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The Application and Analysis of Midas/GTS in Landslide Control

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Abstract:With the help of Midas/GTS software, we researched the landslide in mountain roads via analysis the force under its deadweight, understood the changes of the stress and strain and displacement of the slope, and analysis its force again that after joint the double-row anti-slide piles to the unstable area, until the slope reach a steady state at last, so as to attain the effect that prevent landslide disaster and deal with landslide event timely.

Keywords:Midas/GTS; Landslide; Anti-slide pile; Force-analysis.

I. Introduction

Yunnan province is located in the western mountainous area of China, where the terrain is complex, and more intense movement of regional geology, more frequent earthquakes. By and large, the alignment of high grade road is layout along the mountain valleys and rivers. The difference of elevation of the slope that on both sides of the road is bigger, the areas of landslide are more, we may encounter the landslide inevitably in the process of road construction. In the process of landslide harness, the method currently used is setting anti-slide piles to prevent the landslide to constantly slide. While before we set the anti-slide piles, the sliding force had been known, thus, the software of finite element analysis which good with convenience and accuracy has become a necessary tool.

Midas/GTS was researched and developed by the South Korea Midas IT, the software is majoring in finite element analysis of geotechnical engineering, and this process is accurate in the two-dimension and three-dimension geotechnical analysis, still it have many successful cases in the world. Midas have many advantages, such as quickly modeling, remarkably before and after treatment, completely Chinese interface, and so on, these merits make it widely used in the software market of finite element analysis in China.

Among many types of geological disasters, the landslide disasters distribute widely (all steep slopes are possible to occur), happening frequently, the rainy season occurs more easily. Since the development of the city, large-scale construction of highway, railway, and patterns of land use had been greatly changed. With the engineering of deep excavation and high fill earthwork increasing, the intensity of construction had been increased, as the problem of landslide disasters grew, the technology of landslide prevention has become a hot issue in engineering research. The positions to choose for setting anti-slide pile are very flexibility, and the process of construction was very convenient, its construction time was short, harness effect was good, so it was be widely used. At present, the anti-slide pile had become an effective measure to harness mountainous road landslide in our country, and its forms are changed more and more, its anti-sliding effect is becoming more and more effective.

This study was introduced a slope of the state road NO.219 as the object. We take numerical simulation for the slope by using Midas software that under its deadweight, and obtain the dangerousness when the slope under the action of its gravity stress. We are harness the dangerous slope with double row anti-slide piles, and analysis the Midas numerical model which joined the anti-slide piles, still evaluate the anti-sliding effect, not only to prevent landslide disasters happen, also to guidance the actual works of double row anti-slide piles in slope harness engineering.

II. Material and Methodology

The landmark K21+670~K21+830 is the area of landslide in the highway route NO.219, its total length is 160 meters. The landslide area belongs to heavy hilly topography where the terrain is steep. The elevation of this landslide area is between 1830m~1924m, around 94m elevation difference. Loose bed covered the slope, vegetation lush, mainly for miscellaneous wood, shrubs and weeds. Route through the landslide. Geology act mainly due to water erosion and tectonic denudation. According to the field drilling data, the rock layer of this area was as follows:

1, ⑤$_3$ silt (Q^{4dl+el}) : Grey, brown, loose - a bit tight, slightly wet - wet, the soil is relatively homogeneous, involved quartz particles and a small amount of mica, is distributing the granite area of the earth's surface.

2, ⑦$_2$ lion slope rock mass, middle grain of mica in alkaline granite ($\gamma_5^{3(3)}$) : White, black, weathering involved rust red middle grain mica in alkaline granite, granite of middle grain structure, block structure, joint development. It is acidic intrusive rocks. Strong weathering rock is shape of crushing, block stone, local short columnar section. The weathering of rock mass is short columnar, good integrity. Bearing capacity of foundation to allow basic: weathered the f_{ao} = 300 kPa; Strong weathering f_{ao} = 600 kPa; In weathering the f_{ao} = 1000 kPa.

III. Results and Tables

We are building this model by using Midas software, and taking finite element method to analysis the slope. At the first, limit freedom of horizontal direction of the model, namely route vertical degree of freedom, and limit freedom of X axis and Y axis direction at the same time. The physical and mechanical parameters of the slope are shown in table 1. Midas simulated the stress and strain of the slope that under the gravity condition,

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and the X axis and Y axis direction of displacement distribution, the results as shown in figure 1 to figure 4.

Table 1 The physical and mechanical parameters of the slope

Rock and soil type	elastic modulus (kN/m2)	Severe (kN/m2)	Cohesive force (kN/m3)	poisson's ratio	Angle of internal friction (。)
Silt	14000	18	27	0.3	20
granite	80000	26.3	50	0.3	30

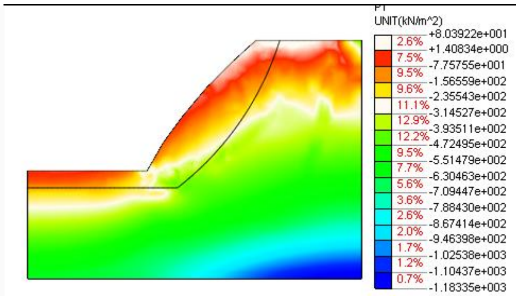

Figure 1 The distribution of main stress in the deadweight

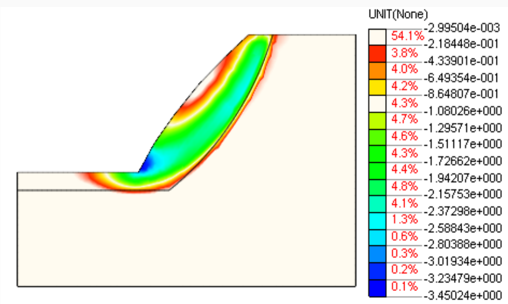

Figure 2 The distribution of main strain in the deadweight

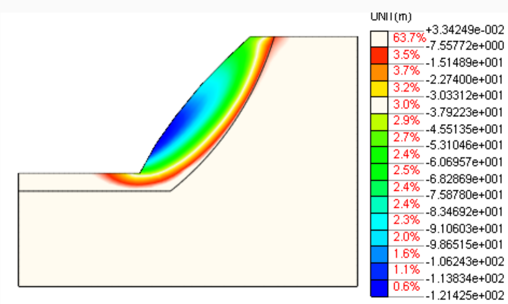

Figure 3 The displacement of X axis direction in the deadweight

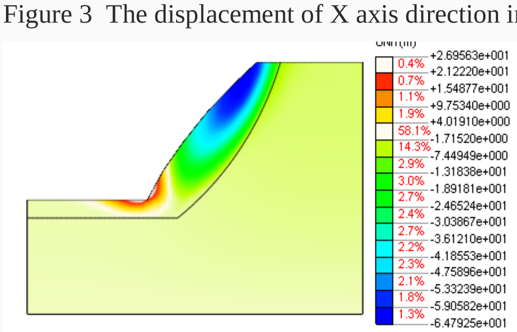

Figure 4 The displacement of Y axis direction in the deadweight

We can see on figure 1 and figure 2, the slope in its deadweight, tensile stress is concentrated in the surface layer of soil, the maximum principal tensile stress is 80.4 kPa, compressive stress is mainly distributed at the bottom of the similar type granite, the maximum principal compressive stress size of 1183 kPa, the principal strain size is between 3.4 ~ 0.003, tensile strain occurs mainly in the junction that between the bedrock and the surface layer silt. The figure 3 and figure 4 shown that the X axis direction displacement range is 121.4 cm ~ 0.033 cm, the Y axis direction displacement range between 64.8 cm ~ 26.96 cm, the maximum displacement is 121.4 cm. The simulation result shows that the safety factor of the slope when under the action of gravity stress is 0.95.

Table 2 Physical and mechanical parameters of the piles

Type		Diamet-er (m)	Leng-th (m)	Poiss-on's ratio	pile spacing (m)	elastic modulus (kN/m^2)
Anti-slide pile	Front row pile	1.4	50	0.2	6	30000000
	Back row pile	1.4	35	0.2	6	30000000

Because of the slope is soil slope, the flour soil layer is thicker. We plan to take double-row anti-slide piles to harness this slope disaster, the anti-slide piles' diameter is 1.4 meter, the space between two piles is 6 meter, the space between two row piles is 13 meter. Physical and mechanical parameters of the piles are shown in table 2.

In the Midas model of slope that governance with anti-slide piles, the constraint condition is same with the state that under the deadweight. After joined the anti-slide piles, distribution of the stress, strain, and X axis with Y axis direction displacement of the slope are shown in figure 5 ~ figure 8.

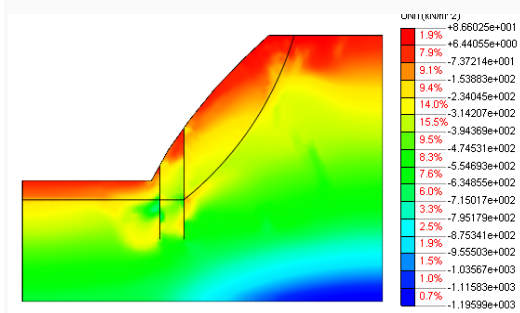

Figure 5 The main stress of the slope while after joined anti-slide piles

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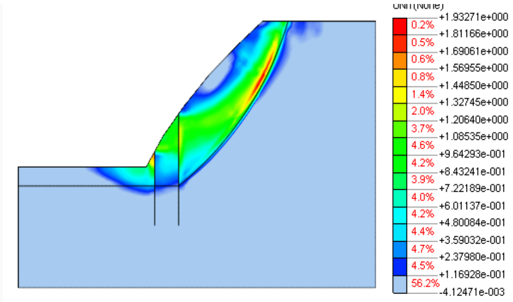

Figure 6 The main strain of the slope while after joined anti-slide piles

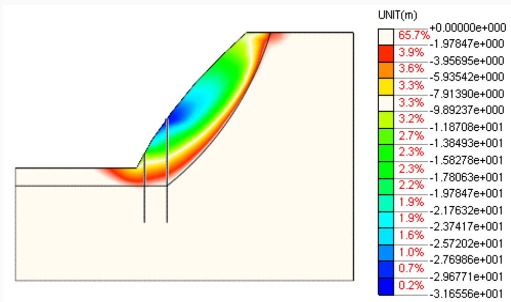

Figure 7 The X axis direction displacement after joined anti-slide piles

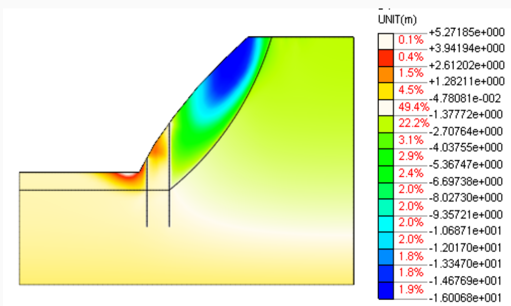

Figure 8 The Y axis direction displacement after joined anti-slide piles

From figure 5 and figure 6, we can see that the slope after governed by double-row anti-slide piles, the maximum principal compressive stress distributed at the bottom layer of granite, size of 1196 kPa. The maximum principal tensile stress distributes on the top surface layer of powder soil and rock, the size of 86.6 kPa. Principal strain between 0.004 ~ 1.93, the maximum strain is in the slide arc zone between the layer of silt and granite. The figure 7 and figure 8 shown that the X axis displacement range is 31.65 cm ~ 0 cm, the Y axis displacement range from - 16 cm to 5.27 cm, the maximum displacement is 31.65 cm, compared with 124.1 cm before it governance, reduced more, the harness effect of slide slope by taking anti-slide piles is remarkable. The result of simulation shows that the slope's minimum safety factor is 1.10 after joined anti-slide piles.

IV. Conclusion

By and large, if the safety factor of the slope is above 1.05 ~ 1.20, we think the slope is stable. In accordance with the result of analysis the Midas software simulation, the safety factor of the slope from 0.95 to 1.10 after setting anti-slide piles, the safety factor fulfill the requirements of slope stability.

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