Experimental study on improvement of silt detention basin used as roadbed

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Abstract. Through a laboratory experiment of improving the silt in Huangdun Lake flood detention area, the reinforcement effect of two different soil conditioners-cement and fly ash on silt of detention area were researched. The study found that soil conditioners can effectively improve the soil compaction and gentle the compaction curves in the peak range, which was beneficial to the control of water content in the concrete construction. Compaction degree had different effects on the compressive strength of this two kinds of improved filler soil. With the increase of compaction degree, the compressive strength firstly showed a different proportion of growth, and began to be steady or reduce weakly after increasing to a certain value. The best compaction degree of the two kinds of improved soil was both between 95%~97%, and the cement fly ash stabilized soil had best ratio in strength, namely with the increase of fly ash content , the compressive strength firstly increased and then decreased, which means the fly ash had the beat optimum mix content.

Introduction

Silt is a special engineering soil with low plasticity, and generally more than 70% of the particle fraction is fine particle and fine sand. The specific surface area is small while the capillary phenomenon is prominent. Especially when the flood comes within the flood detention area, flooded subgrade will face a series of problems which may bring a variety of diseases directly to the road if handled improperly. In the process of highway engineering design and construction, roadbed filling materials should be local except extremely special circumstances. When the silt is used as subgrade directly, it is difficult to be compacted and easy to loosen due to poor cohesion. Therefore, the strength of roadbed can not be ensured. Due to the poor water stability, the cohesive force between saturated soil is lost and the shearing strength plummets which will make the soil soften, collapse and become flow sand finally. A solidification treatment is essential for the silt along the ground before using them as roadbed filling materials. Therefore, it is necessary to carry out the experimental study on improving performance of embankment filling within flood detention area, which is the fundamental prerequisite to ensure the quality of roadbed construction. Some experts and scholars at home and abroad have carried out some studies on this field and have achieved certain achievements[1-5].

Although the flood detention area is an indispensable part of flood control system in China, and highway is also an important link to strengthen economic contacts between regions. In order to effectively solve the contradiction between the two parts, it is necessary to conduct relevant test on the improvement of sandy soil in flood detention area. This test will analyze the effect and adaptability of different modifiers. At the same time, the effect of content and degree of different modifier on soil strength will be analyzed to obtain the best proposal to improve this soil. In addition, it will offer reference for the design and construction of subgrade engineering in flood detention area for our province and even the whole country.

Design of test plan

In our country, lime stabilized soil, cement stabilized soil, cement lime stabilized soil and lime fly ash stabilized soil are mostly applied into high grade highway pavement [6] [7].According to the experience, the cement stabilized soil can be used in almost all soils except the organic matter content and sulfate content. The soil in this experiment was taken from Huangdun Lake flood detention area and was stabilized by cement, cement and fly ash and other materials to compare the strength. According to the following proportion, they are mixed and then were conducted a compaction test to acquire the maximum dry density and optimum moisture content under different ratios. Finally, around different compaction degree (90%, 93%, 96%, and 93%), the improve packing was analyzed in the measure of the unconfined compressive strength of subgrade filling as filling quality control index.

Test method

(1) In this experiment, silt clay is taken from Huangdun Lake flood detention area and is analyzed with two kinds of different dosage of curing agent separately（C3%、C5%, C7%, C3% +FA1/2, C3% +FA1/3, C3% +FA1/4, C5% +FA1/2, C5% +FA1/3, C5% +FA1/4, C7% +FA1/2, C7% +FA1/3, C3% +FA1/4）. Among them, C represents cement, FA represents the fly ash, and the proportion represents the ratio of cement and fly ash, the same as below.

(2) The maximum dry density and optimum water content of soil and improve soil were calculated through the standard compaction test. Under different degree of compaction according to the different optimum water content (90%, 93%, 96%, and 100%), the modified filler was made into cylinder specimens (50mm*50mm) and we carried out unconfined compressive strength test after maintenance for seven days.

Test results

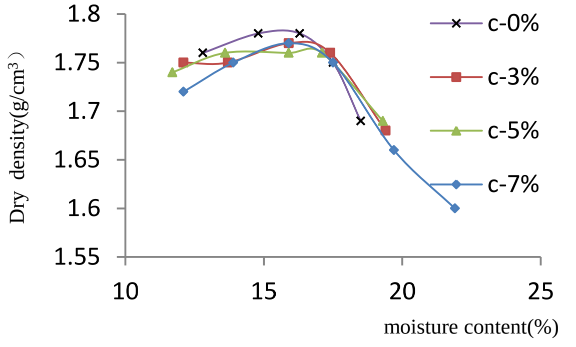
To analyze the liquid plastic limit, specific gravity and particle size of the pit soil and compaction test. The results are shown in Table 1. The soil belongs to the low liquid limit silt according to the results of particle analysis, the combination of liquid and plastic limit and the standard " test procedures for highway geotechnical engineering" (JTG E40－2007). The particles concentrated in the range of soil due to silt (0.002-0.075mm) accounted for about 75% of the total, rarely from the nature of clay. It shows similar properties of silt: it is difficult to be compacted and the capillary effect of the powder is strong because the particles are more uniform and poorly graded.

Table 1 the basic physical properties of soil

w/%	ρ/g/cm^3	Gs	ω_L/%	ω_p/%	I_p
28	1.94	2.70	25.5	19.0	6.2

Compaction effect of cement and fly ash

Different doses of cement stabilized soil and cement dosage of 7%, different fly ash content of cement fly ash stabilized soil compaction curve in Figure 1, figure 2. Figure 1 analysis shows that for the cement stabilized soil, cement dosage increased from 3% to 7%, the optimal water content did not change which are closed to the optimal soil moisture content of 15.8%, while the maximum dry density changes with cement increases from 0% to 7% range showed firstly decreased and then increased. The reason is because the mineral composition of active substances which are produced in the hydration reaction of cement and soil hydrolysis in a series of chemical reactions in soil plasticity, reduce cement increased, which causes the agglomeration of the particles and coarse particles, the small amount of production will cause the increase of the local void soil maximum dry density decreased, but with the increase of cement dosage and the increase in the number of coarse particles corresponding to a certain extent that will make the maximum dry density becomes large.



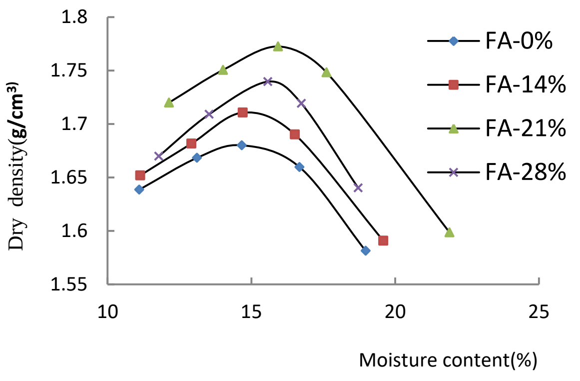


Fig 1 The Compacting Curve with different admixture amounts in Cement

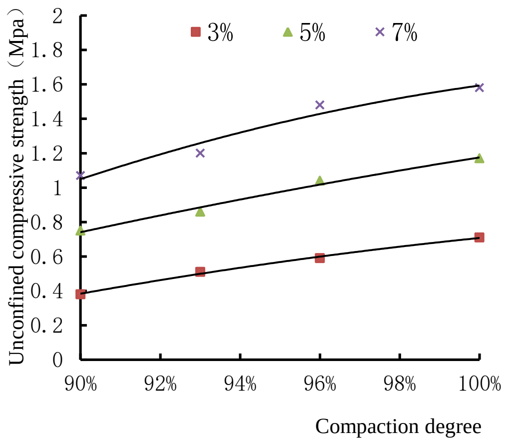
Fig 2 The Compacting Curve of content of fly ash in IMPROVED SOIL with 7% Cement

As shown in Figure 2, with the increase of fly ash content, the overall impact of the real curve moves to the left corner, that is, the maximum dry density and optimum moisture content of the soil is reduced. With the increase of fly ash, it is easier to occur hydration and hydrolysis reaction of cement, leading to the reduction of the optimal water content of combination of material; At the same time, the more the hydration reaction of cement is, the bigger the agglomeration and flocculation of soil particles are. The soil coarse particles increase and the weight of fly ash is light, so the maximum dry density of the mixture decreases with the increase of the content of the mixture. To analyze the compaction curve shape, the left part is slow while the right part is steep, which indicates that when the moisture content is more than the optimal water content, the sensitivity to water is enhanced. Therefore in construction, we had better to strictly make the water content lower than the optimum moisture content and should avoid subgrade construction in rainy days. In addition, the compaction curve becomes gentle with the increase of fly ash content, and the peak becomes wider. This change makes the control of water content become wider in the construction, thus it is easier to grasp the construction quality.

Relationship between unconfined compressive strength and compaction degree of improved soil

The unconfined compressive strength test of cement improved soil and cement fly ash combination was completed in this experiment, and the results of the experiment are shown in Figure 3, Figure 4.

Figure 3 and Figure 4 describe the relationship between the 7d compressive strength and the compaction degree of cement modified filler soil, cement fly ash combined with modified filler soil and cement lime combination. As shown in the figure, the degree of compaction has a significant impact on these three modified soils. The compressive strength of the cement modified soil and cement fly ash composite filler modified soil presented growth in different proportions (40%~180% and 21%~212%) and then (compaction >96%) tend to be stable with the degree of compaction in the range of 90%~100%. Generally speaking, it is not so effective to only improve the compaction degree (>97%) for soil improvement, and the best compaction degree of the two kinds of improved soil is between 95%~97%.



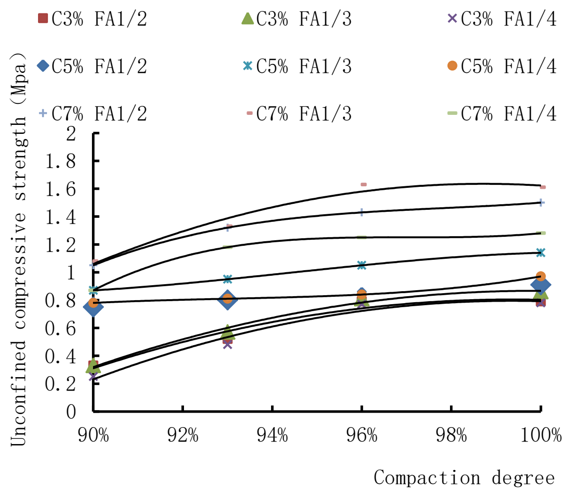


Fig 3 The change curve between compressive strength with different proportion in Compacting Cement Curve and Compaction Degrees

Fig 4 The change curve between compressive strength of different proportion in Compacting Cement and ash Curve and Compaction Degrees

The relationship between the strength of improved soil cement and the content of the components

The relationship between compressive strength and cement content of 7D with different ratio of cement to soil under different compactness is shown in Figure 5.

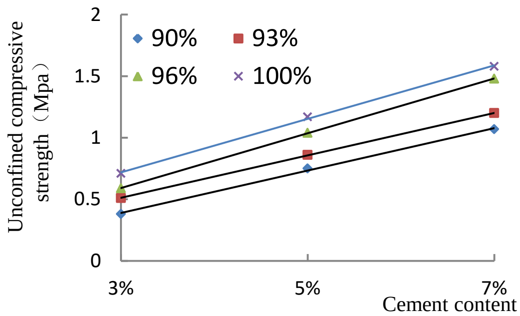


Fig 5 the relationship between content of cement and compressive strength

As can be seen from Figure 5, the strength of the cement soil is improved and the brittleness is more obvious with the increase of the cement content. And the unconfined compression strength is close to linear increase with the same degree of compaction and the increase of cement content.

Relationship between cement fly ash improved filler soil strength and component content

The ratio of fly ash to cement ratio is 1:3, and the relationship between the cement content and the compressive strength of the modified filler is shown in Figure 6. The cement content was 5% under different compaction degree, different dosage of fly ash and modified filler soil compressive strength curve is shown in figure 7.

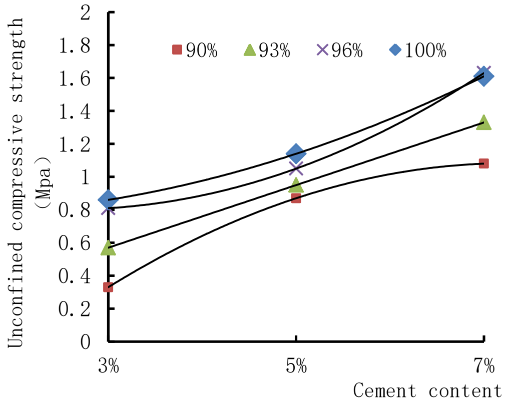


Fig 6 the relationship between content of cement and compressive strength (Compacting Cement and ash Curve)

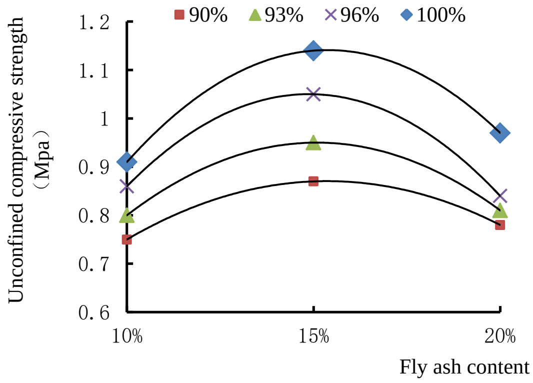


Fig 7 the relationship between content of ash and compressive strength (Compacting Cement and ash Curve)

From the analysis of Figure 6, the effect of cement content on cement fly ash improved filler soil is consistent with that of cement modified soil. The figure 7 shows that when other conditions are the same, the compressive strength of the improved packing soil firstly increases and then decreases with the increase of the content of fly ash. There is a significant turning point when the mixing amount of 15%. This is mainly because the solidification mechanism of the cement fly ash improved filler soil lies in the cement hydration products of the cement soil particles and the interaction between the soil particles and the ion exchange reaction. The low content of fly ash can effectively participate in and promote the reaction of the volcanic ash between the clay, which can enhance the bond strength of the soil particles to a certain extent when the amount of cement is certain; But when the amount of fly ash reaches a certain level, the cement in stabilized soil is not sufficient to fully stimulate the activity of fly ash. In this way, the fly ash scattered in the soil, especially fly ash particles that did not participate in the reaction increase the internal defects due to its particle structure. There are enough padding around the gap, resulting in the strength of the modified filler content was significantly decreased with the increase of fly ash particles. This is similar to the unconfined compressive strength test of other two kinds of cement dosage of cement fly ash.

In addition, compared with the cement soil and cement - fly ash improved soil filler, as the curing time is short, ion exchange among cement, fly ash and material and the volcano ash reaction is not sufficient. When the fly ash content is lower than 10% and higher than 20%, the compressive strength of improved soil conservation contribute little to filler 7d. For different cement content, an appropriate increase of fly ash content (such as the amount of 15%) has a certain role in promoting the strength of filler soil.

Conclusion

(1) In general, the modified additive can effectively improve soil compaction characteristics. The soil compaction curves were at the peak within the flat which is conducive to the control field compaction construction of concrete water content for all kinds of soil compaction conditions.

(2) With the analysis of the degree of compaction variation of unconfined compressive strength, compaction has different effects on the compressive strength of two kinds of improved filler soil. With the increase of compaction, compressive strength was first presented different proportion of the growth but increased to a certain value which begins to be steady or reduce slightly. The best compaction degree of the two kinds of improved soil is between 95%~97%. The strength of the subgrade is not very significant after reaching the 96% degree of compaction.

(3) According to the results of strength test unconfined compressive, the strength of cement and fly ash stabilized soil has best ratio, namely with the increase of fly ash, compressive strength firstly increased and then decreased, the amount of fly ash is the best with the dosage, strictly proper

control of fly ash or have a certain role in promoting the quantity of lime improved soil strength of filler.

(4) From relationship of the unconfined compressive strength of the fly ash cement soil with cement dosage dependence, the strength is increasing with the increasing of cement dosage. The increasing trend of is more obvious when the dosage is more that 5%; At the same time, we can see that it becomes more gentle with the increase of the growth trend of fly ash; According to the relationship of different cement dosage and degree of compaction, the degree of compaction has the least influence on the compressive strength when the cement content is 5%.

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