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Research on Failure of Aeolian Sand Roadbed Slope Through Laboratory Static Load Test

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ABSTRACT: There is little study on failure of aeolian sand roadbed slope. Field test is more difficult, so the author prepares a representative sample of aeolian sand, and makes the failure of aeolian sand roadbed slope through static load test simulation in laboratory to analyze the aeolian sand roadbed slope stability. Test results indicate that the roadbed slope is stable when the roadbed slope ratio is 1:2 and test load is under critical load, the aeolian sand is compacted by water dumping and mechanical compaction or mechanical compaction. The allowable bearing capacity of roadbed increases significantly when the slope ratio is 1:2 and especially the roadbed is compacted by the water dumping and mechanical compaction.
Keywords: aeolian sand, roadbed slope, static load test, slope stability.

1. INTRODUCTION

There are many desert area in China, which distributed mainly in the north-western region arid area, the Qinghai-Tibet Plateau area, Such as Xinjiang, Inner Mongolia, Gansu, Ningxia, Shaanxi, Qinghai, Liaoning, Ji Lin and Heilongjiang provinces and regions. With the western development there will be a large number of projects are being built in these areas, especially road construction projects.

The stability of aeolian sand embankment slope is to ensure the aeolian sand overall stability of subgrade slope to prevent the slope slipped and the foundation instability as well as local subgrade depression or push deformation. The second aim is to ensure that the road base slope, shoulder and both sides of the environment stability, to prevent the subgrade sand buried, shoulder and slope were wind erosion, rain erosion and man-made damage. The design of desert highway subgrade slope is necessary to design a reasonable slope ratio, also to adopt reasonable and reliable protective measures. It is difficulty to do destruction test of aeolian sand subgrade slope (Liu Dapeng, Li Zhiping), and the information of destruction test currently is lack. Therefore it is necessary to carry out simulation tests indoors. The author choose a representative of aeolian sand specimens, studying the sand subgrade slope under different loadings and different compaction conditions in indoors. The study's purpose is to analyse the wind sand roadbed slope stability, then to guide the design and application of roadbed slope Work. That is to ensure the stability of subgrade slope, to extend the useful life of roads. The research have some economic and social benefits.

2. INDOOR TEST ON FAILURE OF AEOLIAN SAND SUBGRADE SLOPE UNDER STATIC LOAD

In order to facilitate comparison and analysis of test data, this simulation test use a circular bearing plate with a diameter of 30 cm at a distance of 50 cm from the edge of the embankment. Load test (simulation of roadbed test components shown in Figure 1 and Figure 2) set the provisions when the bearing plate settlement reach 500 mm Load test stops. Simulation test on basis of subgrade filling methods are divided into two different conditions: (1) The subgrade is layered buried, and each layer thickness is 50 cm. The subgrade have not used mechanical compaction, The simulated subgrade slope ratios are 1:1, 1:1.5, 1:2.0 and 1:2.5 respectively; (2) The simulation subgrade is divided into four layers, each layer of 50 cm thick virtual filling. Using compaction machinery to rolling subgrade and the slope ratio are 1:1, 1:1.5, 1:2.0 and 1: 2.5.

2.1 Experimental Procedure

(1) Leveling the test site and compacting the ground surface with a flat-panel rammer, the author put iron nail as a subsidence by the interval of 0.15 m into the soil, and measure its height.
(2) Filling the embankment stratified according to different working conditions. Measuring subgrade compactness. Then continuing with the layered packing until the desired elevation.
(3) According to the position shown in Figure 2 to install displacement meter, including 1 # measured Point test bearing plate vertical displacement; 2 #, 3 # measuring points were tested side line vertical and lateral displacement, 2 # measuring point reading is positive, said Measuring point displacement upward, on the contrary displacement down; 4 #, 5 # measuring points respectively Measure the vertical displacement 50 cm from the top of subgrade and the bottom of subgrade.
(4) Making the reaction frame is at a predetermined position. Place the load plate in the position shown in Figure 2 and to keep the baring plate is level.

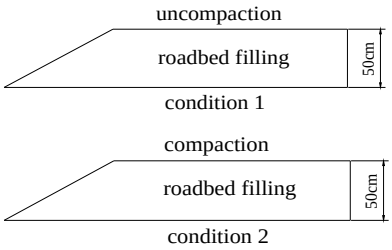


Figure 1 Subgrade construction of two conditions

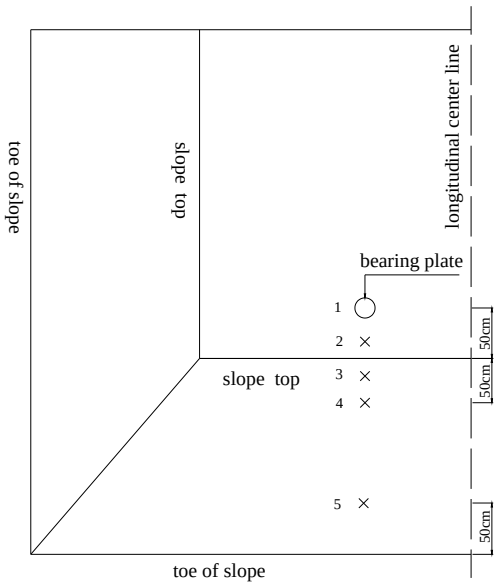


Figure 2 The monitoring instrument layout

(5) Placing in the bearing plate jack and putting the ball seat at the top of the load beam contact. Dynamometer should be placed in the middle of the jack and the beam. The jack must be kept vertical. Then experimenters start to load with a jack and then relax the jack throttle unloading, regulator 1 min. The displacement meter is initialized to zero.

(6) Jack load, using step by step loading method, is to measure force design control load, is less than 0.1 MPa, each level increases 0.02 MPa, after each increase of about 0.04 MPa. In the experiments, experimenter should pay attention to the top of the subgrade and slope cracks. Then begin to the next scheduled load, and continue to read displacement.

2.2 Experimental data

Simulating subgrade static load failure test and geotechnical test specification. There are some differences in the plate load test: Simulate the static load on the subgrade destruction test load time of 1 min, while the plate load test each level load is generally 2 h. According to the compression test, it can be seen that aeolian sand is made at load compression deformation with a very short period of time, the latter part of the small deformation creep. Simulation At the beginning of subgrade test, first read the 1 # meter reading indicator at 1 min. number, reading again after 6 h, dial indicator only changes 0.02 mm. The test loading time of 1 minute to meet the plate load test the requirements of the test. The flat load test generally refers to the role of rigid platens. Half-space surface or near surface, and according to a certain theoretical system foundation bearing capacity, the role of the test load located at the roadbed from the edge Line 50 cm department. (Li Zhiyong) The test data processing only consider the load plate Test data before significant cracks appear around.

The test results show that when working condition 1 simulates subgrade test, it is carried plate settlement larger, p-s curve no obvious straight line and inflection point, mining The allowable bearing capacity is obtained by the method of three-point method or step-by-step regression fitting.

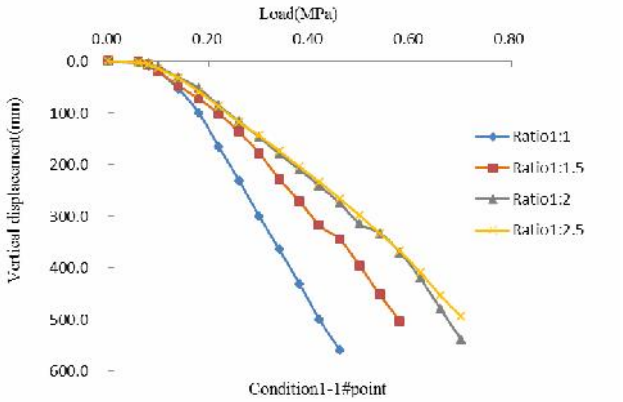
Are less than 110 kPa, the test results and analysis of the operating conditions 2 p-s curve finishing. Method is as follows: Draw the final p-s curve based on p and the corresponding s value line. According to China's building foundation design specifications (GB50007-2002): For low compressibility soil and sand, take s/b = 0.01 ~ 0.015 corresponding to the load of the basic bearing capacity value.

2.3 Analysis of test results

2.3.1 The first condition

Figure 3 shows the displacement and load pressure of different slope ratios in condition 1 of roadbed curve.

As can be seen from Figure 3, the displacement of each measuring point increases as the load increases Large, the displacement of the same measuring point decreases as the slope ratio increases. 1 # measuring point Large amount of displacement, the displacement of 500 mm when the corresponding external load 0.42 ~ 0.46 MPa; 2 #, 3 #, 4 #, 5 # measurement point displacement smaller, With the increase of load, the displacements of 2 #, 3 #, 4 # and 5 # points also increase obviously.



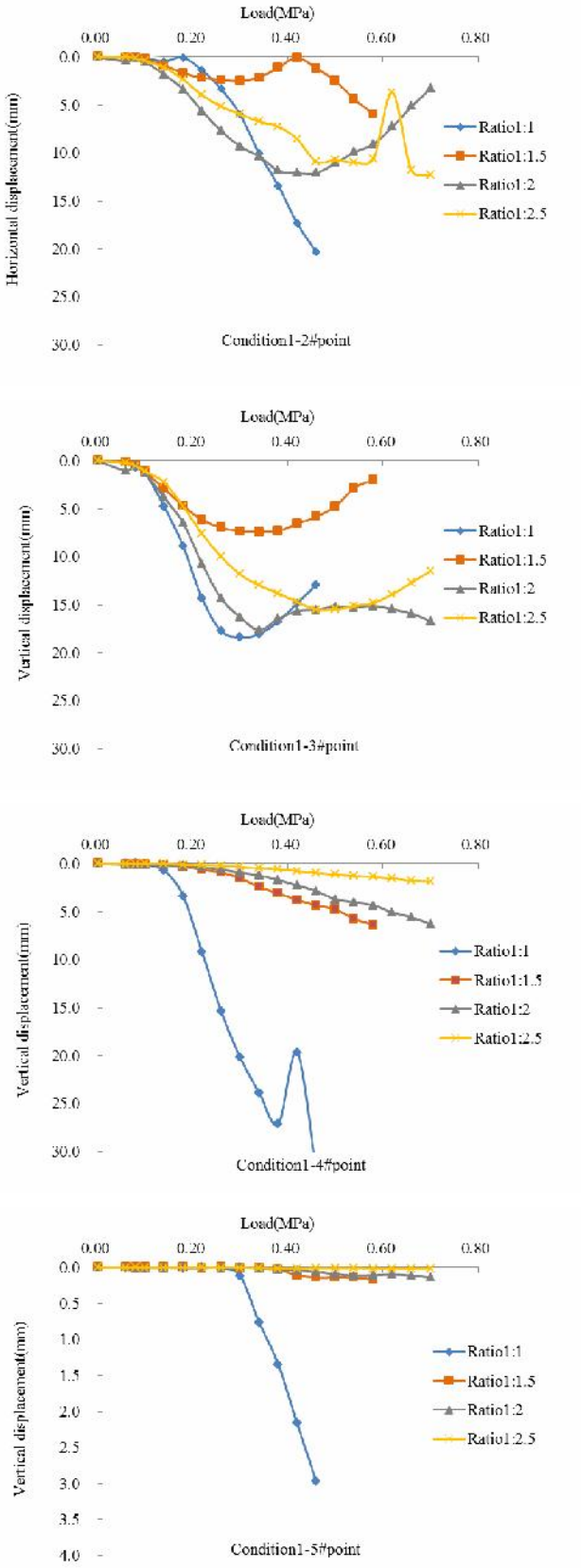


Figure 3 Measuring point displacement and load curve

When the slope ratio is 1:1, the displacement of each measuring point increases sharply point, indicating that subgrade deformation will occur in subgrade under this load shaped. With the load continues to increase, the overall slope of subgrade slope will occur moving, this and measuring point 2 and measuring point 3 appear to increase with the load the corresponding displacement bounce; when

the load increases to 0.30 MPa, measured the displacement of point 5 increases from zero and the curve shows that the load continues increase, the overall slope of subgrade slope occurs. After the end of the experiment, simulation subgrade slope overall sliding surface shape is not obvious, there are obvious uplift. Slope ratio of 1:1.5, the initial load, 4 #, 5 # measuring point displacement close to zero, with the load increased to 0.40 MPa, 5 # measuring point only then began to increase, which shows that the simulated roadbed under the action of load. First, local depression deformation occurs, with the load continues to increase, the roadbed slope will slide overall. After the test, simulate subgrade slope the overall shape of the sliding surface changes are not obvious, the top of the subgrade obvious long Start.

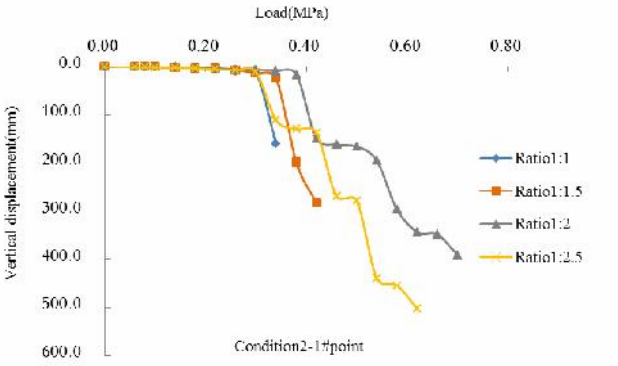
When the slope ratio is 1:2.0, the displacement of the top and the top of the slope is vertical and lateral obviously. The horizontal displacement of measuring point 50 cm away from the top of the slope is smaller. 50 cm away from the bottom of the test point in the upper load level increased to a certain value. The displacement increased sharply, indicating that the simulated subgrade slope is on the part of the bearing plate under the action of stress, there is less possibility of overall slump, and the main subgrade local depression deformation occurred; after the test, the subgrade slope rupture surface not obvious, no obvious uplift slope.

Slope ratio of 1:2.5, the top of the slope at a straight upward and lateral. The horizontal displacement is larger, the displacement at measuring point 50 cm away from the top of the slope is smaller, 50 cm away from the bottom of the test point displacement remains unchanged, indicating that the slope bearing lateral extrusion deformation occurred under the action of the carrier, resulting in the overall collapse of the test, the rupture surface of subgrade slope is not obvious, only a small amount of cracks, no obvious uplift slope.

2.3.2 The second condition

Figure 4 shows the displacement and pressure of different slope ratios in condition 2 of roadbed curve.

Figure 4 shows that the load plate initial displacement relative to the conditions 1 significantly reduced, the displacement of the measuring point with the pressure change is small. The overall stability of the simulated roadbed slope is good; when the load is over critical load (0.32 ~ 0.42 MPa), 3 #, 4 # measuring points The displacement obviously increases, indicating that the top of the slope soil slides as a whole with the increase of slope ratio, the failure of slope is from strong to weak. The slope ratio is 1:1.0, the bearing plate slides integrally with the slope, with a slope ratio of 1: 1.5, cracks began to appear on the subgrade slope, and then the overall slip occurred dynamic. Slope ratio 1:2.0, the slope of the overall destruction of cracks. When the ratio is 1:2.5, the top of the slope can be seen to bulge and the subgrade is partially depressed deformation. Slip surface is not through the foot of the slope of the plane (after the end of the experiment to verify).



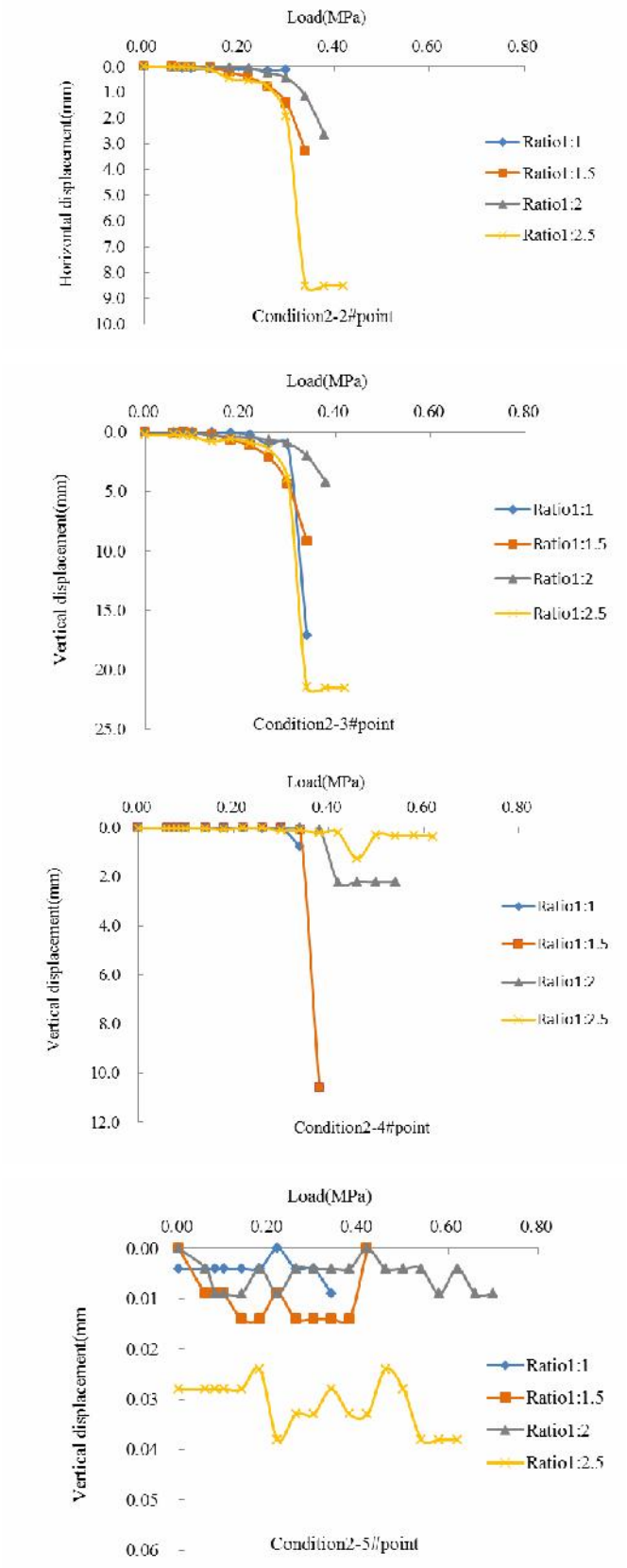


Figure 4 Measuring point displacement and load curve

3. COMPREHENSIVE ANALYSIS

In condition 1, 1# measuring point displacement under load larger. When the settlement is 500 mm, the corresponding external load varies with slope ratio Increase the trend. Load ratio is 1:2.0 and 1:2.5 when the corresponding load containing the basic approach, mainly due to the subgrade slope ratio increased to a certain extent.

When the top of the roadbed to improve the carrying capacity less. Slope ratio 1:1 and 1:1.5, the subgrade is first sent under the stress of the carrier board deformation of local depression, with the increasing of external load, the slope occurred slip and slippery surface through the foot. Slope ratio of 1:2.0 and 1:2.5, the surface of the slope is 50cm away from the top of the roadbed and the bottom of the roadbed. The measuring point of the horizontal displacement relative to the first two when the slope ratio is smaller, subgrade mainly under the action of the bearing plate partial depression deformation (Liu Cheng, Wang Xiaodong).

In condition 2, the initial load carrying capacity of the settlement plate relative to the work. Condition 1 significantly reduced. This shows the compacted subgrade under the action of less than its critical load the overall stability is good, when the upper part pressure is greater than the critical load, the top of the slope of the overall collapse occurred. Slippery does not pass slope foot, load is different, the shape of the sliding surface is not the same. Second subgrade slope than 1:1 when the load-bearing plate allowed to carry force of 81 ~ 121 kPa, slope bearing capacity of 1:1.5 allowable 64 ~115 kPa. Slope is than 1:2.0 allowable bearing capacity of 75 ~ 112 kPa, slope ratio 1:2.5 allowable bearing capacity of 73 ~ 129 kPa. When the slope ratio is 1:2.5, the top of subgrade is under additional load sink deformation occurs, the slope has obvious uplift (Zhang Yang).

4. CONCLUSIONS AND RECOMMENDATIONS

In summary, the static load on the slope of aeolian sand subgrade, the results of simulating indoor tests show that aeolian sand is in the machinery Compaction or water fall plus mechanical compaction state, slope ratio of about 1:2.0, the stability of subgrade slope is less than the critical load. When slope ratio is 1:2.0 the subgrade slope stability is not only good, but also allow the roadbed allowing bearing capacity increased significantly.

Based on the analysis of the stratified settlement of subgrade under two conditions, the subgrade settlement of the simulated embankment is larger when the conditions are filled. When the vibratory compaction the subsidence of the subgrade filler in the simulated subgrade is small. These are caused for static load on the aeolian sand subgrade compaction less impact, vibration load on the subgrade packing density had a significant impact.

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