

## Research Article

# Influence of Organic Matter Content on Engineering Properties of Clays

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Most natural sedimentary clay contains organic matter, and even a small amount of organic matter will have a great impact on the physical and mechanical properties of clay. In order to clarify the influence of organic matter content on clay soil, the illite-quartz mixture was mixed with natural amorphous peat soil (organic matter content is 50%) in different proportions for studying the influence of different organic matter contents on the physical properties (specific gravity,  $G_s$ ; moisture content,  $w$ ; void ratio,  $e$ ; liquid limit,  $w_L$ ; plastic limit,  $w_p$ ; plasticity index,  $I_p$ ) and shear characteristics (cohesion,  $c$ ; friction angle,  $\varphi$ ) of clay soil. The experimental results found that, with the change of organic matter content, the specific gravity and void ratio of clay changed linearly, while the water content, Atterberg limit, shear strength, cohesion, and friction angle changed nonlinearly with the increase of organic matter content. Moisture content and Atterberg limit have a turning point when  $OC = 7.5\%$ . Shear strength, cohesion, and friction angle all have obvious turning points when  $OC = 7.5\%$  and  $OC = 37.5\%$ . The variation of moisture content and Atterberg limit with organic matter content indicates that  $OC = 7.5\%$  may be the limit value for the different forms of organic matter in the clay. When  $OC \leq 7.5\%$ , the organic matter in clay is in the bound state; when  $OC > 7.5\%$ , the bound organic matter reaches saturation; and the free organic matter gradually increases. The change law of shear strength characteristics with organic matter content shows that the interaction between minerals and organic matter exhibits different shear characteristics under different organic matter content. When  $OC \leq 7.5\%$ , clay shows mineral properties, when  $7.5\% < OC \leq 37.5\%$ , clay shows mineral-free organic matter properties, and when  $OC > 37.5\%$ , clay shows free organic matter properties.

## 1. Introduction

Naturally, sedimentary clay often contains organic matter, but the content and type of organic matter have significant differences [1–4]. Different contents and different organic matter forms have significant effects on the structure and properties of mineral soil. In road construction, the road will inevitably cross the high organic soil or peatland area. The organic soil and peat with high moisture content, high compressibility, and low bearing capacity are not suitable for constructing embankments and highways, so the use of Preloading methods, Deep cement mixing, and Excavation-Replacement methods to treat the subgrades is becoming more common [5–7]. However, how to evaluate the influence of organic matter content on soil

engineering properties of clay is still not well understood. The study of the impact of the content and type of organic matter on clay's engineering properties is significant in guiding roadbed engineering design and construction [8–10].

Many scholars have used different methods to study the influence of organic matter on soil's engineering properties. According to the summary of the research methods of the influence of organic matter on soil's engineering properties, the main research methods can be organized into 3 classes. The first method is to collect soil samples with different organic matter contents in multiple areas and then analyze the influence of organic matter contents on the soil's engineering properties. For example, Odell et al. [11] studied 26 groups of different organic soil in Illinois, and the

influence of organic matter content on the Atterberg limit was analyzed. It was found that the Atterberg limit increased with the increase of organic matter content. They also found that organic matter was responsible for most of the variability observed in the samples' plastic limit values; Bush and Keller [12] studied the physical properties of sediments in the two areas of Peru-Chile continental slope and eastern Nazca Plate. The results show that the moisture content and Atterberg limit of sediment are positively correlated with organic matter content; Bennett et al. [13] studied the relationship between organic matter and sediment properties in the two continental margins of the United States. It has been found that moisture content, Atterberg limit, and particle content closely related to organic matter content. However, they concluded that the correlation between organic matter content and Atterberg was not strong enough to imply significant interdependence. Due to different sources of organic matter and different mineral compositions in organic soil in different regions, the biggest drawback of this method is the case that while the organic matter content changes, the mineral and organic matter composition of the soil also change. Another common method is to prepare organic clay composites by adding organic compounds to pure mineral soil. For example, Olgun and Yıldız [14] mixed methanol, ethanol, isopropanol, acetic acid, and distilled water in different proportions and added them to the soil collected from Aksaray city of Turkey to prepare organic soil with different organic matter contents. The Atterberg limit of soil was measured, and triaxial compression tests were performed. The results showed that the liquid limit and plasticity index decreased with increasing ratio of organic matter content to moisture content, and the soil with methanol as the organic matter has a lower compression index and swelling index than other organic soils. Zeng et al. [15] mixed water-insoluble organic matter (humic acid) and water-soluble three organic matters (humic acid phthalein, potassium humate, and fabric acid) with eight clays (six natural clays and two pure mineral clays). The organic compounds of different minerals and different organic matter were prepared, and the physical properties of various organic compounds were studied. The results show that the Atterberg limits of clay with different minerals and different organic matter compositions are quite different. However, this organic compound's composition differs significantly from that of natural organic matter in the soil, which cannot completely take into account the actual situation. Some scholars also deal with organic soil by chemical means to regulate the organic matter in the soil. For example, Roshid and Brown [16] used hydrogen peroxide to remove organic substances from the original soil and then added humic acid to prepare organic soil with organic matter content of 0%~4%, and the engineering properties of soil with different organic matter contents were studied. The results showed that the plasticity, undrained shear strength, and compressibility of soil increased with organic matter content. Booth and Dahl [17] removed the organic matter from sedimentary soil by using hydrogen peroxide solution and then mixed them with original sedimentary soil in proportion to prepare samples of different

organic matter content (0.57%~3.2%). The results show that organic matter has a significant correlation with liquid limit, plasticity index, and specific gravity. However, this method was complex, time-consuming, and laborious and was only suitable for soil samples with minimal organic content.

Besides, the current research on the relationship between the organic matter and the engineering properties of clays is still concentrated in a relatively small range ( $0\% \leq OC \leq 20\%$ ) [11–13, 16–19]. For example, Hameedi et al. [20, 21] and Fattah et al. [22] studied the engineering properties of clay with organic matter content of 2~15% in southern Iraq. However, for special clays such as organic soil and peat, the content of soil organic matter mostly exceeds 20% [23–25]. Aiming at the above shortcomings, the illite-quartz mixture and natural amorphous peat soil (50% organic matter content) were mixed in different proportions to prepare 12 sets of clay soils with the same mineral composition and different organic matter content (0%~50%). This article's primary purpose is to clarify the influence of organic matter content on clay soil's physical and mechanical properties. On the other hand, this study analyzed the threshold of different organic matter (bound and free) forms and the influence of the interaction between organic matter and minerals in different forms on the shear characteristics of clayey soil.

## 2. Materials and Methods

*2.1. Materials.* Natural peat soil samples are collected from the engineering site near Dianchi Lake in Kunming City, Yunnan Province, China, as shown in Figures 1(a) and 1(b). Manual sampling is shown in Figure 1(c). The sample is shown in Figure 1(d). The test results are shown in Table 1. Among them, the ignition loss ( $w_u$ ) was determined for all peat soil samples to ASTM (D2974 2014) [26]; the fibers' content ( $w_f$ ) was determined for all peat soil samples to ASTM (D1997-13) [27], and according to ASTM (D4427 2013) [28] classification methods, it can be judged that the peat soil belongs to amorphous peat soil. X-ray diffractometry (XRD) tests were performed for identifying the mineralogical compositions of the peat soil. Specimens for XRD tests were prepared following the methods described by Whittig and Allardice [29]. Figure 2 presents the X-ray diffraction patterns of peat soil. The predominant clay mineral of the natural peat soil investigated is illite, with a proportion varying within the range of 75% to 85%, followed by quartz (10%~20%). According to the content ratio of illite to quartz in the amorphous peat soil, the mass ratio of illite to quartz in the mixture ( $d \leq 0.038$  mm) added to the test sample in this paper is 4 : 1. The mineral components of peat soil, illite, and quartz are shown in Table 2.

*2.2. Samples Preparation and Test Methods.* Remove residual fibers in the amorphous peat soil before proceeding with the sample, and distilled water was added to prepare a slurry sample with a water content of 2.0 times the liquid limit. The organic content of the slurries after fully mixing was measured to be 50%. The slurries with an initial organic

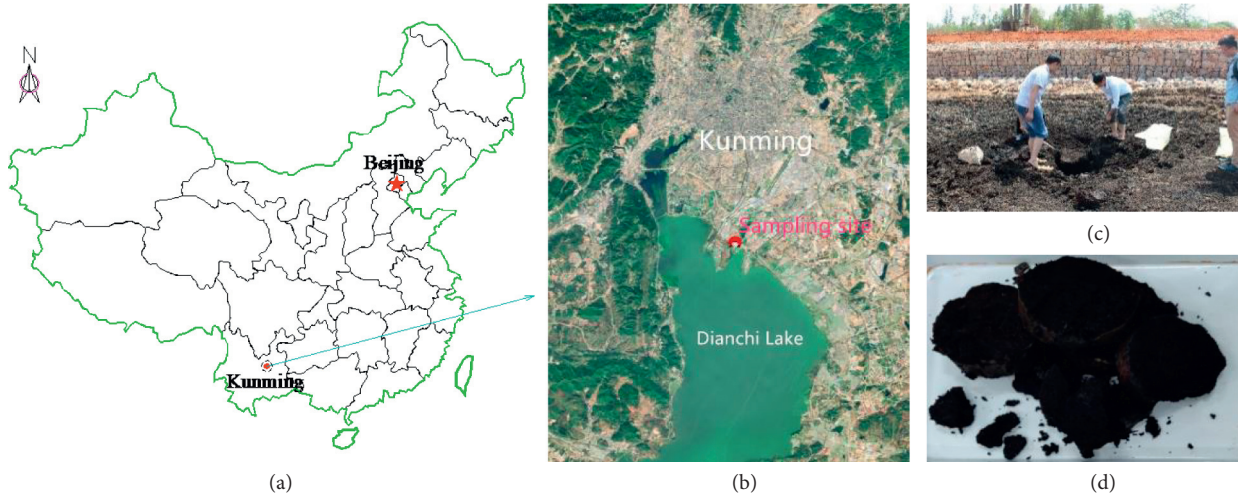


FIGURE 1: Sampling location, sampling process, and sample of peat soil. (a, b) Sampling site location. (c) Manual sampling. (d) Peat soil samples.

TABLE 1: Basic physical properties of peat soil.

$W$ (%)	$e$	$w_L$ (%)	$w_p$ (%)	$G_s$	$\rho$ ( $\text{g}\cdot\text{cm}^{-3}$ )	$w_u$ (%)	$w_f$ (%)
237.4	3.8	136.0	387.0	1.65	1.04	48.1–50.8	0.5–2.3

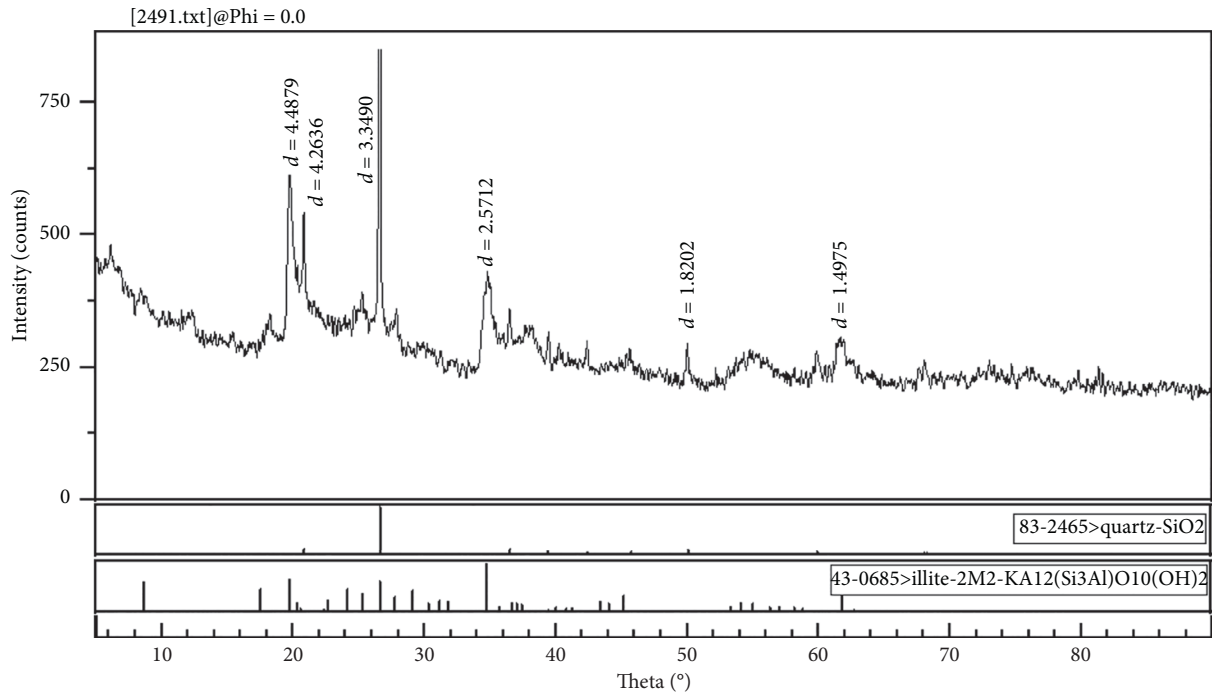


FIGURE 2: X-ray diffraction pattern of peat soil.

matter content of 50% were mixed with illite-quartz (with an organic matter content of 0%) in the required proportions to prepare samples with organic matter content ranging from 0% to 50% (as shown in Figure 3). The specimens were prepared by preconsolidating the clay slurries for 24 h. The slurries were preconsolidated by placing them into a cell

61.8 mm in diameter and 40 mm in height. The specimens were preconsolidated by pressure of up to 50 kPa by gradual pressure increase (12.5, 25.0, and 50.0 kPa) before measuring physical and mechanical parameters.

The physical properties measured consist of the specific gravity ( $G_s$ ), the water content ( $w$ ), and the Atterberg limits

TABLE 2: Chemical composition of peat soil, illite, and quartz sand.

Name	Peat soil	Illite	Quartz sand
SiO <sub>2</sub>	40.25	78.00	>98.00
Al <sub>2</sub> O <sub>3</sub>	21.37	12.33	1.00
TiO <sub>2</sub>	7.41	1.20	
K <sub>2</sub> O	1.55	7.80	
Na <sub>2</sub> O	2.48		
MgO	1.78		
MnO	1.53		
Others	0.21		

TABLE 3: Basic physical properties of samples.

No.	$w_u$ (%)	$G_s$	$e$	$W$ (%)	$w_L$ (%)	$w_P$ (%)	$I_P$ (%)
1	0.0	2.75	0.9	58.0	66	41	25
2	2.5	2.64	1.0	63.0	69	42	27
3	5.0	2.58	1.2	69.0	73	44	29
4	7.5	2.52	1.2	73.0	81	46	35
5	10.0	2.48	1.3	77.0	97	57	39
6	12.5	2.39	1.5	87.2	136	76	61
7	16.7	2.25	1.8	109.2	150	77	93
8	25.0	2.04	2.2	139.9	200	97	104
9	33.3	1.91	2.6	185.1	292	114	178
10	37.5	1.83	3.3	211.5	316	128	188
11	41.6	1.75	3.6	225.3	349	133	216
12	50.0	1.65	3.8	247.4	387	136	242

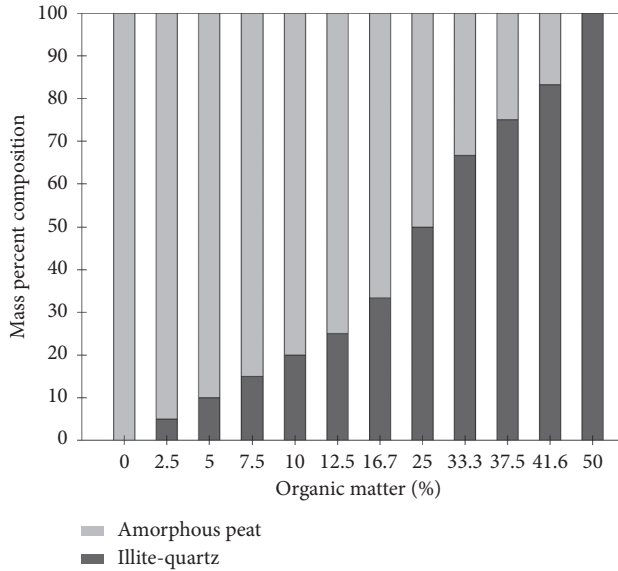


FIGURE 3: Proportion of samples with different organic matter content.

(liquid limit  $w_L$ ; plastic limit  $w_P$ ; and plastic index  $I_P$ ). The tests are undertaken according, respectively, to the test standards ASTM D854 [30]; ASTM (D2974-14) [26]; ASTM (D4318-17) [31].

It should be noted that until now a specific shear test method has not been introduced for peat soils to determine their shear strength parameters. But among conventional shear tests, the ring shear and direct simple shear tests in which the effect of fibers on test procedure is low were found to be more suitable [32]. Hence, this paper uses the direct shear test to test the shear strength of the specimens. Specimens are precompressed (the applied prepressure ( $\sigma_v$ ) was 50 kPa, 100 kPa, 150 kPa, and 200 kPa, resp.) before the shear test. The test is performed according to test standard ASTM (D3080/D3080 M – 11) [33].

### 3. Results and Discussion

**3.1. Physical Properties.** Before studying the influence of organic matter content on the shear properties of clay, the basic physical properties of each group of samples were evaluated. The underlying physical properties are shown in Table 3. The relation curve between different organic matter content and each index was drawn to further analyze each

physical index's change rule under different organic matter content.

**3.1.1. Effect of Organic Matter Content on Specific Gravity.** In previous studies [12, 24], the organic matter and mineral components of peat soil samples from different regions are quite different, the specific gravity of organic soil is not significantly correlated with the organic matter content, and the data is highly discrete. This may be due to the differences in minerals and organic matter and the small range of organic matter content. The effect of organic matter content on the specific gravity value ( $G_s$ ) is evident from Figure 4. The  $G_s$  values of the clays decrease linearly with the increase of organic matter content and have a high correlation ( $R^2 = 0.997$ ). The organic matter content increased from 0% to 50%, and the  $G_s$  values of the sample decreased from 2.75 to 1.65. The decrease in  $G_s$  values with the increase of organic matter is due mainly to the low value of the specific gravity of the organic matter [16, 17, 34, 35].

**3.1.2. Effect of Organic Matter Content on Void Ratio.** In Figure 5, the void ratio versus the organic matter content of the samples is reported. It can be seen that the void ratio increases with increasing organic matter content, and the correlation is very high ( $R^2 = 0.983$ ). Hamouche and Zentar [36] studied sediment with different organic matter and obtained the result that the void ratio increased with organic matter.

**3.1.3. Effect of Organic Matter Content on Moisture Content.** Hamouche and Zentar [36] found that the relationship between moisture content and organic matter content increases linearly. The relationship between organic matter content and moisture content in this paper is shown in Figure 6. It is worth noting that the relationship between moisture content and organic matter content is not a single linear increase. When OC = 7.5%, the straight line turns, and the slope increases from 2.040 to 4.497. Humus has a huge specific surface area and hydrophilic groups, and its strong water absorption is the main reason for the increase of soil moisture content [37].



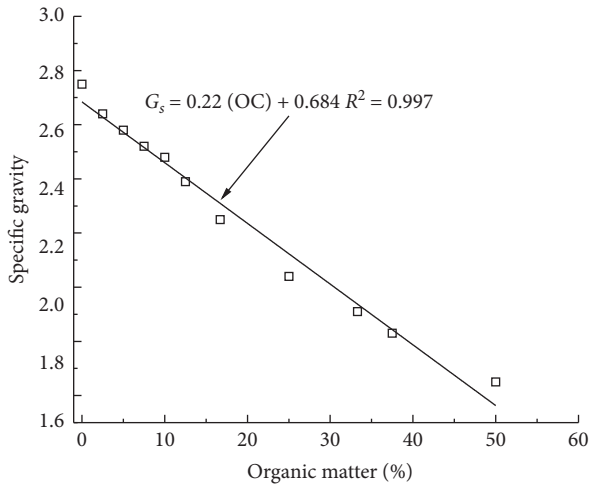


FIGURE 4: Change of specific gravity against organic matter content.

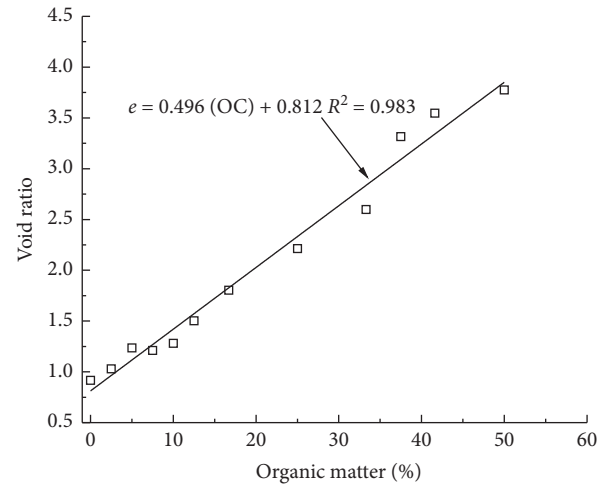


FIGURE 5: Change of void ratio against organic content.

3.1.4. *Effect of Organic Matter Content on Atterberg Limit.* At present, regarding the relationship between the liquid limit and plastic limit and the change of organic matter content, there is a consensus that the liquid limit and plastic limit increase linearly with the increase of organic matter content, as shown in Table 4. It can be seen from the table that although the organic matter content has a high correlation with the liquid limit and plastic limit, the range of the organic matter content studied is relatively small. As for the plasticity index ( $I_p$ ) of organic soil, many researchers have found that  $I_p$  increases with OC, but the correlation is not significant [11, 13, 16, 38, 39].

The relationship between the liquid limit, plastic limit, and plasticity index of clay in this paper with the organic matter content is shown in Figures 7(a)–7(c). It can be seen from Figure 7 that liquid limit, plastic limit, and plasticity index increase with the increase of organic matter content. It is worth noting that the straight line is divided into two stages ( $OC = 7.5\%$ ). When  $OC \leq 7.5\%$ , the organic matter increases by 1%, and the liquid limit, plastic limit, and plasticity index increase by 1.89%, 0.62%, and 1.26%, respectively; when  $OC > 7.5\%$ , the organic matter increases by 1%, and the liquid limit, and plastic limit, and plasticity index increased by 7.48%, 2.15%, and 5.21%, respectively.

3.2. *Effect of Organic Matter Content on Shear Properties.* Shear strength tests were carried out on 12 groups of samples to evaluate the influence of different organic content on the shear strength and related peat soil parameters. The shear strength-displacement curve of cohesive soil when the prepressure is 50 kPa, 100 kPa, 150 kPa, and 200 kPa is shown in Figures 8(a)–8(d), respectively. It can be seen from Figure 8 that the shear strength-displacement curve has no obvious peak, and Badv and Sayadian [25] also obtained similar research results. It is worth noting that the shear strength-displacement curve gradually moves down with the increase of organic matter content at the same vertical pressure. This phenomenon becomes more obvious with the increase of vertical pressure.

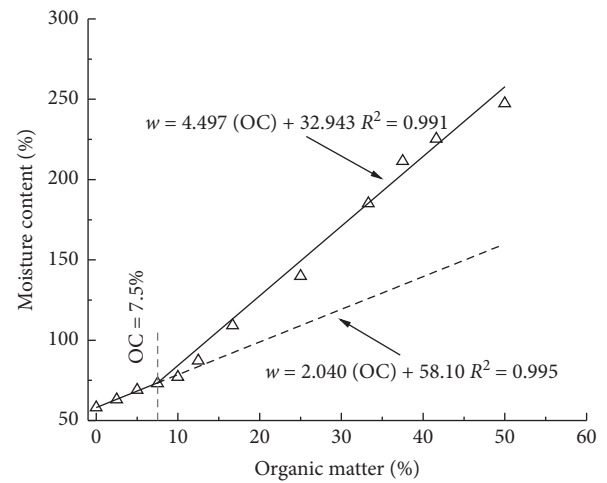


FIGURE 6: Change of moisture content against organic content.

According to ASTM (D3080/D3080M–11) standard [33], when there is no peak value, the shear stress corresponding to the shear displacement of 10% is taken as the shear stress when the specimen fails. Table 5 shows the shear strength and shear strength indexes (cohesion and friction angle) of 12 groups of samples under different consolidation pressures. The relationship between shear strength, shear strength parameters, and organic matter content was drawn to analyze further the change rule of shear characteristics under different organic matter content.

3.2.1. *Effect of Organic Matter Content on Shear Strength.* Figure 9 plots the change curve of the sample's shear strength with the organic matter content under different vertical pressures. It can be seen from the figure that the shear strength of clay gradually decreases with the increase of organic matter content. It is worth noting that when  $OC = 7.5\%$  and  $OC = 37.5\%$ , the straight line has a turning point and the rate of change of shear strength slows down.

TABLE 4: Some research results on the relationship between organic matter content and liquid limit ( $w_L$ ) and plastic limit ( $w_p$ ).

Data sources	OC (%)	$w_L$ (%)	$R^2$	$w_p$ (%)	$R^2$
Odell et al. [11]	0%~6%	$w_L = 4.937 (OC) + 36.01$	—	$w_p = 3.736 (OC) + 19.25$	—
Booth and Dahl [17]	0%~4%	$w_L = 11.31 (OC) + 80.04$	0.94	$w_p = 4.157 (OC) + 41.05$	0.92
Adejumo [39]	0%~25%	$w_L = 1.024 (OC) + 42$	0.98	$w_p = 0.521 (OC) + 25.1$	0.97
Hamouche and Zentar [40]	0%~15%	$w_L = 1.89 (OC) + 25.13$	0.99	$w_p = 1.80 (OC) + 16.7$	0.95
	5%~15%	$w_L = 3.08 (OC) + 15.61$	0.96	$w_p = 3.00 (OC) + 4.32$	0.96

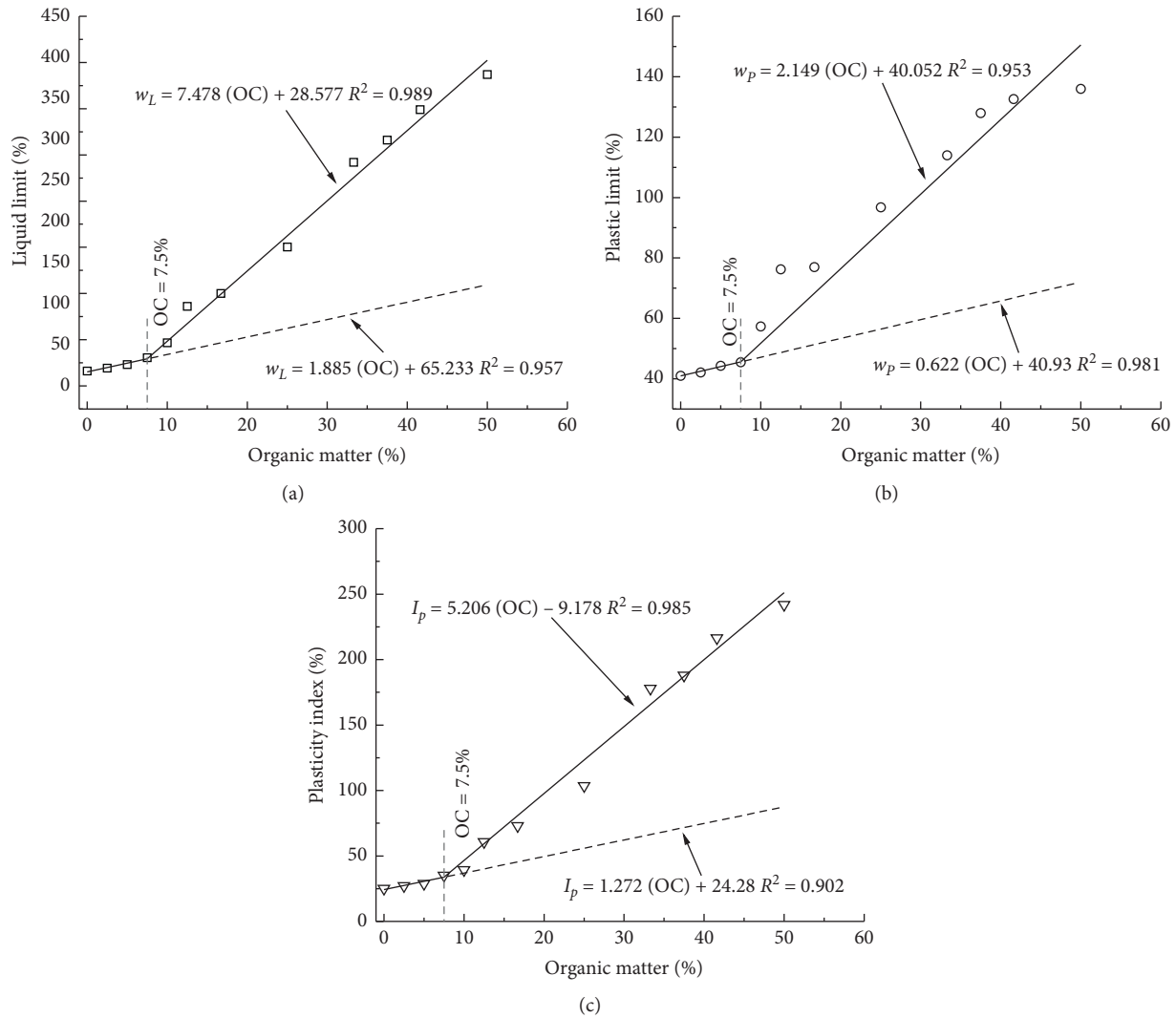


FIGURE 7: Change of Atterberg limit against organic content: (a) liquid limit, (b) plastic limit, and (c) plasticity index.

3.2.2. *Effect of Organic Matter Content on Cohesion and Friction Angle.* Pulat and Yukselen-Aksoy [41] conducted shear tests on municipal solid wastes from Europe, Turkey, and the United States of America and found that the internal friction angle decreases linearly with the increase of organic matter content, with a correlation of 0.6. Although the cohesion force increases with the organic matter content, there is no explicit function relationship; Braidia et al. [42] studied the clay in five different areas of Santa Maria and found that the internal friction angle decreased linearly with the increase of organic matter

content, and the correlation was in the range of 0.1 to 0.6. They also believe that cohesion has nothing to do with organic content; Edil and Wang [43] analyzed the relationship between effective friction angle and organic matter content based on the existing research data of organic soil and peat in Minnesota and Wisconsin and found that the data has great dispersibility.

From the above research results, it can be found that the correlation between organic matter and the friction angle is relatively weak, and the data are discrete. The relationship between organic content and cohesion is very vague. The

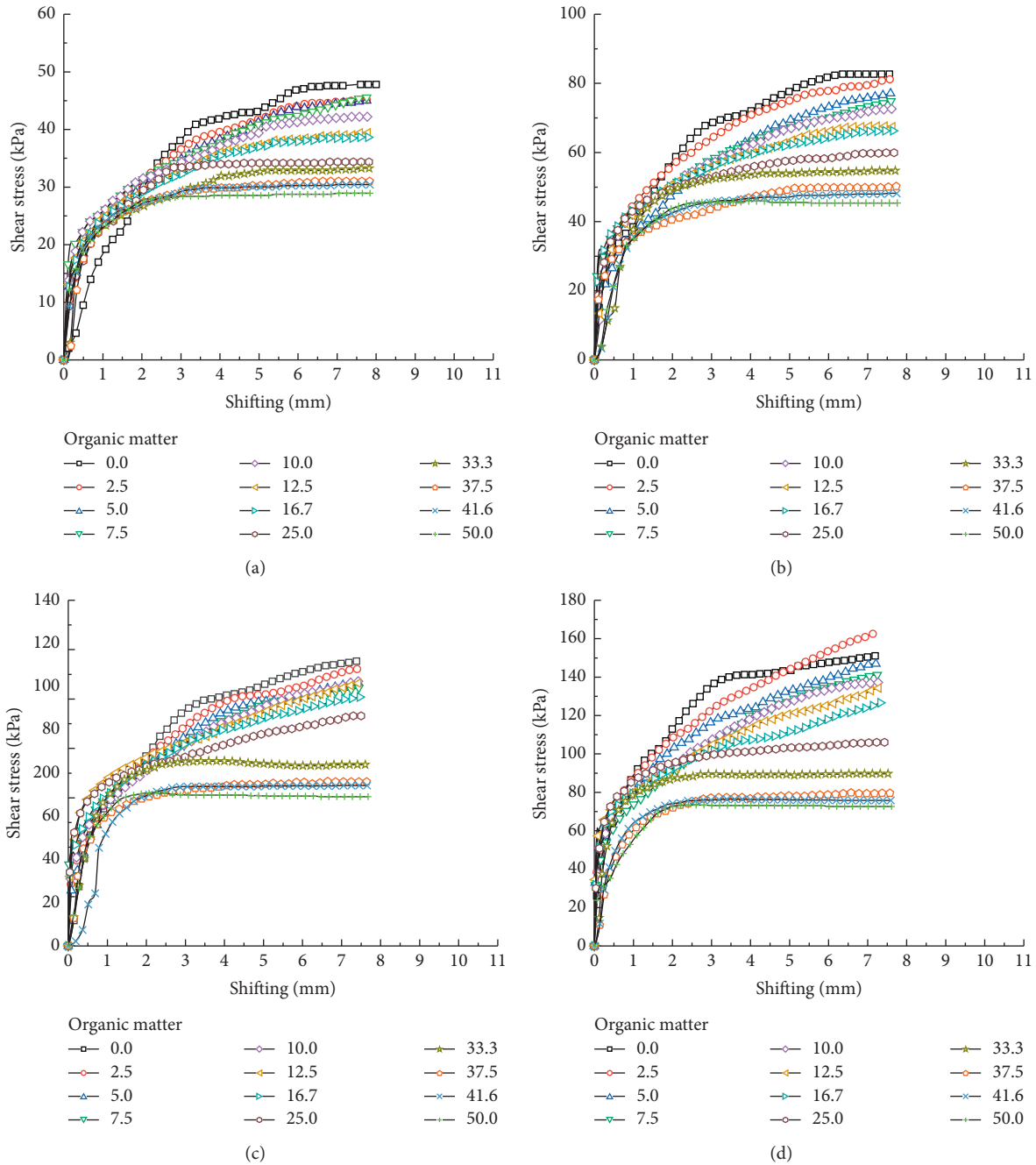


FIGURE 8: Shear strength and shear displacement curves of 12 groups of samples under different vertical pressures. (a) The prepressure is 50 kPa. (b) The prepressure is 100 kPa. (c) The prepressure is 150 kPa. (d) The prepressure is 200 kPa.

author believes that this is caused by differences in minerals and organic components in the organic soil collected from different regions. In this paper, the variation of cohesion with organic matter content is shown in Figure 10(a), and the change rule of friction angle with organic matter content is shown in Figure 10(b). As the content of organic matter increases, the cohesion of clay increases and the angle of internal friction decreases. It is worth noting that the straight line turns when  $OC = 7.5\%$  and  $OC = 37.5\%$ , and the absolute value of the straight line slope gradually decreases. The change rate of clay cohesion and friction angle slows down.

3.3. Discussion. Organic matter in amorphous peat soil is mainly humus. The specific gravity of humus is smaller than that of minerals, and its morphology is similar to colloid and has a larger specific surface area and more hydrophilic groups than minerals. In organic soil, humus and mineral soil particles are not simply mechanically mixed, and complex physical and chemical reactions occur between them to form an organic matter-mineral complex. Minerals and humus will form a mineral-humus complex through anion exchange, ligand exchange surface coordination, hydrophobicity, entropy, cationic bridging, and hydrogen

TABLE 5: Shear properties of samples.

No.	$w_u$ (%)	Shear strength (kPa)				$c$ (kPa)	$\varphi$ (°)
		$\sigma_v = 50$ kPa	$\sigma_v = 100$ kPa	$\sigma_v = 150$ kPa	$\sigma_v = 200$ kPa		
1	0	40.0	72.9	105.7	138.6	7.2	33.3
2	2.5	39.0	70.4	101.8	133.1	7.7	32.1
3	5.0	37.4	66.0	94.7	123.3	8.8	29.8
4	7.5	36.9	64.4	91.9	119.4	9.4	28.8
5	10.0	36.3	63.3	90.2	117.1	9.4	28.3
6	12.5	35.8	61.7	87.7	113.6	9.9	27.4
7	16.7	35.9	60.4	84.9	109.4	11.4	26.1
8	25.0	32.3	52.9	73.5	94.1	11.7	24.4
9	33.3	31.2	48.9	66.6	84.3	13.5	21.5
10	37.5	30.7	46.5	62.4	78.2	14.8	17.6
11	41.6	30.8	46.5	62.2	77.8	15.1	17.4
12	50.0	30.5	45.5	60.4	75.3	15.6	16.6

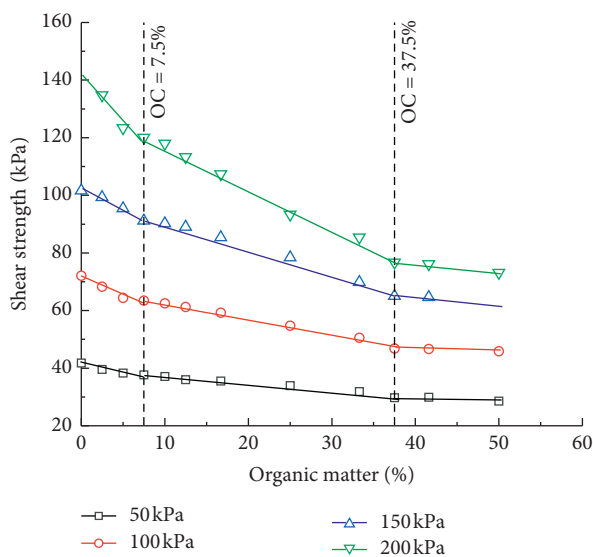


FIGURE 9: Relationship between organic matter content and shear strength under different vertical pressures.

bonding in soil science (Figure 11). The organic matter firmly absorbed by the mineral particles on the soil particles' surface is called the bound organic matter, and the organic matter far away from the mineral particles and not affected by adsorption is called the free organic matter [37].

According to the above analysis, it can be concluded that as the content of organic matter increases, there is a threshold between different forms of organic matter (bound state and free state). When the organic matter content in the soil is lower than the threshold, the organic matter mainly exists in the combined state; when the organic matter content exceeds the threshold, the mineral soil's adsorption capacity for organic matter reaches saturation and free organic matter increases (Figure 12).

Due to the interaction between organic matter and minerals, different forms of organic matter (bound and free) will affect the physical properties of the soil. According to the results of this paper, the impact is mainly reflected in the moisture content and the Atterberg limit. Atterberg limit is the boundary water content that divides the soil consistency

state and is closely related to the water content in the soil. Because humus is a hydrophilic colloidal substance, the Atterberg limit and moisture content of clay soil increase with the increase of organic matter (humus) content. However, bound organic matter is adsorbed by mineral particles, and its adsorption capacity for water is relatively weak, while the free organic matter is more free than bound organic matter and has a relatively strong adsorption capacity for water. It can be seen from the results of this test that the water adsorption capacity of the clayey soil had changed when  $OC = 7.5\%$ . Therefore,  $OC = 7.5\%$  may be the limit value of bound organic matter and free organic matter. When  $OC < 7.5\%$ , minerals and organic matter adsorb each other, organic matter exists in the form of the bound state, and the adsorption capacity for water is weak; when  $OC = 7.5\%$ , bound organic matter reaches saturation; when  $OC > 7.5\%$ , the free organic matter gradually increases and the water adsorption capacity increases.

The shear properties of clays are different from the Atterberg limit and moisture content. The cohesion of clay mainly depends on factors such as the cementation between soil particles and electrostatic gravitational effect; the friction angle mainly depends on the coarseness and arrangement of the surface of the soil particles. The content of organic matter increased from 0% to 7.5%; the combined organic matter has little effect on the cementation between soil particles and the arrangement of soil particles. Therefore, the cohesion and friction angle of clay show similar properties to minerals. As the organic matter content increased from 7.5% to 37.5%, the free organic matter gradually increased between the soil particles. The free organic matter played a role in connecting and also played a role in "lubricating" the soil particles. The cohesion and friction angle of clay have a certain impact. The soil is affected by the combined action of minerals and free organic matter, showing the nature of mineral-organic matter. With the further increase of organic matter content ( $OC > 37.5\%$ ), the free organic matter between soil particles far exceeds the bound organic matter, resulting in a reduction in contact points between soil particles and a significant change in their arrangement. Therefore, the friction angle of clay is reduced. The colloidal humus significantly improves the cementation between the particles, increasing



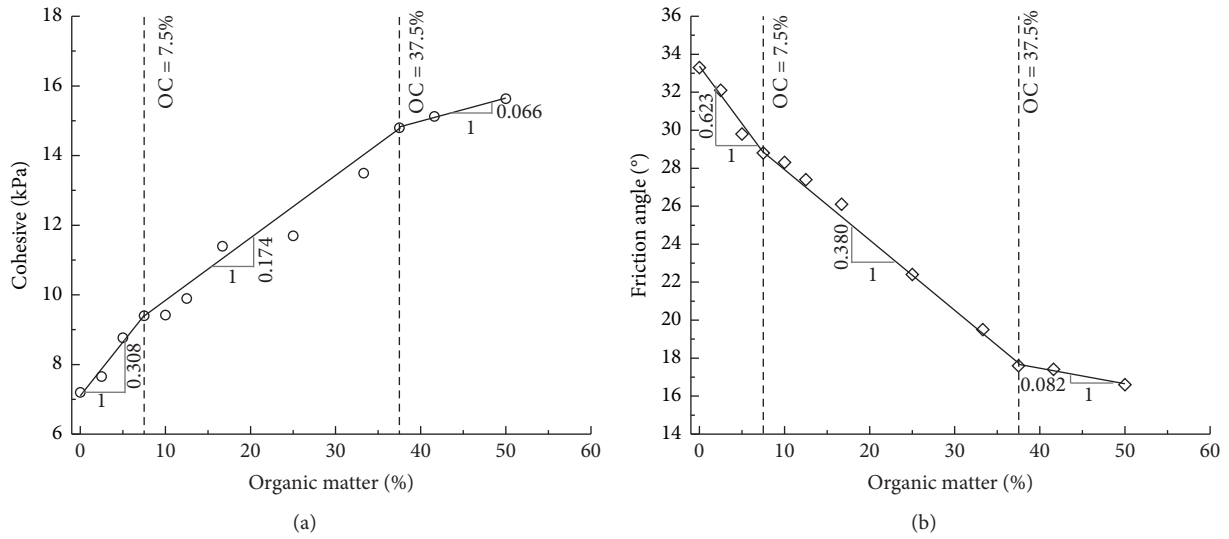


FIGURE 10: Relationship between organic matter content and cohesion and friction angle. (a) Cohesion. (b) Friction angle.

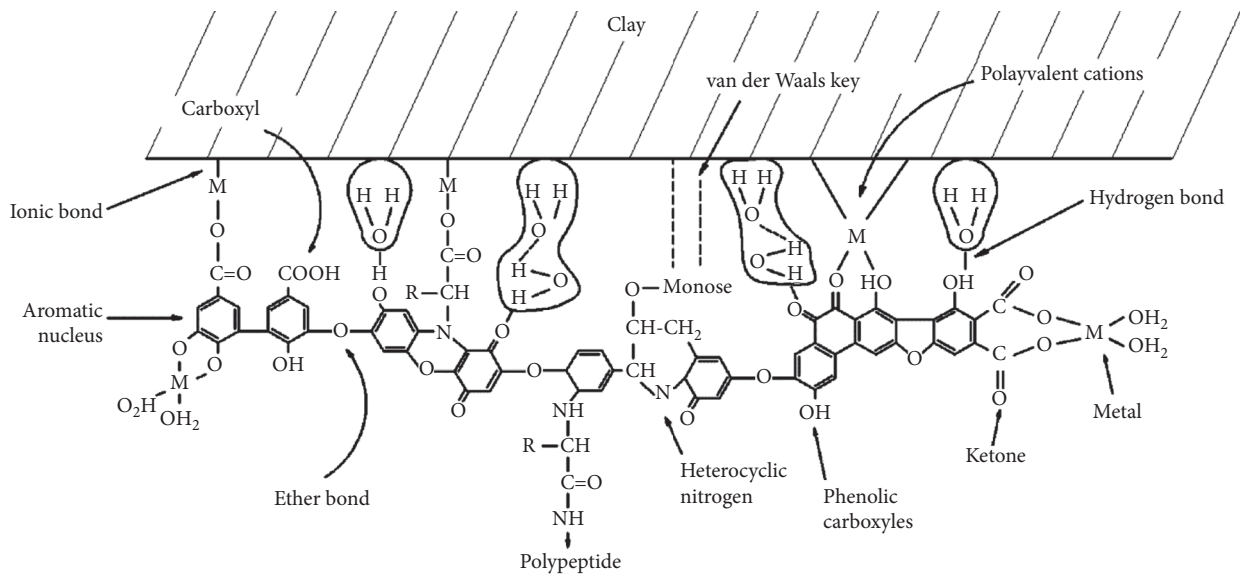


FIGURE 11: Clay mineral-humus complex [37].

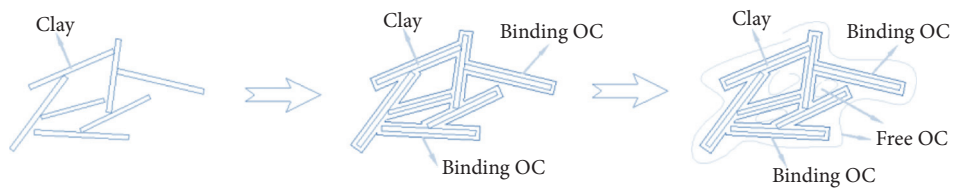


FIGURE 12: Schematic diagram of different adsorption patterns of organic matter.

the cohesion of the clay soil. At this stage, the clay is mainly affected by free organic matter and exhibits the properties of free organic matter.

#### 4. Conclusions

- (1) The organic matter content in the soil has a linear relationship with specific gravity and void ratio. The specific gravity decreases with the increase of organic matter content, and the void ratio increases with the increase of organic matter content; the moisture content and Atterberg limit increase with the increase of organic matter content, but turned at  $OC = 7.5\%$ , and the change rate increased. As the organic matter content increases, the cohesion increases, the friction angle decreases, and the shear strength decreases. When  $OC = 7.5\%$  and  $OC = 37.5\%$ , the cohesion, friction angle, and shear strength have obvious transitions.
- (2) The change rule of water content and Atterberg limit with organic matter content shows that  $OC = 7.5\%$  is the threshold of the change of water absorption capacity of clay. When  $OC \leq 7.5\%$ , the organic matter is in a bound state. When  $OC > 7.5\%$ , the bound organic matter is saturated and the free organic matter increases.
- (3) Under different organic matter content, the difference in the interaction between organic matter and soil particles leads to the difference in shear characteristics of clay. When the organic matter content is less than  $7.5\%$ , the clay soil exhibits mineral properties; when the organic matter content is  $7.5\% \sim 37.5\%$ , the clay soil exhibits the properties of mineral-free organic matter; when the organic matter content exceeds  $37.5\%$ , the clay soil exhibits nature of free organic matter.

#### Data Availability

The data used to support the findings of this study are included within the article.

#### Conflicts of Interest

The authors declare that they have no conflicts of interest.

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