

The Application Research on Cement Stabilized Hill-skill Gravelly Soil as the Reinforcing Layer for High-grade Highway

Lu Bai^{1,a}

¹College of Civil Engineering, Xu Chang University, Xu Chang, 461000, Henan, China

^a345502768@qq.com

Keywords: cement-stabilized hill-skill gravel soil, high-grade highway reinforcing layer, compaction test

Fund Project: Results of 2015 science and technology development project of Xuchang City(No. 1504007), Results of 2015 produce-learn-research project of Xuchang University(No. 2015CXY10, 2015007), Results of 2016 Colleges and universities in Henan province key scientific research project.

Abstract. In order to use the hill-skill gravelly soil as the reinforcing filler material for the high-grade highway. Based on its uneven particles, the unmanageable construction quality, etc., physical properties of the soil on the condition of different gravel mixing amount are analyzed through indoor experiments to determine the new way to detect the degree of compaction and to inspect construction quality combined with actual engineering, opening up a new way for the rational utilization of local resources.

Introduction

The hill-skill gravelly soil is the earth-rock aggregate of the rotten mountain surface. The application of this soil is to solve the problem of the road construction clay's short supply, soil and water loss, etc., which is a conception. Due to the uneven particles and unmanageable degree of compactness, although this kind of soil has been applied in China, the application scope is limited. Besides, the relevant study on how to accurately measure roadbed compaction degree is still relatively lack. Therefore, it is very necessary to test the roadbed compaction degree on the condition of the uneven hill-skill particles and to enlarge the application scope of hill-skill soil through the engineering practice.

The mechanical property of hill-skill gravelly soil

The hill-skill gravelly soil is characterized by its clear corner angle, high intensity and uneven particles. Due to the different natural environments at different places, the properties of hill-skill gravelly soil are distinct. The hill-skill gravelly soil in Wuliang, Yuzhou of Henan is taken as the example. Its physical property can be seen in Table 1.

Table 1 Hill-skill gravelly soil Physical properties

Grain size analysis									The biggest size mm	Non-uniform coefficient Cu	Liquid limit W _l	The plastic index I _p
Mesh/mm	>20	10	5	2	1	0.5	0.25	<0.075				
Content/%	7.5	8.4	13.9	34.4	14.9	8.5	5.2	7.2	100	95.2	27.5	11.7

As can be seen in Table1, the hill-skill gravelly soil is a kind of coarse-grained soil with very big nonuniform coefficient. At the same time, the water content of liquid limit of fine aggregate and the plasticity index in the soil mass are relatively small. The stability of water temperature is good[1,2].

The indoor experiment analysis of hill-skill gravelly soil as the reinforcing layer

The material composition

Cement: P.C32.5 complex portland cement in Tianrui, Yuzhou of Henan.

Aggregate: hill-skill gravelly soil in Yuzhou, Henan.

Indoor testing program

The hill-skill over 100mm in the original hill-skill gravelly soil is removed. According to Test Methods of Materials Stabilized With Inorganic Binders for Highway Engineering (JTG E51-2009), the standard compaction test and no lateral confinement compression test are conducted. The mass ratio is employed in the indoor mix design. The design program is as follows:①4%cement+hill-skill gravelly soil(the mixing amount of hill-skill is 30%); ②4%cement+hill-skill gravelly soil(the mixing amount of hill-skill is 40%);③4%cement+hill-skill gravelly soil(the mixing amount of hill-skill is 50%); ④4%cement+hill-skill gravelly soil(the mixing amount of hill-skill is 60%); ⑤ 4%cement+hill-skill gravelly soil(the mixing amount of hill-skill is 70%).

Results and analysis of indoor test

After preserving and water-saturating test-pieces for 7and 28 days relatively, the test result of no lateral confinement compression degree can be seen at Table 2.

Table2 Laboratory test results

Hill-skill content/%	The best water content/%	Maximum dry densit/ (g/cm ³)	The intensity of 7 days/MPa	The intensity of 28 days/MPa
30	9.7	2.061	2.7	4.5
40	7.8	2.089	2.7	4.6
50	6.9	2.113	2.6	4.6
60	6.8	2.079	2.8	5.0
70	6.6	2.064	3.0	5.1

Table 2 indicates that 7-day and 28-day intensity of cement stabilized hill-skill gravelly soil satisfy the condition of reinforcing layer on the roadbed top surface for high-grade highway road use. And compression strength with no lateral confinement of cement stabilized hill-skill gravelly soil increases with the increase of gravelly stone content[3].

Testing methods of degree of compactness

Through indoor standard compactness test, the maximum dry density of hill-skill mixing amount: 30%、40%、50%、60%、70% has been confirmed. At the rest periods, the hill-skill mixing amount's maximum dry density can be gained by interpolation method. Comparing the actual content of hill-skill stones for hill-skill gravelly soil during construction with the mixing amount of

hill-skill stones determined by indoor standard experiment, the corresponding standard maximum dry density can be gained. The degree of compaction can be calculated according to relevant requirements of Technical Specification for Construction of Highway Subgrades(JTG F10-2006), thus estimating whether the degree of compaction conforms to the standard requirement on the condition of corresponding hill-skill content. The construction quality can be checked further through corebit sampling[4].

Application and detection of test section

The construction testing of Qiwang 1km test section in the reconstruction project in Yuzhou, Henan is taken as an example. According to the design requirement, the width and the compaction thickness of cement stabilization hill-skill gravelly soil are 24.5 meters and 15cm relatively.

In the construction of this highway section, after removing hill-skill stones over 100mm based on the quality requirement, the hill-skill stone content is approximately 30% through testing. Therefore, according to the first kind of mix proportion, indoor standard testing statistics of 4% cement+hill-skill gravelly soil(hill-skill content is 30%) is used to control the degree compaction. The construction quality is tested according to the requirement of Quality Inspection and Evaluation Standard for Highway Engineering(JTG F10-2006), and the testing result can be seen at Table4 and Table5.

Table 4 Mix proportion and result of cement stabilized hill-skill gravelly soil's reinforcing layer

Construction level	Materials (%)			Maximum dry density (g/cm ³)	Optimum water content (%)	7d no lateral confinement compression strength(Mpa)	Standard deviation (Mpa)	Variablco-efficient (%)	CBR (%)
	cenm-ent	stone	soil						
Reinforcement of roadbed top surface	4	30	70	2.069	9.7	2.061	0.39	8.6	43

Table 5 The sampling test result of reinforcing layer corebit

Test Item	Test Quantity	Design Value	Test Value
Intensity (Mpa)	8sets	>1.5	2.1
Degree of compaction (%)	10	>96	96.5
Deflection 1/100mm	80points	<150	71
Degree of thickness(cm)	8	15	16.3
flatness(mm)	8	<15	11

Conclusion

The research indicates that under the reasonable grading, the cement stabilized hill-skill gravelly soil can be used as the reinforcing layer of high-grade highway, which not only ensures the project quality, but also is helpful for using local materials, reducing construction cost and water and soil loss. This is a relatively good application way[5].

References

- [1] Chunhao Li ,Chenghua Yu ,et al.Studay on pavement performance of cement stabilized hill-skill grave soil base.Subgrade Engineering,vol.6 special(2010),P.163.
- [2] Shuxiu Huo .Applieation of hilside soil in roadbed base layer.Hebei jiaotong Science and Technology,vol.2 special(2005),P.10.
- [3] Guofu Liu .Hill-skill soil subgrade construction technology research.Sanxin Architecture,vol.9 special(2009),P.291.
- [4] Fengmei Li .Studay on performance of hill-skill soil.Communications Standardization Issue,vol.7 special(2006),P.109.
- [5] Ying Du.Construction technology of subgrade hill-skill soil.Highways & Transportation in Inner Mongolia,vol.2 special(2014),P.24.