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The application of supporting technology by frame with pre-stressed anchors and anchor-plates in one slope engineering

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ABSTRACT

Based on the superhigh slope in LongNan, Gansu province, the new supporting technology by fame with pre-stressed anchor-plates was proposed to use in the fill area. This technology is an improved technology of pre-stressed anchors. The technology of pre-stressed anchors was better used in the excavation slope project. In order to ensure the fill slope stability and the convenience of construction, the technology of pre-stressed anchor-plates was invented. The monitoring datas show that the reinforcement effect is obvious in the slope by frame with pre-stressed anchors and anchor-plates, thus, the scheme could be provide a good reference for the design and construction of the similar projects in the future.

1.PROJECT OVERUEW

The slope is located in the East River District loop, the maximum height of the slope is 42m, and the minimum height is 17m.The slope length is 324m. Original slope in weathered unloading, under the combined effect of rainfall and human engineering activities, a variety of natural or artificial internal and external stress, there are different degrees of collapse, rock fall and falling rocks and other geological disasters, which will have the impact of road traffic safety. According to the actual situation of the scene, intending to use frame supporting structure with pre-stressed anchor supporting supporting structure and anchor supporting a supporting structure reinforcement and design of the project. The original slope landform is showed by fig. 1 and Fig. 2.

2.GOVERNANCE SCHEME

Artificial slope cutting height is between 17m to 42m, the ratio of slope is 1:1, and the degree of slope is 45°, according to slope support highly optimized design scheme, choose a rating cut slope and prestressed anchor support supporting structure and anchor plate support support structure for processing scheme is safe and economical. The foundation of first grade Slope frame supporting structure with pre-stressed anchor

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supporting structure uses the short pile foundation, which can ensure the upper part of the frame supporting structure with pre-stressed anchor structure to produce uneven settlement. At the bottom of the slope reinforced concrete apron is mainly to prevent slope rain water to flow to the bottom of the slope, and then etching based, ensure the rainwater flow to road rainwater collection pipe ditch.

Fig. 1 The original landform of the slope

Fig. 2 The slope local landform

3.SITE GEOLOGICAL CONDITIONS

According to the description of the drilling site and the in-situ test results, the ground layer is divided into six engineering geological strata, respectively: Layer soil①, loessial silty clay ②, loess like silt②1, round gravel layer③, pebble layer④and Silurian system Bailong River group phyllite and gymnasium⑤, a total of six engineering geologic layer.

4.DESIGN PARAMETERS

To K0+730 slope as an example, the slope design of slope angle 45°. In slope reinforcement depth range with loess and strong weathering phyllite, the filler is filled with the Loess - like silty clay and gravel mixture, parameters of the slope of the slope are shown in Table 1.

Table 1 design soil parameters of K0+730(H=40m)

Soil layer number	Name of ground	Thickness of soil layer (m)	Heavy γ(kN/m^3)	Cohesion c(kPa)	Internal friction angle φ(^{0})	Interfacial bond strength τ (kPa)
①	Loess like silty clay (filler)	9	20	21	26	50
②	Loess like silty clay	11	17	25	25	22
③	Strong weathering phyllite	26	26	35	40	150

5.DESIGN SCHEME

Slope excavation section of the frame supporting structure with pre-stressed anchor structure for supporting, Fill section using the framework of prestressed anchor plate structure to reinforcement. Set up an unloading platform every 10 meters along the slope of height,and the width of the unloading platform is 2m. Each level slope rate from the top to the bottom of the slope are 1:1.K0+730 slope section design is shown in Fig. 3.

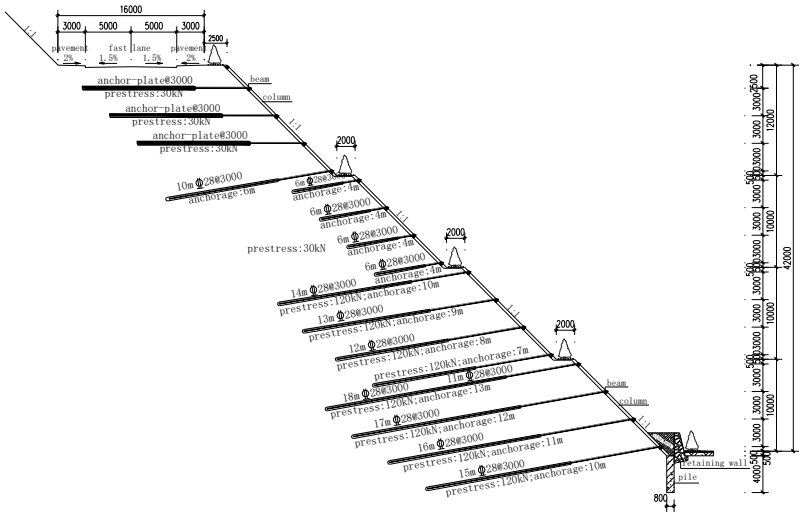

Fig. 3 K0+730 Sectional drawing (H=42m)

5.1 slope cleaning

The artificial way to clear away dust and weeds on the slope,according to the slope angle design of slope cutting processing, so that the slope angle of the slope to meet the design requirements. Cut slope is shown in Fig. 4 shows.

Fig. 4 Cut slope on site

Fig. 5 Drill hole of anchor

5.2 The design of anchor and anchor plate

The anchor's diameter is 130 mm, and the horizontal spacing is 3.0 m , anchor and the horizontal angle is 10.Anchor material selection is 32 mm and HRB400 fine rolled twisted bar, anchorage adopt the steel plate and high strength bolts, anchor free period adopt the main reinforcement processing to prevent corrosion, while the main reinforced using butter and outsourcing PVC casing, and then using M25 cement slurry outside casing, finally,the free end is seal. Pedestal is C30 concrete plate, width is 200 mm, thickness is 150 mm , using double reinforcement Φ10 @ 150 x150 10, and

row spacing is 100 mm. Anchor hole as shown in Fig. 5, bolt production as shown in Fig. 6.

Fig. 6 Anchor production

Fig. 7 Anchor plate reinforcement

Anchor plate shape is rectangular, made of reinforced concrete, thickness is 100 mm, the area calculated with pulling force according to the need for. In order to increase the friction, corrugated plate surface can be made of corrugated-core,etc.Horizontal spacing of anchor plate and the vertical spacing are 3m, anchor plate with the horizontal angle is 10. Anchor plate reinforcement as shown in Fig. 7, anchor plate casting as shown in Fig. 8, anchor plate layout as shown in Fig. 9.

Fig. 8 Anchor plate casting

Fig. 9 Anchor plate layout

5.3 the drainage

Bottom with 500 mm ×500 mm concrete gutter drainage, drainage slope is 3%. Every platform adopts 300 mm ×300 mm horizontal drainage gutters. At the vertical direction setting a 30m's drainage gutters, width is 500 mm, fill dense with asphalt hemp thread.

5.4 frame beam

Beam and column are formed with orthogonal , beam and column section size is 300 mm ×300 mm, and adopts C30 concrete, protective layer thickness is 30 mm, encryption area range is 500 mm, stirrup used HPB300 reinforcement, longitudinal reinforcement using HRB335 reinforced. Every 18m set up the deformation cracks along the length direction, the deformation cracks from slope top to bottom, seam wide is 50 mm , waterproof material is asphalt hemp thread, completely filled.

5.5 anticorrosive processing

The anchorage adopts steel fabric cover after derusting, painting anticorrosive paint, buried into the C30 cast-in-place concrete, thickness is 100 mm, protective layer thickness is 50mm; Free period adopt the high quality PVC plastic casing corrosion, within 100 mm long fill butter corrosion on both ends of the casing, around outside engineering tape fixed, one end connected to the anchorage, the other side into the anchoring section is 500 mm.

5.6 fill process

Firstly, clear slope surface humus soil and the miscellaneous soil at the slope fill process , the original slope excavation steps, the steps' width and height are 300 mm, the fill materials select of pebble and loess powder mixture of clay, according to the loess powder clay: pebble = 2:8 mix, construction technique adopts hierarchical rolling, rolling layers of virtual height is 30 cm, after rolling compaction coefficient is not less than 0.96.

Fig.10 Partial completion of slope

Fig. 11 Overall completion elevation of slope

6.ANALYSIS MONITORING DATA

According to the design requirements, in accordance with the safety of the slope engineering and the actual situation, starting slope monitoring of the top horizontal displacement and vertical displacement from October 16, 2015. The slope was finished in May 20, 2016.And the completion of slope was shown in fig.10 and fig.11.

The level cumulative displacement of slope monitoring as shown in Fig. 12, vertical cumulative displacement monitoring diagram as shown in Fig. 13. Slope monitoring by the end of May 6, 2016, as can be seen from the Fig. 12 and Fig.13, slope has stabilized at the end of December 2015, the displacement change rate become slowly, the maximum horizontal displacement of slope of point 1 to point 6 were 10.1 mm, 10.2 mm and 10.2 mm, 10.9 mm, 10.3 mm and 10.4 mm, the maximum vertical displacement of the slope of point 1 to point 6 were 7.9 mm, 7.3 mm and 7.5 mm, 7.6 mm, 7.4 mm and 7.4 mm.Pile top horizontal displacement monitoring alarm value take cumulative value, the cumulative value up to 50 mm or every day displacement value is more than 3 mm, appearing continuous cumulative displacement change for a few days.

7.CONCLUSIONS

(1)From the monitoring results, pre-stressed bolt support frame structure and the anchor plate has excellent effect on retaining structure horizontal displacement and vertical displacement

(2)Frame pre-stressed anchor supporting structure can be widely used and excavation slope engineering, and the framework of pres-tressed anchor plate supporting structure is a new kind of supporting structure, can be applied in filled slope.

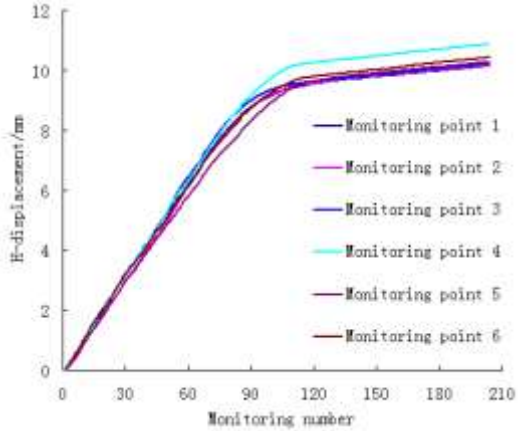

Fig.12 The horizontal displacement of slope

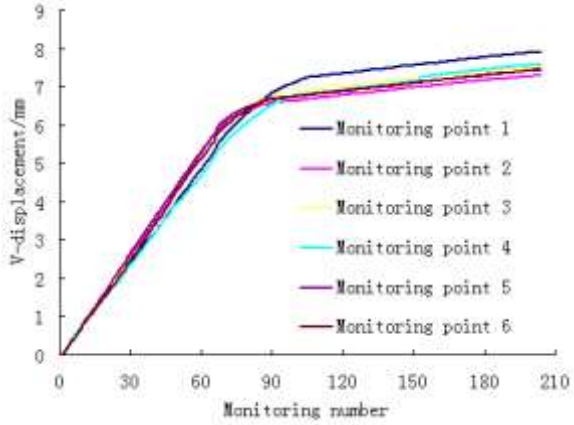

Fig.13 The vertical displacement of slope

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