Analysis of Influencing Factors of a Dangerous Rock Deformation Body

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Abstract: This paper expounds the geological conditions of a dangerous rock deformation, and analyzes the influencing factors of dangerous rock mass, mainly including the loose and broken rock mass caused by earthquake, the reduction of shear strength of rock mass caused by rainfall, and the root splitting of weathering plants, which has caused great threat to the people.

Keywords: Dangerous Rock Deformation; Influencing Factors; Geological Conditions

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 at the gathering point, tourist hotels and provincial roads at the foot of the slope, which directly threaten the lives and property of tourists during the tourist season.

2. Topography

The project area belongs to a middle-low mountain valley landform formed by structural denudation and river erosion, with deep incision; some sections present a deeply incised medium mountain canyon landform. The entire dangerous rock mass is located in a rocky steep slope landform, with the ridge being high in the north and low in the south. The elevation of the whole hillside ranges from 1650 m to 2400 m, and the slope gradient is 45°~85°. The cliff of the dangerous rock is steep, with a slope direction of approximately 140°~180° and a gradient of 75°~85°; local sections are sheer cliffs where dangerous rocks stand tall. At the foot of the slope, some sections are steep slopes with a gradient of 45°~65°, while others are gentle slopes with a gradient of 15°~30°. The main threat targets of the entire dangerous rock area are Provincial Highway 301 and the new village below the slope. The topographic features of the dangerous rock mass are shown in Figure 1.

Figure 1. Dangerous Rock Mass Topographic Map

3. Stratigraphic Lithology

According to the on-site investigation and combined with the collected regional geological data, there are mainly Quaternary Holocene collapsed slope accumulation (Q_4^{col+dl}), Quaternary Holocene alluvial accumulation (Q_4^{al+pl}), and the underlying bedrock is Triassic Zagashan Formation (T_2^{zg}) metamorphic sandstone, which is described as follows:

(1) Collapse lamination (Q_4^{col+dl})

Gravel soil: gray-brown, brownish-yellow, pointed, angular, poor sorting, loose ~ slightly dense, particles with a particle size greater than 20mm account for about 90%, the main component of crushed stone is sandstone with a small amount of silty clay, the thickness varies from 0~9m, of which the thickness on the slope is between 0~2.5m, and the crumbling slope layer at the foot of the slope is thickly distributed, its thickness is between 4~9m, and the layer is widely distributed on the slope of the exploration area.

(2) Alluvial layer (Q_4^{al+pl}): sand and pebble gravel, which is mainly distributed in river banks and village aggregation points, gray-yellow and gray. Pebbles and gravel have poor roundness, mostly angular, particle size is mostly 5~15cm, occasionally more than 30cm blocks, and crushed rock parent rocks are mostly slate, sandstone and limestone, which are weathered.

(3) Triassic Zagashan Formation (T_2^{zg})

Metamorphic sandstone: grayish-brown, strongly weathered ~ moderately weathered, thin~medium-thick layered and massive structure, iron-calcareous cementation, the main components are quartz, feldspar, mica particles, joint cracks developed, strong weathering, single rock strata, and local development of quartz veins. The joint cracks and their development in this layer of rock mass are fragmented. The upper part is a strong wind layer, with joints and cracks, soft rock, and some can be broken by hand, while the lower part of the rock mass is hard and the cracks are more developed. The stratigraphic occurrence of this layer of rock mass is 240°∠25°, which is the main stratum in this exploration area.

4. Hydrogeological Conditions

Hydrogeological conditions in the survey area are affected by stratum lithology, structure, topography and hydrographic network cutting degree, distribution of aquifers and aquifers is controlled by geological structure, groundwater in the area can be divided into loose rock pore water and bedrock fissure water according to occurrence conditions.

(1) Loose rock pore water

It is mainly distributed in loose accumulation layer, and its water quantity and distribution are controlled by atmospheric precipitation, topographic conditions and rock soil layer properties. It belongs to seasonal upper stagnant water; it mainly receives atmospheric precipitation supply, flows along slope, and its water quantity is poor. It is discharged to rivers by evaporation and infiltration.

(2) Bedrock fissure water

It is mainly stored in bedrock cracks, and the water mainly receives the recharge of atmospheric precipitation and pore water of loose rocks, which is not easy to enrich and is relatively poor. It mainly migrates downward along bedrock interfaces and bedrock cracks, and is finally discharged into low-lying rivers.

5. Geological Structures

The county where the dangerous rock body is located is located on the anticline in the north section of Minshan Mountains in the western geosynclinal area of Sichuan Province. There are obvious fault zones on its west, north and south sides, which constitute complex and belong to the intense area of neotectonic movement. It is composed of a series of anticlines or synclines, forming a series of NE and NS structural systems. This area is located in the south margin of the east-west structural belt of Qinling Mountains, east side of Songpan-Ganzi fold system and adjacent to the north-east structural belt of Longmen Mountains in the south. The third-order structural lines with different directions form an arc curve protruding southward, while the county seat is located at the top of the curve of structural lines and is mainly controlled by the north-south structural faults. The structure in the area is generally characterized by a complex synclinal structure with a dip to north. The strata in the area are strongly folded, broken and structurally fractured.

6. Neotectonics and Earthquakes

Since Quaternary, the neotectonic movement in the area has been intense, and the intermittent uplift of the neotectonic movement has formed the third-and fourth-order planation planes, and multi-level falls and waterfalls have occurred in some valleys. Due to recent strong uplift of neotectonic movement, valley erosion is intense, forming "V" type valleys with large vertical gradient.

Affected by geological structure conditions, seismic activity in the county and its adjacent areas is frequent, and many strong earthquakes have occurred in history. According to the national seismic zoning, the basic earthquake intensity is VIII.

7. Analysis of the Factors Affecting the Formation of Dangerous Rocks

7.1 Earthquake

Before the earthquake, the dangerous rock collapse only manifested as local rockfall, and most dangerous rock zones maintained good stability, with deformation characterized by sporadic block falling without large-scale dangerous rock collapse. Earthquakes have two

main effects on dangerous rock zones: first, dangerous rocks in the epicentral area are affected by vertical seismic forces, which further fragment the dangerous rocks and trigger collapses; second, horizontal seismic forces directed outward from the slope easily cause instability of dangerous rocks. When an earthquake occurs, extreme seismic forces are generated, leading to deformation or even destruction of rock masses in a critical state.

7.2 Rainfall

The relationship between heavy rainfall and rockfall is as follows: ① More than 80% of rockfalls occur in the rainy season, and few occur in the early rainy season and dry season. ② The longer the continuous rainfall duration and the greater the heavy rainfall intensity, the more collapses and rockfalls occur. ③ Continuous rainy weather leads to more collapses and rockfalls than short-duration heavy rainfall events.

7.3 Other Factors

Weathering, plant root wedging (root splitting), and human engineering activities in the study area damage the slope structure and aggravate the deformation and failure of dangerous rocks.

In summary, earthquakes are the inducing factor for the formation of dangerous rock masses, while weathering and rainfall are the main factors affecting the stability of dangerous rock masses.

8. Conclusions

The main influencing factors of collapse include loose and broken rock and soil caused by earthquake, reduced shear strength of rock and soil caused by rainfall, and plant root splitting caused by weathering. The main threat objects are provincial roads at the foot of slope, village gathering points and passing tourists. The total number of threatened households is 43, threatening 183 local residents, and geological disasters threaten about 8 million direct properties.

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