Compaction Characteristics of Aeolian Sand with Different Sediment Percentage

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Abstract. In order to research compaction characteristic of aeolian sand with different sediment percentage, and get suitable roadbed filling, seven kinds of aeolian sand with different sediment percentage is made by taking representative sample of aeolian sand. Aeolian sand samples are compacted by heavy compaction method. The sediment percentage of aeolian sand is greater than 8%, the roadbed filling is suitable for compacted by using heavy compaction method to determine the maximum dry density of aeolian sand with different sediment percentage. When the sediment percentage of aeolian sand is range of 16.5%–30.2%, the dry density of aeolian sand is close to maximum dry density and has the best compaction effect, the aeolian sand is a kind of suitable material for roadbed filling.

Keywords: Aeolian sand with different sediment percentage · Compaction characteristics · Heavy compaction method · Roadbed filling

1 Introduction

With the planning and implementation of the western development, Highway construction project in desert area of China will be more and more. Aeolian sand is the most abundant and cheapest material in desert area. It's unknown whether aeolian sand can be used subgrade and roadbed filling material. Chen Zhongda, Zhang Dengliang and other scholars carried out the study of the engineering properties of aeolian sand and achieved some results. But at present the compaction characteristics of aeolian sand with different sediment percentage are seldom studied. Combined with the engineering practice the typical aeolian sand samples have been taken, and seven kinds of aeolian sand with different sediment percentage were prepared (Zhang and Wang 2013). Compaction characteristics of aeolian sand with different sediment percentage has been studied experimentally. Then through comparative analysis, the paper finds the best compaction effect of aeolian sand which under different sediment percentage. Research results will promote aeolian sand with different sediment percentage widely used in highway construction project of desert area. Research results has very important economic significance in highway construction.

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2 Basic Characteristics of Aeolian Sand

2.1 Basic Characteristics of Natural Aeolian Sand

Through the experiment the dry density of natural Aeolian sand samples is in range of 1.56–1.69 g/cm^3, and relative density of natural Aeolian sand samples is in range of 2.65–2.72 g/cm^3. Its natural water content is under 3.80% generally. The particle size of Aeolian sand samples for more than 90% is about 0.074–0.60 mm. The non-uniform coefficient of Aeolian sand samples is Cu = 2.13, and the gradation coefficient Cc = 1.01. By analyzing the mechanical composition of Aeolian sand particles, it was found that the gradation of aeolian sand was bad, with even fine grains with diameters mostly ranged from 0.074 mm to 0.60 mm.

2.2 Grading Index of Aeolian Sand with Different Sediment Percentage

Aeolian sand samples were prepared with different sediment percentage respectively at 5%, 15%, 30%, 40%, 50%, 60% and 70%. Grading Indexes of prepared Aeolian sand samples were listed in Table 1.

Table 1. Grading indexes of samples

Samples	Effective particle size (mm)	Non-uniform coefficient	Curvature coefficient	Diameter < 0.074
Sample1	0.090	3.500	1.125	5.200
Sample2	0.050	5.400	1.250	16.500
Sample3	0.031	5.150	1.050	30.200
Sample4	0.030	4.670	1.040	41.300
Sample5	0.025	3.640	1.800	49.500
Sample6	0.020	3.600	2.500	59.400
Sample7	0.018	3.700	2.640	68.600

The Table 1 shows that non-uniform coefficient increase first and then decrease with the increasing of sediment percentage. The effective particle size decreased with the increasing of sediment percentage. The values of curvature coefficient in the range of 1–3. The result indicates that mostly Aeolian sand samples were bad Gradation.

3 Compaction Test

3.1 Standard Heavy Compaction Test

3.1.1 Test Equipment and Scheme

Test equipment: heavy compaction instrument, balance System, Mixing tools, Oven and dryer, measuring cylinder, aluminum box, repair knife, flat ruler, and etc.

Test scheme: According to the Ministry of Transport of the People's Republic of China standards "Test Method of Soils for Highway Engineering (JTG E40-2007)", the

soils of compaction test has three layers and each layer was impacted 98 times. The compaction hammer falls according to 45 cm drop height. Seven kinds of Aeolian sand with different sediment percentage samples were selected and tested under different water contents.

3.1.2 Experiment Results and Analyses

Seven kinds of Aeolian sand with different sediment percentage samples were prepared to do standard heavy compaction test. The compaction curves were shown in Fig. 1. The relationship of maximum dry densities and the quantity sediment shows in Fig. 2.

As can be seen from Fig. 1, the dry density of aeolian sand with sediment appeared a peak value when water content was zero. The dry density decreases with the increasing of water content. When water content was in range of 4%–6%, the dry density begin to increase until appears to another peak value as water content was about 10%. The compaction characteristics of aeolian sand with sediment is like to aeolian sand. It's typical property of aeolian sand. When sediment percentage was in range of 30.2%–59.4%, the compaction characteristics of aeolian sand with sediment was in the transition zone. The compaction curves show the samples are mixing of aeolian sand and sediments. The dry densities are lower than aeolian sand. When sediment percentage is over 59.4%, the compaction characteristics of the samples obviously are properties of fine grained soils. As water content of the samples is below the optimum water content, the dry density increases gradually with the increasing of water content (Li et al. 2006; Zheng 2014). When water content reaches the optimum water content the dry density reaches maximum. If water content is more than the optimum water content, the dry density decreases. We can also kwon the dry density will decrease with the increasing of sediment percentage. The optimum water content also increase with the increasing of sediment percentage.

In Fig. 2, the maximum dry density increase with the increasing of sediment percentage of aeolian sand. When sediment percentage was about 20%, the maximum dry density reaches the maximum value. Then the dry density gradually decreases with the increasing of sediment percentage. When sediment percentage of aeolian sand is in range of 20%–40%, the large change rate of the maximum dry density is relatively obvious (Yang et al. 2011; Zhang et al. 2015). Sediment percentage of aeolian sand is over 40% then the maximum dry density reducing rate is relatively slow.

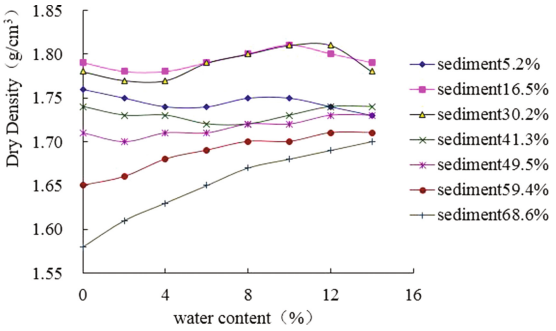

Fig. 1. Relations of maximum dry density and the quantity of sediment

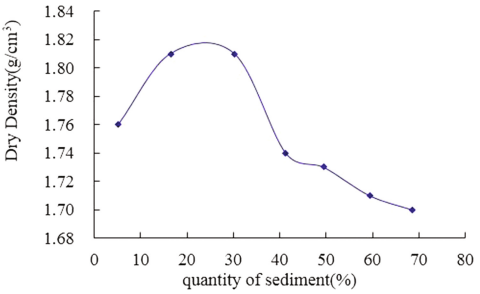

Fig. 2. Heavy compaction curve of seven samples

4 Conclusion

When sediment percentage of aeolian sand is below 30.2%, the compaction properties behave the characteristics of aeolian sand. When sediment percentage is over 59.4%, the compaction properties of the samples obviously show characteristics of fine grained soils. When sediment percentage was in range of 30.2%–59.4%, the compaction characteristics of aeolian sand with sediment showed a mixture of aeolian and sediment. The dry density reaches to the maximum value when sediment percentage of aeolian sand is 20%.

It's sediment percentage of aeolian sand is greater than 8%, the roadbed filling is suitable for compacted by using heavy compaction method to determine the maximum dry density of. When the sediment percentage of aeolian sand is range of 16.5%–30.2%, the dry density of aeolian sand is close to maximum dry density and has the best compaction effect, the aeolian sand is a kind of suitable material for roadbed filling.

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