Geological Characteristics Analysis and Treatment of a Dangerous Rock Deformation Body

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Abstract: This paper details the deformation characteristics of a dangerous rock deformation body. Although the dangerous rock deformation body is stable as a whole, its rear edge is still undergoing continuous creep deformation. Under the induction of external factors such as heavy rainfall and earthquakes, local collapse or even large-scale instability may occur at any time. Through systematic geological investigation and stability analysis, a comprehensive control scheme dominated by passive protection, combined with active protection nets, anchoring, manual danger clearance and crack sealing, is adopted to effectively control the potential geological hazards of the dangerous rock deformation body.

Keywords: Deformation Characteristics; Stability Analysis; Landslide Control

1. Engineering Background

The earthquake not only caused a large number of casualties and economic and property losses, but also induced numerous secondary geological disasters such as collapse, landslide and debris flow. These hidden dangers of major geological disasters are urgent, harmful and highly dangerous, which not only seriously endanger the safety of life and property of urban residents, but also seriously affect the overall arrangement and requirements of post-disaster recovery and reconstruction work. According to the field investigation and interview, there are many dangerous rocks in the collapse area, including villagers in the village gathering point, tourist hotels and provincial roads at the foot of the slope, which directly threaten the lives and property of tourists below during the tourist season.

2. Topography

The collapse is located on the mountain on the north side of the new village gathering point. The terrain slope of the mountain is steep, generally 30° ~ 50°, and it is steep locally, and its slope can reach more than 80°, which is almost vertical. There are many dangerous rock belts and dangerous rock monomers on the slope, mostly developed in steep slopes and steep cliffs. The landform of the exploration area belongs to erosion and erosion slope landform, and there is no wide and gentle platform in the area, all of which are slopes. This survey adopts independent coordinate system, with the highest elevation of 2128m, the lowest elevation of 1608m and the relative height difference of 520m (see Figure 1). According to the field investigation, the landforms in the exploration area can be divided into three landforms: slope landform, steep cliff landform and gully landform, which are as follows:

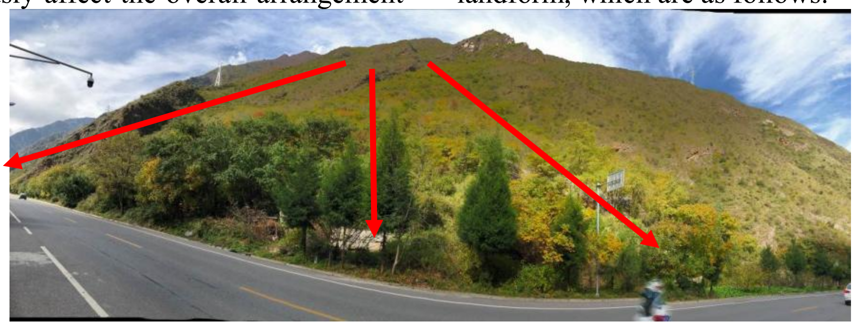

Figure 1. Overall Slope Topography of the Exploration Area

(1) Slope landform

The slope is located at the inner side of the provincial road at the gathering point of Xincun. The slope slope is generally 30°~50°, the average slope is about 45°, and the slope aspect is 150°~170°. The overburden on the slope is mainly composed of colluvial slope blocks and gravel soil. The exposed parts of some bedrock are steep cliffs and scarps. The elevation of the whole slope is about 520m. There is no broad and gentle platform on the slope body. Shrubs and grass develop on the slope body. The vegetation coverage rate is about 70%, and the vegetation is dense.

(2) Steep Cliffs

The steep cliff is located at the place where the topographic gradient changes and the bedrock is exposed. The joints and cracks are developed at the steep cliff, the rock mass is broken, and the local rock mass on the surface layer is loose. The topographic gradient at the steep cliff is steep, generally the slope is 55°~85°, and the relative height difference can reach 10~60m.

(3) Gully

Three large gullies are developed in the exploration field (see Figure 2), among which G1 gullies are oriented at 336° and about 450m long. The gullies are developed at the right lower part of WYD4 dangerous rock zone and WYD5 dangerous rock zone. There are many slope stones accumulated in the gullies, mainly those after WYD4 and WYD5 collapse. Below the gullies are provincial roads and new village gathering points. G2 gully is about 320° in direction and 500m in length. The upper part of the gully is developed at the right lower part of WYD6, and its lower part passes through the slope toe of WYD11. There are many slope stones accumulated in the gully, mainly concentrated in the lower part of the gully near provincial roads. Below the gully are provincial roads and new village gathering points, without buildings; G3 gully is about 310°~330° in direction and about 500m in length. The upper part of the gully develops below WYD15 and on the left side of WYD13. There are many slope stones accumulated in the gully, mainly concentrated in the lower part of the gully near provincial roads. Below the gully are provincial roads and new village gathering points.

Figure 2. Topographic Map of the Exploration Area

3. Formation Lithology

According to the engineering geological survey and mapping, the strata exposed in the exploration area are Quaternary colluvial deposit (Q_4^{col+dl}), Quaternary alluvial-diluvial deposit (Q_4^{al+pl}) and metamorphic sandstone of Triassic middle Zagashan Formation (T_2^{zg}) from old to old.

(1) Quaternary colluvial deposit (Q_4^{col+dl})

Quaternary colluvial deposit (Q_4^{col+dl}): grayish yellow and gray, mainly composed of crushed stone and clay. The lithology of crushed stone is mainly metamorphic sandstone with grain size of 2~ 80cm and maximum of 120cm. The ratio of rock to soil is about 3:7. The upper part is loose and the lower part is medium dense. This rock layer is mainly formed by weathering and peeling of metamorphic sandstone and collapse accumulation of dangerous rock. This layer is distributed on the slope body of the whole exploration area.

(2) Quaternary alluvium and diluvium (Q_4^{al+pl})

Quaternary alluvium (Q_4^{al+pl}): gray, mainly composed of sand pebble and block gravel, locally containing gravel and viscous components, loose to slightly dense, with good roundness of block gravel. Its parent rock component is metamorphic sandstone. The pebble particle size is 2cm~ 40cm, and the maximum particle size can reach 60cm. The rock and soil of this layer are mainly distributed on both banks of river and Xincun aggregation point, and are river alluvium.

(3) Middle Triassic Zagashan Formation (T_2^{zg}) metamorphic sandstone

Metamorphic sandstone of Zhagashan Formation (T_2^{zg}): grayish yellow, gray, residual texture, massive structure, mainly composed of quartz, upper rock mass is strongly weathered layer, joints and fissures are developed, rock mass is broken, surface rock mass is partially loose, rock quality is relatively soft, lower rock mass is moderately weathered layer, sandstone strength is relatively high, massive structure, affected by structure and weathering, joints and fissures are developed in unloading zone of rock mass, and the whole exploration rock mass is relatively broken.

4. Undesirable Geological Phenomena

The unfavorable geological phenomena in the exploration area mainly include a slope, dangerous rock belt and dangerous rock monomer, slope slope block stone and slope block stone accumulation area.

Dangerous rock zone and dangerous rock monomer, showing wide range and large scale. It is mainly concentrated in the exposed section of steep cliff bedrock and formed by weathering of metamorphic sandstone. Among them, most of the dangerous rocks are steep dip, crack development, crack width is about 2~5.0cm, the maximum width is about 10.0cm, and there is basically no filling material in the crack. In the early earthquake, the rock mass in the exploration area is subjected to the vibration of seismic shear wave and longitudinal wave, the joint crack in the rock mass is further developed, extended and expanded, and the crack width is further enlarged, resulting in more developed cracks in the dangerous rock mass, some of which have been connected, the rock mass stability is poor, and the phenomenon of rock block falling and dangerous rock often occurs. Some dangerous rock units in the dangerous rock zone are separated from the parent rock, with large unit volume, many threat objects and poor stability of dangerous rock units.

The slope block stones are widely distributed, numerous and scattered in the exploration site. According to the field investigation, a large number of slope block stones are distributed on the whole slope body in the exploration area. The slope block stones vary in size, and there are many large block stones, with the particle size generally 0.5~2m. The slope body is dense with trees and shrubs, and the trees growing on the steep slope hinder the movement of small isolated stones on the slope, resulting in small isolated stones falling for a certain distance and staying on the slope after encountering trees. According to the site investigation, small isolated stones could be seen at the roots of trees. According to the field engineering geological survey and mapping, there are 3 slope rock accumulation areas distributed on the whole slope body, 3 slope rock accumulation areas are distributed on the lower part of the slope body, 1 slope rock accumulation area is developed on the middle and upper part of the slope body, and a large number of dangerous rock blocks falling down from the upper dangerous rock zone are distributed in the slope rock accumulation area, and the grain size and square quantity of the dangerous rock blocks are relatively large, most of which are about 0.5~1.5m, and the maximum can reach 2.5m; At the same time, most of the slope rolling stones have no support at the front edge, and are easy to roll along the slope under the action of rainstorm and earthquake. In this "8.8 earthquake", many slope rolling stones roll along the slope and jump to the bottom of the slope.

5. Stability Evaluation of Dangerous Rocks

According to the on-site engineering geological survey and mapping, after the previous earthquake, the structural plane of the collapsed dangerous rock belt in front of the village house is affected by the earthquake, its rock mass cracks are more developed, the structural plane penetration is better, and the crack opening is wider.

After calculation, it can be seen that the 15 dangerous rock belts are in a basically stable ~ unstable state in the natural state, in an unstable ~ unstable state under the action of heavy rain or continuous rainfall, and in an unstable ~ unstable state under the action of earthquakes. With the passage of time and the long-term erosion of rainwater, the structural plane of the dangerous rock mass is gradually penetrated, and the shear strength of its structural surface gradually decreases, and at the same time, under the comprehensive action of fracture water pressure, the dangerous rock mass has the possibility of collapse and instability again.

6. Technical Plan for Prevention and Control

According to the specific situation of the distribution range, development characteristics, failure mode and hazard objects of the collapsed body, the treatment plan is adopted: passive protection is the mainstay, combined with active protection net + anchoring + manual danger clearance + crack sealing.

(1) Passive protection net: For WYD7, WYD9, accumulation area II and the slope rolling stones above, a passive protection net is set up under the slope foot of the WYD7 and WYD9 dangerous rock belts to block the rolling stones on the slope.

(2) Stone barrier + passive protection net, for WYD2, WYD3, WYD4, WYD5, WYD6, WYD8, accumulation area I slope rolling stone, set up a stone barrier on the west side of the exploration area near the relatively gentle terrain inside the highway, and set up a passive protection net in the narrow terrain on the right side of the stone barrier

(3) Pile and slab stone barrier: For the high distribution position of WYD13, WYD14 and WYD15, as well as the slope rolling stone accumulation area III. on the slope, a pile slab stone barrier wall is set up on the east side of the exploration area near the inside of the road to block the collapsed blocks;

(4) For the conditions of active protection of WYD1, WYD10, WYD11 and WYD12, and the conditions of no passive protection in the terrain of the dangerous rock zone, the GPS2 active network is used for protection of WYD1, WYD10, WYD11 and WYD12;

(5) Artificial clearance: If the cracks in the dangerous rock belt are broken and the dangerous rock blocks are cut small, the dangerous rock belt is treated by manual removal of dangerous rocks. For WY9-1, WY9-2, WY10-1, WY11-1, WY11-2, WY11-7, WY11-8, and WY11-9, manual clearance is adopted; For the eight highly threatening slope rolling stones distributed on the top of WYD10 and WYD11, manual danger removal was adopted.

(6) Anchoring: For the large volume of WY11-3, WY11-4, WY11-5 and WY11-6 dangerous rocks, steep terrain slopes, rock mass fragmentation, and no passive protective measures, anchoring is used for treatment;

(7) Crack sealing, C20 concrete crack sealing of the cracks in the dangerous rock belt, so as to achieve the purpose of reinforcing the dangerous rock mass. C20 concrete is used to seal the cracks at the trailing edge of WY11-3, WY11-4, WY11-5 and WY11-6 dangerous rock monomers.

7. Conclusion

Through systematic analysis of the geological conditions and deformation characteristics of the dangerous rock deformation body, combined with its distribution range, development characteristics, failure mode and threatened objects, a comprehensive prevention and control scheme dominated by passive protection, supplemented by active protection nets, anchoring, manual danger clearance and crack sealing is determined. This scheme can effectively block the movement path of dangerous rock blocks and slope rolling stones, enhance the stability of the dangerous rock mass, and thus effectively control the potential geological hazards of the dangerous rock deformation body, providing a reliable guarantee for the safety of life and property of residents and tourists in the lower part, as well as the smooth progress of post-disaster recovery and reconstruction work.

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