Compression Tests on Remodeling Lishi Loess

NIANQIN WANG, XIAOYU CHEN, PANPAN YANG and LIANCHANG ZHUO

ABSTRACT

Lishi loess is often used as a building foundation and roadbed filling, the property changed obviously after compaction. In order to reveal the compression characteristic variation, the compression test were conducted under a series of controlling the degree of compaction and moisture content conditions, discussion on the impact of pressure compaction degree and moisture content about compression characteristics of Lishi loess. Some test results are got: ① When the compaction degree is 90%, with the increasing of moisture content, compression modulus after the first increase and then decrease; When the compaction degree is 93%、95%, the compression modulus reduce significantly; ② Any moisture content of Lishi loess, with degree of compaction increasing the compression modulus increases and then decreases after. Analysis that: ① For different compaction degree Lishi loess, moisture content is different, the compression of soil is different; But the moisture content closer to optimum moisture content, the smaller difference of compression between the soil; ② For different moisture content of Lishi loess, the compaction degree is different, the compression of soil is also different; When the degree of compaction is 93%, the compression modulus of soil maximum, the compression minimum, resistance to compression is the strongest; ③ For different moisture content of Lishi loess, relations of compression modulus and degree of compaction can used 2 times polynomial $E_s=aK^2+bK+c$ fitting. 1

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INTRODUCTION

In recent years, many cities in China frequently appeared house crooked, pour floor events, and soil deformation is a major cause of these adverse events. The engineering properties of soil is greatly affected by soil consolidation and compression, the soil deformation is closely related to geotechnical problems of the earth structures and the foundation of seepage, stability and settlement[1]. For the compression deformation characteristics of loess, the previous carried out extensive research and achieved fruitful results. Zhang Maohua[2] conducted uniaxial compression test in the case of increase (decrease) wet for undisturbed Q3 loess, obtained the loess compression deformation with the variation of saturation; Yin Jie[3] conducted a lot of indoor one-dimensional consolidation tests for the four liquid limit remolded loess, discussed influence of the initial moisture content, liquid limit on the intrinsic compression characteristics of remolded loess, the results showed that the compression curve of remolded loess not only related to liquid limit of soil, but also is affected by the initial moisture content; Chen Kaisheng[4] based on one-dimensional consolidation tests, analyzes the relationship between water content, degree of compaction and compression deformation coefficient, compression factor of compacted loess, studied compacted loess loading constitutive model and increase (decrease) wet constitutive model. Zeng Lingling[5] conducted GDS triaxial compression test under different stress paths for natural sedimentary soil, got different stress ratios on the influence law of natural sedimentary soil compression Characters.

Previous research on compressive deformation of loess, mostly about loess surface consolidation compression tests based on different moisture contents and external load conditions, while rarely research on reshape Lishi loess. In order to explore its compression deformation rule, somewhere Lishi loess of xi'an as the research object, conducted compression test under different moisture content and different compaction degree conditions, try to explore the water content and degree of compaction on the influence of the compressive deformation of Lishi loess.

TEST MATERIALS AND METHODS

Test Program

Experiment with soil from a Loess Plateau region of Xi'an. The characteristics of soil is: yellow, more humid, soil evenly, dense structure, with large pores, multi-stone containing ginger, belong to Q2 loess (The basic physical properties indicators of soil as shown in table I) According to the general configuration method of the moisture content, configure the needed sample in different moisture content, then using the mould pressure sample method preparation. In this paper, using lever-type
compression apparatus method, the samples with different moisture contents were carried on lateral confined compression consolidation test.

### TABLE I. THE BASIC PHYSICAL PROPERTIES INDICATORS OF SOIL.

<table>
<thead>
<tr>
<th>Natural moisture content</th>
<th>Natural density</th>
<th>Liquid limit</th>
<th>Plastic limit</th>
<th>Plasticity index</th>
<th>Liquidity index</th>
<th>Cohesion</th>
<th>Internal friction angle</th>
<th>Specific gravity of soil particle</th>
</tr>
</thead>
<tbody>
<tr>
<td>ω/%</td>
<td>ρ/g·cm⁻³</td>
<td>ωₘ/%</td>
<td>Iₚ</td>
<td>Iₗ</td>
<td>φ/°</td>
<td>Gₛ</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.3</td>
<td>1.45</td>
<td>28.2</td>
<td>17.4</td>
<td>10.8</td>
<td>-0.75</td>
<td>0.05</td>
<td>25</td>
<td>2.70</td>
</tr>
</tbody>
</table>

**Sample Preparation and Instrument**

1. Test instrument: lever-type compression apparatus;
2. Sample size: bottom area is 50cm², height is 2cm;
3. Sample preparation: First drying soil samples, grinding powder on the rubber plate, through 2mm sieve, determination of moisture content after air-dried. According to the set moisture content and the degree of compaction, calculated desired air-dried soil quality and water addition. The air-dried soil samples weighed, according to the required amount of water spray pure water evenly, into the plastic bag after fully stir well, sealed with tape to stand 24h so that moisture distributed evenly. Then poured soil samples into pressure samples device with cutting ring, using static pressure to the required density[6].

**ANALYSIS OF TEST RESULTS**

**The Influence of Compaction Degree on Compressibility**

Figure 1 shows, for any moisture content of Lishi loess, with the increasing of compaction degree, compression modulus after the first increase and then decrease, but the variation of compression modulus different because of the different moisture content. For the compression modulus values, the soil samples of moisture content 13.5% maximum, followed by 15.5% soil samples, the soil samples of moisture content 17.5% minimum. But when the compaction degree is 90%, for the compression modulus values, the soil samples of moisture content 13.5% is less than the soil samples of moisture content 15.5%, this is because two kinds of soil compression is different. The degree of compaction is 90%, when the moisture content is 15.5%, low compression soil, when the moisture content is 13.5%, medium compression soil. When the compaction degree is 93%, compression modulus of soil maximum, compressibility minimum, the strongest resist compression ability. That is: to different moisture content of Lishi loess, increase the same compaction degree, compressibility of the soil is different. Therefore, appropriate increase the soil compaction degree can improve the ability to resist
compression. By sorting compression test data, Lishi loess compression modulus and compaction degree relation curve can be used 2 times polynomial fitting, relationship as follows:

\[ Es = aK^2 + bK + c \]  

(1)

In the formula (1) K is the degree of compaction; a, b are coefficients associated with moisture content; c is a constant.

**The Influence Of Moisture Content On Compressibility**

Figure 2 shows, to a certain compaction degree of Lishi loess, when the compaction degree is 90%, with the increasing of moisture content, compression modulus after the first increase and then decrease. When the compaction degree is 93%, 95%, with...
the increasing of moisture content, compression modulus reduce significantly, reduce amplitude with the increasing of moisture content decrease gradually, and the smaller the compaction degree, which the reducing trend is more obvious. That is: to different compaction degree of Lishi loess, increase the same moisture content, compressibility of the soil is different; especially when moisture content is lower than the optimal moisture content of 15.3% difference is bigger. Moisture content is more closer to the optimal moisture content, the smaller difference in compressibility of soil; therefore, reduce the moisture content of soil can effectively improve anti-compressibility, but affected by compaction degree, so in engineering practice, with different compaction degree of the soil should be through reducing the different water content to improve the resist compression ability.

CONCLUSIONS

(1) When the compaction degree is 90%, with the increasing of moisture content, compression modulus after the first increase and then decrease; When the compaction degree is 93%, 95%, the compression modulus reduce significantly, reduce amplitude with the increasing of moisture content decrease gradually, and the smaller the compaction degree, which the reducing trend is more obvious.
(2) For any moisture content Lishi loess, with the increasing of compaction degree, compression modulus after the first increase and then decrease; When the compaction degree is 93%, compression modulus of soil maximum, compressibility minimum, the strongest resist compression ability.

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