS-1, DSS-2 and DSS-4. Thickness is from 2.0m (DSS-4) to 4.5m (DSS-2) and the layer bottom is from 5.0m (DSS-4) to 7.0m (DSS-4) deep. Standard penetration resistance N from 6 to 14. In total, 7 samples were taken from this layer, the obtained physico-mechanical properties of the samples have shown that, natural moisture is from 18.13% to 33.04%, wet density from 1.872 to 2.076g/cm<sup>3</sup>, liquid limit from 27.4 to 46.1%, plasticity index from 8.1 to 22.1% (see average value of the physico-mechanical properties - table 2). The main characteristics of the layer are as follows :

Wet density	$\gamma_w$	=	1,978 g/cm <sup>3</sup>
Unconfined compressive strength	$q_u$	=	0.555 Kg/cm <sup>2</sup>
Compression index	$C_c$	=	0.175 cm <sup>2</sup> /kg
Coefficient of consolidation	$C_v$	=	8.09 x 10 <sup>-4</sup> cm <sup>2</sup> /s
Coefficient of volume compressibility	$m_v$	=	4.52 x 10 <sup>-5</sup> cm <sup>2</sup> /g

#### 1.5 . Layer 4a: Stiff, high plasticity, brownish grey CLAY (CH)

It was found at the boreholes DSS-3 and DSS-4. The thickness is from 1.6m (DSS-4) to 2.5m (DSS-3) and the depth of the layer bottom is from 5.0m (DSS-4) to 5.5m (DSS-3). Standard penetration resistance from 12 to 15. In total, 2 samples were taken from this layer, the obtained physico-mechanical properties of the samples have shown that, natural moisture is from 20.69% to 24.81%, wet density from 1.950 to 2.081g/cm<sup>3</sup>, liquid limit from 50.5% to 56.5%, plasticity index is from 27.3% to 31.7%, (see average value of the physico-mechanical properties - table 3). The main characteristics of the layer are as follows :

Wet density	$\gamma_w$	=	2,016 g/cm <sup>3</sup>
Unconfined compressive strength	$q_u$	=	0.806 Kg/cm <sup>2</sup>
Compression index	$C_c$	=	0.1285 cm <sup>2</sup> /kg
Coefficient of consolidation	$C_v$	=	9.97 x 10 <sup>-4</sup> cm <sup>2</sup> /s
Coefficient of volume compressibility	$m_v$	=	1.99 x 10 <sup>-5</sup> cm <sup>2</sup> /g

#### 1.6 . Layer 4b: Loose, whitish yellowish grey SAND (SC)

Was found at all the boreholes. The thickness is from 6.0m (DSS-4) to 13.0m (DSS-2) and the depth of the layer bottom is from 10.0m (SS-03 and DSS-5) to more 30.0m. at the boreholes SS-03, DSS-5 with 30.0m depth, its thickness has not been determined yet. Standard penetration resistance from 6 to 17, sometimes to

28. In total, 22 samples were taken from this layer, the obtained physico-mechanical properties of the samples have shown that, natural moisture is from 14.54% to 21.65%, wet density from 1.930 to 2.168g/cm<sup>3</sup>, liquid limit from 17.9% to 61.6%, plasticity index is from 4.1% to 32.8% (see average value of the physico-mechanical properties - table 4). The main characteristics of the layer are as follows :

Wet density	$\gamma_w$	=	2,079 g/cm <sup>3</sup>
Unconfined compressive strength	$q_u$	=	0.774 Kg/cm <sup>2</sup>
Compression index	$C_c$	=	0.139 cm <sup>2</sup> /kg
Coefficient of consolidation	$C_v$	=	8.21 x 10 <sup>-4</sup> cm <sup>2</sup> /s
Coefficient of volume compressibility	$m_v$	=	3.52 x 10 <sup>-5</sup> cm <sup>2</sup> /g

#### 1.7. Layer 4c: Medium dense, yellowish grey POORLY DRADED SAND with SILT (SP-SM).

Was found only at the borehole SS-06. The thickness is 10.5m and the depth of the layer bottom is 23.5m. Standard penetration resistance from 11 to 16. One sample was taken from this layer, the obtained physico-mechanical properties of the samples have shown that, natural moisture is 10.16%, wet density 2.135g/cm<sup>3</sup>. (see average value of the physico-mechanical properties - table 5).

#### 1.8 . Layer 4d: Medium dense, yellowish grey SILTY SAND (SM)

Was found at all the boreholes. The thickness is from 3.0m (SS-05) to more 29.0m (DSS-4) and the depth of the layer bottom is from 19.0m (SS-03) to more 40.0m (DSS-4). Standard penetration resistance from 10 to 30. In total, 29 samples were taken from this layer, the obtained physico-mechanical properties of the samples have shown that, natural moisture is from 11.42% to 19.39%, wet density from 1.892 to 2.190g/cm<sup>3</sup>, liquid limit from 15.3% to 22.1%, plasticity index is from 2.4% to 6.4% (see average value of the physico-mechanical properties - table 6). The main characteristics of the layer are as follows :

Wet density	$\gamma_w$	=	2,088 g/cm <sup>3</sup>
Compression index	$C_c$	=	0.101 cm <sup>2</sup> /kg
Coefficient of consolidation	$C_v$	=	8.98 x 10 <sup>-4</sup> cm <sup>2</sup> /s
Coefficient of volume compressibility	$m_v$	=	3.05 x 10 <sup>-5</sup> cm <sup>2</sup> /g
Angle of internal friction	$\Phi_d$	=	32° 37'
Cohesion	$C_d$	=	0.031 Kg/cm <sup>2</sup>

**1.9 . Layer 4e: Medium dense, yellowish brown well graded SAND with SILT (SW-SM)**

It was found at the boreholes SS-04 and SS-06. The thickness is from 3.0m (SS-06) to more 3.0m (SS-06) and the depth of the layer bottom is from 26.0m (SS-04) to more 30.0m (SS-06). Standard penetration resistance from 10 to 18 (sometimes smaller 10). In total, 20 samples were taken from this layer, the obtained physico-mechanical properties of the samples have shown that, natural moisture is from 10.31% to 20.34%, wet density from 1.603 to 2.121g/cm<sup>3</sup>, liquid limit is 20.6%, plasticity index is 7.1%.

***Hydrogeological conditions***

At the surveying area, the groundwater level is affected by the tide and changeable according to seasons. The depth of the groundwater level in the boreholes during the investigation time is from -0.9 to -1.2m. (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: 1

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	2
	#16 (1.18 mm)		98.8	99.2	98.3	2
	#30 (0.6 mm)		97.9	98.9	96.9	2
	#50 (0.3 mm)		95.8	97.7	93.8	2
	#100 (0.15 mm)		90.8	91.4	90.1	2
	#200 (0.075 mm)		84.9	86.7	83.0	2
	< 0.005 mm		51.9	56.7	47.0	2
2	Natural moisture content (%)	w	62.45	76.13	48.76	2
3	Natural unit weight (g/cm <sup>3</sup> )	$\gamma$	1.592	1.697	1.486	2
4	Dry unit weight (g/cm <sup>3</sup> )	$\gamma_d$	0.992	1.141	0.844	2
5	Specific gravity	Gs	2.588	2.599	2.577	2
6	Porosity	n	0.620	0.680	0.560	2
7	Void ratio	$e_v$	1.670	2.080	1.259	2
8	Degree saturation (%)	S	97.50	99.80	95.10	2
9	Liquid limit (%)	LL	69.6	88.4	50.7	2
10	Plastic limit (%)	LP	36.4	42.9	29.8	2
11	Plastic index (%)	PI	33.2	45.5	20.9	2
12	Water plasticity ratio (%)	B	0.82	0.91	0.73	2
13	Unconfined compression (Kg/cm <sup>2</sup> )	qu	0.225	0.330	0.120	2
14	Compression index (cm <sup>2</sup> /kg)	Cc	0.9430	1.0670	0.8200	2
15	Coefficient of consolidation (cm <sup>2</sup> /s)	Cv	4.40E-04	4.52E-04	4.27E-04	2
16	Preconsolidation pressure (kg/cm <sup>2</sup> )	Pc	1.499	1.665	1.233	2
17	Coefficient of volum compressibility (cm <sup>2</sup> /g)	Mv	6.87E-05	6.88E-05	6.85E-05	2
18	Permeability (cm/sec)	k20	2.54E-08	2.62E-08	2.45E-08	2

## AVERAGE VALUE OF PHYSICA - MECHANICAL PROPERTIES

Layer 4 : Stiff, low plasticity, yellowish brownish grey SANDY CLAY (CL)

Table: 2

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)		98.2	100.0	90.1	7
	#30 (0.6 mm)		95.8	100.0	86.1	7
	#50 (0.3 mm)		89.7	100.0	75.7	7
	#100 (0.15 mm)		80.0	100.0	57.8	7
	#200 (0.075 mm)		70.8	98.4	53.1	7
	< 0.005 mm		38.2	53.9	28.8	7
2	Natural moisture content (%)	w	25.26	33.04	18.13	7
3	Natural unit weight (g/cm <sup>3</sup> )	$\gamma$	1.978	2.076	1.872	7
4	Dry unit weight (g/cm <sup>3</sup> )	$\gamma_d$	1.584	1.731	1.420	7
5	Specific gravity	Gs	2.675	2.700	2.602	7
6	Porosity	n	0.410	0.470	0.350	7
7	Void ratio	$e_v$	0.699	0.899	0.546	7
8	Degree saturation (%)	S	96.30	99.30	88.80	7
9	Liquid limit (%)	LL	38.6	46.1	27.4	7
10	Plastic limit (%)	LP	25.1	27.9	15.8	7
11	Plastic index (%)	PI	17.1	22.1	8.1	7
12	Water plasticity ratio (%)	B	0.27	0.66	-0.09	7
13	Unconfined compression (Kg/cm <sup>2</sup> )	qu	0.555	0.779	0.388	4
14	Compression index (cm <sup>2</sup> /kg)	Cc	0.1750	0.2360	0.0950	3
15	Coefficient of consolidation (cm <sup>2</sup> /s)	Cv	8.09E-04	9.50E-04	7.17E-04	3
16	Preconsolidation pressure (kg/cm <sup>2</sup> )	Pc	0.581	0.736	0.426	3
17	Coefficient of volum compressibility (cm <sup>2</sup> /g)	Mv	4.52E-05	5.25E-05	3.75E-05	3
18	Permeability (cm/sec)	k20	3.51E-08	3.83E-08	3.18E-08	3