Review on Organic Soil Stabilization

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I Introduction

The organic content is recognized as one of predominant factors retarding cementing process in soils. In the case of lime stabilized soil, the influence of the organic matter on the lime reactivity is attributed to the obstruction of pozzolanic reaction. Investigation carried out by Thompson (1966) suggested that the organic matter either prevents the dissolution of soil silica and/or alumina or combines with the lime added to the soil. In the case of the cement stabilized soil, the organic matter also affects the cementing process. However, some studies have shown that not all of the organic compounds really have a negative effect of the cementing process (for example, Trembley et al., 2002). Attempts to stabilize organic soils have been examined by many works such as. Kuno et al. (1989) and Onitsuka et al. (2003). They showed that the soil containing humic acid, one of organic compounds, can be increased in strength after treated by lime/cement mixed with gypsum and salt, respectively.

Although there are some researches concerning the effect and the mechanism of organic matter on various binders stabilizing soils, the precise quantity and type of the organic compounds interfering with lime or cement and other binder reactions cannot be accurately defined especially for Ariake clay. This paper has been written to propose the outlines for further works to overcome those mentioned problems based on the review from the pertinent information. Some references including Onitsuka et al. (2003), Trembley et al. (2002), and Kuno et al. (1989) are briefly explained in following sections.

II Literature Review

Onitsuka et al. (2003) studied on the effect of organic matter on quick lime or Portland cement stabilized Ariake clays. Three samples from various locations with different organic compounds are stabilized with quick lime and Portland cement. The properties of samples are tabulated in Table 1.

Table 1 Properties of soil samples (Onitsuka et al.)

Samples	Location	Depth, m	Water Content, %	Liquid Limit, %	Plastic index	pH	Salt Content, g/l	Particle size distribution, %			Organic Matter, %	Ignition Loss, %	Humus Content, %	Humic Acid, %	Fulvic Acid, %
								Sand	Silt	Clay					
Clay 1	Okawa	1	185	143	90	6.0	0.7	3	52	45	1.1	8.0	1.9	1.6	0.3
Clay 2	Ashikari	3	150	133	71	7.6	15.4	1	44	55	1.1	7.3	1.7	0.3	1.4
Clay 3	Isahaya	3	170	150	88	8.0	23.1	0	19	81	1.1	10.0	2.4	0.3	2.0

The result shows that the clay containing higher humic acid (Clay 1) failed to be stabilized with quick lime, while strength values obtained from Clay 2 and Clay 3 are much greater as illustrated in Figure 1. Consequently, the humic acid was extracted from the clay samples using NaOH (Clare and Sherwood, 1956), then adding again humic acid and salt in different contents to the samples. As shown in Figure 2, the result indicates that at the same humic acid content, strength loss is less in higher salt concentration sample. The study concludes that the humic acid has adverse effect on the strength of stabilized clay, however, the effect can be mitigated by the increase of salt concentration.

Trembley et al. (2002) studied the effect of the organic compounds on soil stabilization with cement. Thirteen organic compounds usually found in soil were mixed separately with mass of 10% dry soil sample to two different soils and treated with 10% of Portland cement or Geolite 10 (enriched sulfate cement developed by Onoda Chemico Co., Ltd.).

Key words: organic, soil stabilization, lime, cement, humic acid, salt, gypsum
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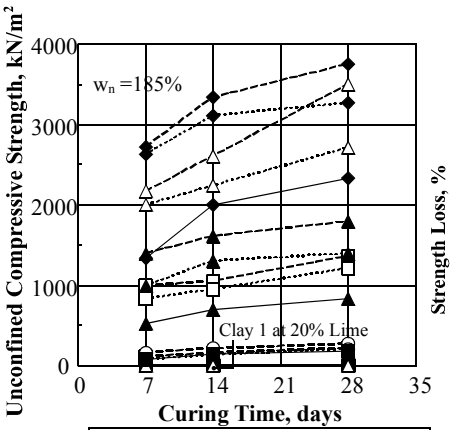
The research summarized that some compounds (i.e. acetic acid, humic acid, tannic acid, sucrose and ethylenediaminetetraacetic acid) strongly affected the cementing process by inhibiting the hydration reactions however others had no affect on the cementing process or delay the setting time to attain the final strength.

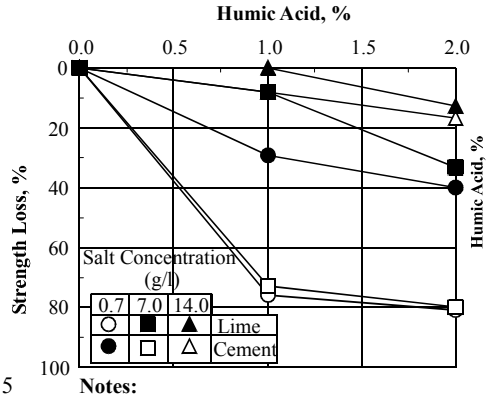
Kuno et al. (1989) investigated the effectiveness of various binders on soils having different humic acid contents and natural water contents. Thirty-five very soft cohesive soils throughout Japan were stabilized with 5 binders, which were slaked lime, quick lime, slaked lime with gypsum, Portland cement and Portland cement with gypsum. Finally, guideline for stabilizing soils containing humic was introduced as demonstrated in Figure 3 and Table 2. The research concluded that in high humic acid and water content soil, adding gypsum to Portland cement or slaked lime is more effective for stabilization than Portland cement or slaked lime alone.



	Mixing Contents (%)			
	5	10	20	30
Lime	○	□	△	N/A
Cement	N/A	■	▲	◆

Clay1 ——— Clay2 — — — Clay3 ----------
Notes: N/A -Not Available

Fig. 1 Strength development of lime and cement stabilized (Onitsuka et al., 2003)



Notes:

1. At w_n =150%, Curing 7 days, Extracted Clay 1 and 20% Lime/Cement
2. Strength loss, % = $(q_{u0}-q_u)x100/q_{u0}$

Where q_u is the strength at any humic acid content, and q_{u0} is the strength at humic acid content at 0%.

Fig. 2 Retarding effect of humic acid on strength at various salt concentration (Onitsuka et al, 2003).

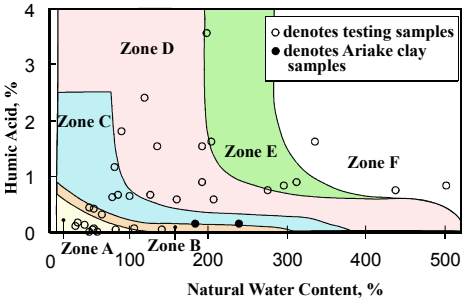


Fig. 3 Soil classification zones based upon the water content and humic acid content (Kuno et al, 1989).

Table 2 Guideline for selecting binders on the basis of soil classification shown in Figure 3 (Kuno et al, 1989)

Soil Classification	Binder				
	Slaked Lime	Quick Lime	Slaked Lime+ Gypsum	Portland Cement	Portland Cement+ Gypsum
Zone A	○	○	○	○	○
Zone B	●	●	○	○	○
Zone C	X	●	●	○	○
Zone D	X	X	X	○	○
Zone E	X	X	X	X	●
Zone F	X	X	X	X	X

Notes:
1. ○ denotes the short-term strength increase is excellent,
2. ● denotes the short-term strength increase is not so good,
3. **X** denotes even in a long term the strength does not manifest itself.

III Conclusions and Recommendations

The proficiency in strength gained of organic soil stabilization is due to many factors such as type of organic compounds, soil minerals, type of selected binder, etc., in the other hand we can say that the efficiency of organic soil stabilization depends on each particular case. Regarding to Ariake clay, only a few researches investigated on this topic. In further works, it is worth to study by using concept of Trembley et al. (2002) to mix the soil with various organic types and stabilize with different binders that are successful for organic soils such as salt, gypsum mixed with cement or lime etc. Moreover, chemical analysis shall be performed along with testing to study the mechanism for each substance; the understanding of such mechanism may be applied to other soil improvement purposes for example, manufacture of granular material from dredged soil.

IV References

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