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Research Article

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Evaluation of Soil Engineering Characteristics of Some Soils in Entisol and Inceptisol

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Abstract The soils of the research area are classified in Entisol and Inceptisol Orders. Entisol Order is classified in Typic Xerofluvent Subgroup, Inceptisol Order is classified in Fluventic Haploxerept, Calcic Haploxerept, Typic Haploxerept subgroup. The adhesion, cohesion and shear resistance values of the soils and therefore the behavior of the soils against cultivation and depending on the soil engineering properties are very different. For this reason, the functions of moisture in soils should be well evaluated in the mechanization conditions of soils. Otherwise, air, water and communication will be adversely affected by compaction layers, which are undesirable in the soil, and decreasing porosity rates, and root development will not be under normal conditions, and undesirable physical conditions occur. The liquid limit values of the soils entering the Entisol Order vary between 30.60% and 58.60% in surface horizons, and between 35.90% and 56.60% in subsurface horizons. Differences in liquid limit values are due to the privileges in the clay fractions of the soils. The liquid limit values of the soils entering the Inceptisol Orders vary between 27.80-40.10%. The plastic limit values of Entisol Order soils vary between 14.17-26.55% and 9.86-16.92% of Inseptisol Order soils. Classification according to the Casagranda plasticity card is CL- moderately plastic inorganic clays for Ineptisol Order, while Entisol Order is classified as CH- Excess plastic inorganic clays. The moisture value, which provides the most suitable tempering conditions, varies between 16±1-23±1 in Entisol Orders soil and 12.5±1-18±1 in Inceptisol Orders.

Keywords Soil mechanics, Suitable annealing conditions, Liquid limit, Plastic limit

Introduction

Peneplain plain is dominant in large areas located in the south of Yıldız Mountains in Thrace. This plain has drawn its final border with the Sea of Marmara with the Oligocene marine sediments in the Tekirdag region [1], forming sea terraces. Meanwhile, different geological deposits were formed by terrestrial events. In addition, different geological deposits were formed by terrestrial events. These formations have vertically split the alluvial deposits in the Quaternary and deposited new alluvial deposits and a wide variety of materials, especially in the Holocene. This situation continues along the northern shores of the Sea of Marmara. Apart from the different structures of the parent material, the topographic conditions of the region also cause the formation of a wide variety of soils with catenasal and toposequens relationships. The reasons for the formation of soils, the development of different profiles in different geomorphological units, the catenasal (the formation of soil profiles with different characters due to the changes in natural drainage and relief) are in relation and their privileges are described by toposequens (From the arrangement of the related soils, it is primarily examined under the conditions of the formation of soils that are different from the others due to topography, which is one of the soil-making factors [2].

Cangir and Ekinci [3], engineering properties were determined in each horizon of the model profiles at large group levels of soils with xeric and ustic moisture regime belonging to Entisol, Inceptisol, Mollisol and Vertisol orders formed on Oligocene, Miocene and Pliocene sediments within the borders of Tekirdag province. In addition, basic data on land use are presented.

One of the prerequisites for the planning and management of agriculture is the use of agricultural land in accordance with the natural quality and ability of the land, in line with the sustainable land management theories that should be applied. In this, the characteristics of the soils should be defined, the tillage conditions should be determined and their position in nature should be well examined.

Materials and Methods

The topography of the Kayı and Aydınpınar streams drainage network system, which is within the borders of Tekirdag Süleymanpaşa, was studied in the topography of the Oligocene marine and quaternary aged low and high sea-floor area forming the toposequens relationship. Main material properties of investigation profiles obtained from field observations; The main materials of profiles KA1, KA6 and KA7 are composed of Oligocene marine (marine) sediments and represent the highlands in the study area. The sediments at this location form the sea terraces of the regressive series that precede the present sea coastline. Profile numbered KA2 was studied at the mouths of Aydınpınar stream and profile KA3 at the side stream mouths of Kayı stream. The main materials of these profiles are formed from the old river sediments of the region; it was formed by the transportation of marine sediments located behind the river bed. While the sediments in the area of profile KA5 are composed of the old Quaternary sediments of Kayı stream; The main materials of profiles KA4 and KA8 are composed of young alluvial deposits of the same stream. The main material of profile KA9 was formed by the transport of marine sediments in and around the location of profile KA6 by mud currents proportionally to the slope. Soils classified in the 2 Entisol and 7 Inceptisol Orders show distribution in the study area. The general soil properties of the soils are explained in [2].

Grain size distribution (Texture) and sand fractions in the research soils; It was determined according to the hydrometer method [4]. The texture triangle was used in naming the texture classes [5]. The amount of moisture in the soil; samples were found by keeping them in a drying oven at a constant temperature of 105 °C [6]. Atterberg limits; liquid limit was determined by AASHO T 89-60 method, plastic limit was determined by AASHO T 90-56 method and proctor was determined according to AASHO T 99-57 method [7]. Plasticity index; it was found by subtracting the plastic limit from the liquid limit. Clay activity; it was calculated by dividing the plasticity index by the clay ratio [8]. The Casagranda Classification was made using the Casagranda plasticity card in the obtained liquid limit and plasticity index values [9]. The classification of the research soils was made according to the Soil Survey Staff, [10].

Results & Discussion

According to the location of surface horizons and subsurface horizons that will affect soil engineering properties, liquid limit, plastic limit and plasticity index from Atterberg Limits, classes according to casagranda plastic card, AASHO evaluation results, combined group (USC) classes, clay activity and proctor (humidity-maximum density relationship) are given in Table 1 and 2.

Table 1: Soil Engineering Properties of Epipedon (Surface Horizon) and Subsurface Horizons of Entisol Order Soils.

Profile	Horizon	Depth (cm)	Clay (%)	Classification 1	2	3	4	5	6	7	8	9
	Ap	0-14	39.81	58.60	19.87	38.73	CH	A-7- 6(20)	CH*	0.97	19.7	23±1
KA4	2A	14-35	30.62	56.60	22.25	34.35	CH	A-7- 6(18)	CH*	1.12	19.2	23±1
	3A	35-56	26.84	57.80	19.80	38.00	CH	A-7- 6(17)	CH*	1.42	19.5	23±1
KA8	Ap	0-24	18.27	30.60	15.91	14.69	CL	A-6 (7)	CL*	0.80	13.8	16±1
	2C	24-48	20.76	35.90	14.17	21.73	CL	A-6 (11)	CL*	1.05	14.7	16±1

1)Liquid Limit, 2) Plastic Limit, 3) Plasticity Index, 4) Explanation According to Casagranda Plasticity Card (CL- Moderate plastic inorganic clays; CL- Low plastic inorganic clays, lean clays, cohesionless soils; CH- Excess plastic inorganic clays), 5) AASHO Group index, 6) Combined Group (USC), 7) Clay Activity, 8) Proctor % (Humidity-maximum density relationship), 9) Moisture (%) that provides the most suitable annealing condition.

*CL- Low to medium plastic inorganic clay. *ML- Inorganic silt, low, plastic clayey, fine sand. *CH- High plastic clays, oily clays.

Table 2: Soil Engineering Properties of Epipedon (Surface Horizon) and Subsurface Horizons of Inceptisol Order Soils

Profile	Horizon	Depth (cm)	Clay (%)	Classification 1	2	3	4	5	6	7	8	9
	Ap1	0-13	32.35	39.69	13.44	26.25	CL	A-6 (12)	CL*	0.81	15.5	13±1
KA1	Ap2	13-19	34.77	39.00	12.80	26.20	CL	A-6 (11)	CL*	0.75	15.4	13±1
	AB	19-32	30.74	38.50	15.59	22.91	CL	A-6 (10)	CL*	0.74	15.9	13±1
	Bw1	32-53	34.07	39.87	14.13	25.74	CL	A-6 (11)	CL*	0.76	16.3	14±1
	Ap1	0-15	27.21	37.60	15.25	21.77	CL	A-6 (10)	CL*	0.80	14.8	16±1
KA2	Ap2	15-27	31.50	39.02	15.49	23.53	CL	A-6 (10)	CL*	0.75	15.8	16.5±1
	AB	27-42	33.85	36.41	16.92	19.49	CL	A-6 (8)	CL*	0.58	14.9	16±1
	Ap1	0-10	39.90	40.10	13.55	26.55	CL	A-6 (13)	CL*	0.67	16.1	13.5±1.5
KA3	2Ap2	10-18	24.68	27.80	11.34	16.46	CL[a)]	A-6 (3)	ML*	0.67	11.6	13±1
	2Ap3	18-25	23.81	27.85	9.86	17.99	CL[a)]	A-6 (3)	ML*	0.69	10.8	13±1
	2Bw1	25-52	21.63	29.05	13.39	15.66	CL[a)]	A-6 (2)	ML*	0.72	12.8	15±1.5
	Ap	0-10	33.73	37.10	11.77	25.33	CL	A-6 (11)	CL*	0.75	15.4	12±2.5
KA5	Bw	10-35	31.81	37.83	12.56	25.27	CL	A-6 (12)	CL*	0.79	15.8	13±1.5
	2A	35-65	32.15	36.10	12.41	23.69	CL	A-6 (11)	CL*	0.74	15.5	12.5±1.5
KA6	Ap1	0-19	26.34	35.50	15.02	20.48	CL	A-6 (10)	CL*	0.78	14.8	17±1.5
	Ap2	19-30	21.26	34.12	15.19	18.93	CL	A-6 (8)	CL*	0.89	14.6	17±1.5
	AB	30-44	24.36	33.10	14.07	19.03	CL	A-6 (9)	CL*	0.78	13.9	16±1.5
KA7	Ap1	0-13	24.49	37.37	13.86	23.51	CL	A-6 (10)	CL*	0.96	14.5	17±1.5
	Ap2	13-24	28.97	36.00	14.42	21.58	CL	A-6 (11)	CL*	0.75	14.8	17±1.5
	A	24-36	24.81	36.10	15.10	21.00	CL	A-6 (9)	CL*	0.84	16.1	18±1
	Ad	36-58	26.47	36.30	14.96	21.34	CL	A-6 (8)	CL*	0.81	15.4	17±1
KA9	Ap	0-15	14.14	36.50	13.74	22.76	CL	A-6 (9)	CL*	1.61	14.9	17±1.5
	Bw	15-140	18.63	34.10	14.81	19.29	CL	A-6 (9)	CL*	1.04	13.4	16±1.5

1)Liquid Limit, 2) Plastic Limit, 3) Plasticity Index, 4) Explanation According to Casagranda Plasticity Card (CL- Moderate plastic inorganic clays; CL- Low plastic inorganic clays, lean clays, cohesionless soils; CH-Excess plastic inorganic clays), 5) AASHO Group index, 6) Combined Group (USC), 7) Clay Activity, 8) Proctor % (Humidity-maximum density relationship), 9) Moisture (%) that provides the most suitable annealing condition.

*CL- Low to medium plastic inorganic clay. *ML- Inorganic silt, low, plastic clayey, fine sand. *CH- High plastic clays, oily clays.

From the atterberg limits of the lands entering the Entisol Order; liquid limit values were varied between 58.60% and 56.60% in the surface and subsurface horizons of the KA4 profile; It was determined as 30.60% and 35.90% in the surface and subsurface horizons of the KA8 profile. The differences in the liquid limit values determined in the horizons of both profiles are due to the privileges in the clay fractions of the soils.

While the plastic limit values vary between 19.80% and 22.25% in the KA4 profile, it is 15.91% and 14.17% in the epipedon and sub-surface horizons in the KA8 profile. Soils with a relatively high proportion of smectite clay have lower load bearing capacities than other soils. At the same time, another indicator of the load-bearing capacity of the soil is the moisture content in plastic limit conditions such as liquid limit. While the load carrying capacity increases in conditions below the plastic limit value, there is a sudden decrease as it approaches the liquid limit value above this value. Therefore, the plastic limit value gains importance for processing with the annealing conditions of the soils and appropriate tillage techniques.

The difference between the liquid limit and the plastic limit gives the plasticity index and is an important criterion for tillage. With the increase of the plasticity index, the annealing condition of the soils worsens. The plasticity index of the profile no. KA4 is much higher than the profile no. KA8. Plasticity index and clay activities also indicate the behavior of the soil against swelling and shrinkage. They are active in terms of clay activities.

According to the Casagranda plasticity card, since the liquid limit values in the KA4 profile are above 50% and the "A" line, they are classified as excessive plastic inorganic clays. In profile KA8, on the other hand, since the liquid limit values are above 30% and the "A" line, they are classified as moderately plastic inorganic clays. According to the AASHO classification, the KA4 profile is classified in the A-7-6 class, and the KA8 numbered profile is in the A-6 class.

The group index of the AASHO classification in profile KA4 is over 17 in horizons within 56 cm depth, and the group index in profile KA8 is 7 in epipedon and 11 in parent material. With these features, the structure of the KA4 profile is worse than the KA8 profile in terms of soil engineering. In the combined group classification established according to the texture of the soil, its plasticity properties and its quality as a construction material; Profile KA8 was classified as low to medium plastic inorganic (CL), while profile KA4 was determined in high plasticity inorganic clays, oily clays (CH) class.

While humidity-maximum humidity value (proctor) is determined around 19.5% in the KA4 profile; In the KA8 profile, this value is 13.8% in the epipedon and 14.7% in the main material within 48 cm of depth. In these humidity conditions, traffic should not be allowed on the land. Considering the engineering properties of the soils, 23±1% around the KA4 profile and 15-17% humidity around the KA8 profile, taking into account the subsoil layer, should be plied and traffic should be allowed.

In Figure 1, the granulation curves of the surface horizons of the exploration profiles are given. When evaluated according to the granulation curves, the profile KA4 creates a clay-silt uniform (significantly graded) horizontal striped curve; Profile numbered KA8 forms a variable (well graded) flat inclined curve from fine silt to fine sand.

When we evaluate the Atterberg limits of the soils entering the İnceptisol Orders; Liquid limit values vary between 33.10% and 39.87% in profiles KA1, KA2, KA5, KA6, KA7 and KA9. However, while it is 40.10% in the surface (Ap1) horizon of the profile no. KA3 that is deposited and deposited, 27.80% in the sub-horizons constituting the lithological profile; 27.85%; It is 29.05% and below 30%. Plastic limit values also have the lowest value in this profile. It was determined that the plastic limit values of the other profiles varied between 11.77% and 15.59%.

According to the Casagranda plasticity card, except the KA3 profile, the others are classified as moderately plastic inorganic clays because their liquid limit values vary between 30% and 50%. The KA3 profile, on the other hand, is classified as low-grade plastic inorganic clays, lean clays-cohesionless soils, since the liquid limit values of the others, except for the Ap1 horizon, are below 30%. The Ap1 horizon is classified as moderately plastic inorganic clays.

According to the AASHO classification, all profiles were determined in the A-6 group index. In the unified soil classification established according to the texture of the soils, plasticity properties and quality as a construction material, the profiles other than KA3 (including the Ap1 horizon) are in the class of plastic inorganic clays from low to medium, while the profile no. KA3 (2Ap2, 2Ap3, 2Bw1) is inorganic silt, low, it is classified in plastic clayey, fine sandy class. All of them are active in terms of clay activities.

In the KA1 profile, the humidity-maximum humidity value (proctor) varies between 15-16.5%. Land traffic should not be allowed in these humidity conditions. The KA1 profile and the surface and sub-surface horizons of its surroundings should be plowed under the tempering conditions of 13-14% humidity. Soil tillage operations should be done in suitable tempering conditions of 15.5-17.5%. In the KA3 profile, with a value of 16.1 in the epipedon, the sub-horizons vary between 10.8-12.8%. The most suitable annealing conditions for the version of this profile and its surroundings are between 13.5-14% humidity. The proctor of the KA5 profile is around 15.5% and plowing should not be done in these humidity conditions, but the ideal annealing conditions for plowing vary between 11.5-14%. While the maximum humidity value of the KA6 profile is 14.5%; ideal annealing conditions should be in the humidity range of 15.5-17.5%. The humidity-maximum humidity value of the KA7 profile is 14.5%-16.1%. In this range, land traffic should not be allowed in the humidity range and plow should be done in the humidity range of 16.5-18%. However, since there is an Ad horizon in profile KA7, bottom blasting is required with a ripper from below 65 cm in the driest period of the soil. While the humidity-maximum humidity value of the profile no. KA9 varies between 13.4-14.9%, plowing should not be allowed. Suitable annealing conditions for plowing are in the 16-17% humidity range (Table 2).

When we evaluate according to the granulation curves; Profiles KA1, KA2, KA5, KA6, KA7 form variable (well graded) flat inclined curves from clay to fine sand. While the profile no. KA3 creates a clay-silt uniform (badly graded) horizontal striped curve; The KA9 profile forms a variable curve from fine silt to fine sand (Figure 1).

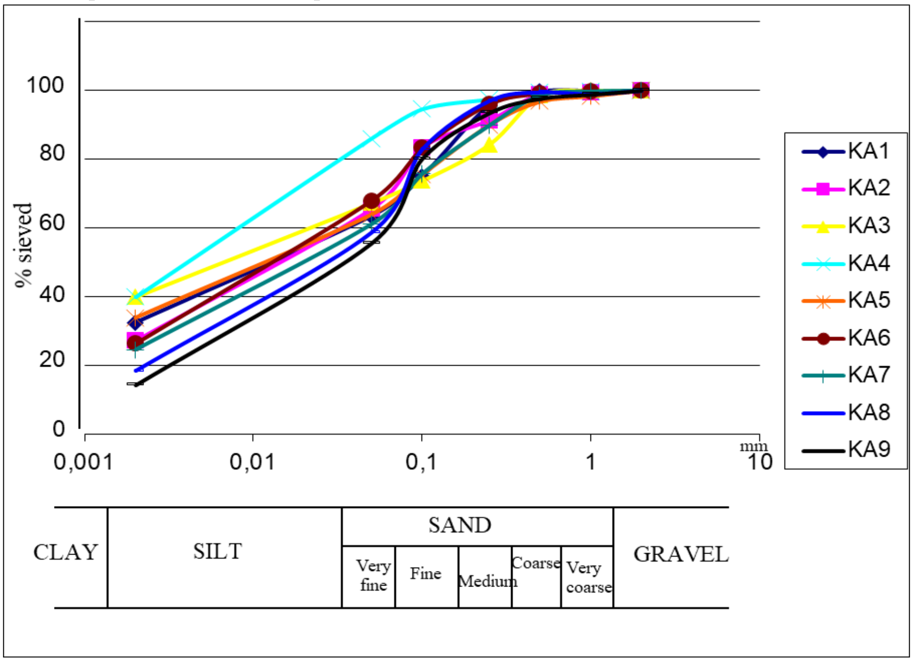

Figure 1: Granulation curves of surface horizons of survey profiles

Conclusion

Tillage is the mechanical preparation of the soil and increasing granulation by arranging loosening, mixing, crumbling and turning events in order to create ideal root growth layers, by providing a good seed bed and germination environment for the cultivation of cultivated plants. The adhesion, cohesion and shear resistance values of each privileged soil are very different, depending on the soils' behavior against cultivation and soil engineering properties. For this reason, the functions of moisture in soils should be well evaluated in the mechanization conditions of soils. Otherwise, air, water and communication will be adversely affected by compaction layers, which are undesirable in the soil, and decreasing porosity rates, and root development will not be under normal conditions, and undesirable physical conditions will occur [11]. In order to prevent the formation of undesirable lumpy soils, not to indirectly increase the number of operations in mechanization, and to ensure granulation at the intersection of adhesion and cohesion under normal annealing conditions without increasing the shear or friction strength of soil tillage tools, and to minimize soil compaction, moisture conditions of the soils should be taken into consideration.

As seen in the research soils, the annealing conditions for tillage also differ depending on the clay content. By knowing the clay amount of the soils well, plow should be made at the appropriate moisture content for the purpose of tillage.

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