Durability Improvement of Granite Residual Soil by Lime

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ABSTRACT

Granite residual soil is a kind of common building material for subgrade in China. However, its stability and durability are not as good as requested by specification. Lime is regarded as an effective modifier for granite residual soil. The influence of lime dosages on stability and durability of granite residual soil are evaluated and its effectiveness is verified and quantified based on lab tests of modulus and strength. It is shown that the performance improvement is obvious. Modified granite residual soil has better support to pavement structure and improves the stability and durability of pavement.¹

INTRODUCTION

Granite residual soil is a kind of debris material after physical weathering and chemical weathering, which has characteristics of heterogeneity, variation, water softening and high liquid limit. Due to the influence of the nature of the parent rock, climatic conditions and weathering, granite residual soil is different in nature and has obvious regional characteristics, some high liquid limit granite residual soil in the subgrade filling process is difficult to compact. Meanwhile, granite residual soil has high water content when filled in rainy and humid area. Due to the influence of construction schedule and other reasons, the phenomenon of "spring soil" appears during the rolling process which affects the durability. As a result, some granite residual soil can be used directly, but some cannot meet the technical requirements

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in specification. So it is necessary to analyze the gradation composition and other characteristics of granite residual soil to improve the durability accordingly. Lime is regarded as an effective modifier for granite residual soil.

**RAW MATERIALS**

The gradation of granite residual soil is used in this investigation is listed in table I.

| size (mm) | 10 | 5  | 2  | 1  | 0.5 | 0.25 | 0.075 |
|-----------|----|----|----|----|-----|------|-------|
| percentage of pass (%) | 100 | 96.0 | 90.5 | 86.8 | 78.5 | 59.8 | 35.8 |

The CaO and MgO’s content of lime is 68.5%, which is in accordance with the specification requirement. The dosages of lime in the experiment are 0%, 3%, and 5% respectively.

**EXPERIMENT ON BEARING CAPACITY IMPROVEMENT BY LIME**

With the lime dosage of 0%, 3% and 5%, the bearing capacity at different compaction degrees (92%, 94%, and 98%) were obtained. The test results are shown in Table II.

| Compaction Level | 0% | 3%  | 5%  |
|------------------|----|-----|-----|
| 92%              | 6.3| 33.8| 35.6|
| 94%              | 7.2| 38.5| 40.0|
| 96%              | 8.2| 45.4| 47.3|

It can be concluded from Table 2 that the CBR strength increases with the dosage of the lime content. The CBR is only 8.2% without lime, while the CBR value is 38.5% and 40.0% under 94% compaction condition at lime dosage of 3% and 5% respectively, which meet the requirements of subgrade.
EXPERIMENT ON DURABILITY OF LIME MODIFIED GRANITE RESIDUALS OIL

Resilient Modulus Experiment

The resilient modulus of the subgrade soil must meet certain requirements. Therefore, the resilient modulus of 0%, 3% and 5% lime content of soil samples are tested respectively and listed in Table III.

| Compaction Level | 0% | 3% | 5% |
|------------------|----|----|----|
| 92%              | 25 | 70 | 88 |
| 94%              | 26 | 75 | 92 |
| 96%              | 28 | 80 | 95 |

It is shown that the resilient modulus is less than 30MPa in the absence of lime conditions. It doesn’t meet requirements of the asphalt pavement design specification (JTGD50-2004) which requires soil subgrade resilience modulus values should be more than 30MPa and E-class heavy traffic Soil subgrade should be more than 40MPa. For the granite residual soil with high moisture content and liquid limit, the use of lime for treatment, is very effective. When the lime content is 3%, the resilient modulus is about 2 times higher than without mixed with lime. When the lime content is 5%, resilient modulus is about 2.5 higher than without mixed with lime. It shows that when mixed with the lime, the properties of high liquid limit soil has change greatly, the more the lime content is, the higher the elastic modulus is.

Disintegration Experiment

The disintegration of the soil is caused by the internal concentrated stress of the infiltrated free water in the soil[3]. Lime may have effect to improve the resistance to disintegration of granite residual soil.

Three times wet and dry cycle disintegration test are carried out to soil samples with 0%, 3% and 5% lime content. The test data are listed in Table IV.

| Lime content | Initial weight (g) | Weight after the first cycle (g) | Weight after the second cycle (g) | Weight after the third cycle (g) |
|--------------|--------------------|---------------------------------|----------------------------------|---------------------------------|
| 0%           | 168                | 164                             | 162                              | 160                             |
| 3%           | 164                | 163                             | 163                              | 162                             |
| 5%           | 166                | 164                             | 163                              | 162                             |
It can be seen from the data that the final disintegration rate is very low 1-4%. In consideration of the disturbance of the operation to the sample, it is considered that there is no significant difference in the rate of disintegration of the samples between different lime contents. It can be seen that the degradation resistance and the cementation and water stability of the granite residual soil have been greatly enhanced after lime improved. Therefore, it is considered that the improvement effect is best when the minimum lime incorporation amount is 4% in the viewpoint of the resistance to disintegration.

CONCLUSIONS

(1) For high liquid-limited granite residual soils, it can meet the specification requirements when mixed with lime at natural moisture content, and a greater CBR value and better resilience modulus can be obtained.

(2) Based on the laboratory experiment, the lime-modified granite residual soil is more suitable for the construction practice. The road performance is better and the durability is improved greatly.

(3) Lime has little effect on disintegration of granite residual soil. When granite residual soil is modified, the lime content of 2-4% is suggested for treatment at which the strength and durability can meet the specification requirement.

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