A Landslide Treatment Technology

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Abstract: This article provides a detailed description of the basic characteristics and material structure of a landslide, analyzes the stability of the slope, proposes a support design scheme, and explains the construction techniques for each sub item.

Keywords: Landslide Control; Structural Characteristics of Landslide Materials; Support Design

1. Terrain and Landforms

The county is located at the southern foot of Micang Mountain, and the northern part of the county belongs to the Zhongshan District of Micang Mountain. In terms of geological structure, it belongs to the transitional zone between the Qinling Trench and the Sichuan Platform, located on the northern edge of the Yangtze Platform, in the fold belt of the Sichuan Basin and the northern edge of the Sichuan Basin. the terrain is high in the north and low in the south, with the highest peak Guangwu Mountain at an altitude of 2508m and the southern end of Mumen River Valley at an altitude of 370m, with a relative height difference of 2138m. Due to the influence of geological lithology, the terrain of the country is complex and the cutting depth varies. In the southeast, the Zhongshan area is controlled by faults, and the valley cutting is strong, with a relative height difference of 1200-1600m. the ridges are narrow and steep, with a steep slope. To the northwest is a monoclinic Zhongshan, with deep valleys and a relative height difference of 600-1000m, and steep rocks crisscrossing vertically and horizontally. the central part of the county has formed a generally southward sloping monocline structure with a single-sided mountain terrain, with a cutting depth of 300-1000m. the rest of the southern region has a cutting depth of 315-500m. the mountainous area of the county accounts for 95% of the total area, while the hilly and valley flat dams only account for 5%. The overall terrain in the area is high in the north and low in the south. the landform can be roughly divided into two categories: medium deep cutting erosion tectonic mid mountain terrain and shallow and medium cutting erosion (erosion) tectonic mid low mountain terrain. the former is mainly characterized by block shaped mountains, fault block mountains, folded mountains, and monocline mountains, distributed in the northern part of Nanjiang County, while the latter is characterized by single-sided mountains, quasi single-sided mountains, table shaped mountains, etc., distributed in the southern part of the county.

2. Stratum Lithology

The exposed strata in the county include the Precambrian, Paleozoic Cambrian, Cambrian, Ordovician, Silurian, Permian, Mesozoic Triassic, Jurassic, Cretaceous, and Cenozoic Quaternary strata. the strata exposed in the exploration work area include:

Quaternary residual slope deposits (Q_4el+dl)

Distributed at the top of the entire slope area, it is a powdery clay containing gravel, purple red, slightly wet, plastic, containing powder particles and a small amount of iron manganese oxides and mica flakes. the soil is uneven, slightly shiny and smooth, with moderate dry strength and toughness, a thickness of 0.4-4.2m, and an average thickness of 2.0m.

Quaternary landslide deposits (Q_4col)

It is fragmented and gravelly soil, purple red, slightly wet, and slightly dense, which is the product of the weathering of mudstone and siltstone at the top and the collapse and accumulation at the foot of the slope.

Sandstone and mudstone interbedded in the Shaximiao Formation of the Middle Jurassic (J_2s)

The slope rock mass is composed of interbedded sandstone and mudstone, with an attitude of 162 °∠ 10 °. the rock dip is inclined at a small angle to the slope direction, forming a prograde slope with a purple red to blue color and thin to medium thick layer structure. the joints and fissures are developed, and the rock mass is strongly weathered, making it the main source of landslide materials.

3. Geological Structures

The county is located on the northern edge of the Yangtze Platform, spanning two secondary tectonic units: the Chuanzhong Depression and the fold belt of the northern edge of the Yangtze Platform. the Precambrian basement in the northern region of the area is exposed on the surface through erosion caused by the Yanshan Movement, with obvious characteristics of a geosyncline. Its southern and northern edges are thrust on top of the cover layer, forming an east-west trending horst structure; the southern sedimentary rocks are the cover layer, with obvious platform type characteristics. the main direction of the structural lines in the area is northeast southwest.

The basal fold structure is mainly characterized by strong anticlines and synclines (such as the two anticlines and the Zhongzishan syncline), while the overlying folds are characterized by asymmetric short axis or linear folds that slightly deflect southward and wide and gentle folds (such as the Xinchang syncline, the Xinguan syncline, the Xinhua syncline, and the Longfengchang syncline combination). the basal edge folds are relatively strong.

There are two periods of faults in the area: the Lvliang period and the Yanshan period. the two phases of faults are concentrated in the contact zone between the southern and northern edges of the uplifted basement structure and the cover layer, and are particularly developed on the southern edge side. Both phases of the fault strike in a northeast southwest direction, consistent with the direction of the basement fold line. the Lvliang period fault is not very obvious due to magma filling, while the Yanshan period fault is more obvious and shows inheritance from the Lvliang period fault. Typical Yanshanian faults in the area include the Lanchaiba reverse fault, Daheba reverse fault, and Miaoya fault. Except for small faults that are consistent with the properties and direction of the basement at the edge of the cover layer, faults are generally not developed.

4. Hydrogeological Conditions

The work area is located in a single-sided mountainous area, which is controlled by the lithology, topography, and structure of the strata. the types of groundwater include upper stagnant water and bedrock fissure water (including structural fissure water and weathered zone fissure water), with bedrock fissure water being the main type. the enrichment of groundwater is controlled by topography, lithology, structural location, and spatial combination of structures, and the occurrence patterns of different types of groundwater vary.

The groundwater in this area is generally replenished by atmospheric precipitation, agricultural irrigation water, and surface water. Due to the covering layer being composed of silty clay containing gravel and the underlying bedrock being mudstone, there is more stagnant water in the upper layer. On the west side of the slope is a steep cliff. After rainfall, surface water is discharged and collected on the slope, and there is agricultural irrigation water. the upper layer of stagnant water is buried shallowly, usually 1.5m deep. Long term immersion in water at the base cover interface can easily lead to landslides that slide along the base cover interface.

Bedrock fissure water occurs in the Jurassic Shaximiao Formation, with sandstone as the main aquifer and mudstone as the relatively impermeable layer. the sandstone layer is 15-20 meters thick, and the development of its structural fissures affects the water yield of groundwater. Generally, cracks are not developed, groundwater storage conditions are poor, and groundwater volume is scarce.

5. Human Engineering Activities

The county has abundant land resources and belongs to a resource-based economy. the development of land, minerals, hydropower, forests, tourism and other resources is booming, and the construction of urban and rural areas as well as highways is developing rapidly. Human engineering activities include agricultural cultivation, mineral development, urban and rural areas, and road construction.

Unreasonable urban, rural, and transportation engineering construction activities alter the natural shape of the slope, forming steep and high slope terrain, increasing the free face or load of the slope, affecting or disrupting the stress balance of the slope itself, and causing landslides, collapses, or the development of potentially unstable slopes.

6. Landslide Morphology and Boundary Characteristics

6.1 Landform of Landslide Area

The landslide is located in the central part of the county, with a generally southward sloping single-sided mountain slope. the slope is mostly paddy fields, with some areas being dry land. On the west side of the landslide is a steep cliff with exposed bedrock, ranging from 10-40m in height. the rock type is sandstone from the Shaximiao Formation of the Jurassic System. On the east side, there is a line between the middle gully and the inclined rock gully of the slope. the rear edge is the boundary between steep and gentle terrain, and the front edge is located in a relatively low and gentle depression with a thick soil layer. the elevation of the rear edge of the slope is 820m, the elevation of the front edge is 671m, and the relative height difference is 149m (see photo 4-1).

During this survey, 12 obvious cracks were visible on the landslide body, revealing the deformation characteristics of the landslide through the development characteristics of these cracks. In addition, houses on the slope are affected by landslides, causing cracks in the walls. the deformation characteristics of the landslide can be determined based on the direction of the cracks.

According to the different deformation conditions of landslides, they are divided into strong deformation zones and weak deformation zones. the strong deformation zone of the landslide is located in the middle and rear of the landslide, with a valley shaped plane and a low-lying terrain compared to the surrounding terrain. the rear edge and both sides of the strong deformation zone are bounded by the landslide boundary, and the front edge to the boundary area where the deformation weakens sharply and gently. the other areas are weakly deformed zones. the strong deformation zone began to deform in the 1990s, and after a heavy rainfall, the rear edge began to move downwards by 0.4-0.5m, forming three long cracks on both sides. Since 2009, there has been a general rainstorm in Bazhong area, and the landslide deformation has intensified. Cracks have appeared in the east and front edge of the strong deformation area, and houses in the east of the weak deformation area have also been deformed.

Figure 1. Overall View of Landslide

6.2 Boundary Characteristics of Landslide Area

The Erhuangping landslide is located in San She, Bailiang Village, Ganchang Town, with a geographical range of N32 ° 23 ′ 13 ″~32 ° 23 ′ 31 ″ and E106 ° 54 ′ 31 ″~106 ° 54 ′ 39 ″. the rear edge elevation is 804m, the front edge elevation is 725m, the relative height difference is 79m, and the plane is "water bottle shaped". Most of the landslide area is paddy fields, which form a stepped shape from high to low.

The landslide has a longitudinal length of 478 meters and a transverse width of 50-160 meters. the thickness of the sliding body is 0.7-4.2 meters, and the volume of the landslide is about 28 × 104 cubic meters. the main sliding direction is 159 °, and the slope is 11 °. It belongs to a shallow medium traction type soil landslide. the sliding body is composed of silty clay containing gravel. It is speculated that the sliding zone is the base cover interface, the sliding bed is mudstone, and the rock attitude is 162 °∠ 10 °.

The boundary behind the landslide is the last level crack; On the west side of the landslide is a steep cliff with exposed bedrock, reaching a height of 10-40m; From the front edge to the gully C1 to the front edge of the building, Yuexing National First Line; On the east side, there is a shear crack L3 in the middle of the slope to the inclined rock ditch.

7. Characteristics of Landslide Material Structure

According to drilling and well exploration, the lithological characteristics of the sliding soil from top to bottom are as follows:

(1) Structural characteristics of sliding material

The sliding body is clay, yellow brown to gray white, plastic, loose in structure, containing a small amount of angular gravel, about 5%. Its lithology is mainly sandstone, with angular shapes and particle sizes ranging from 0.01 to 0.05m.

(2) Structural characteristics of sliding bed material

According to the drilling results, the sliding bed of the landslide is composed of mudstone from the Jurassic Middle Shaximiao Formation (J2s), with an attitude of 162 ° C and a dip angle of 6 ° C 10 °, strongly weathered zone with a thickness of 1-4m, underlying moderately weathered blue sandstone. According to the drilling, the strongly weathered mudstone is purple red in color, fragmented, and can be broken by tapping (see photo 4-28); Moderately weathered sandstone is in the shape of short to long columns, with intact rock cores and no weak interlayers found. There are obvious nearly vertical joints, with an occurrence of 164 ° ∠ 77? Closed, no dissolution phenomenon.

8. Characteristics of Sliding Soil

The sliding zone is clay, yellow brown to gray white, soft plastic, with a smooth feeling when touched by hand, with a thickness ranging from 0.1m to 0.7m, containing a small amount of round gravel, about 5%. Its lithology is mainly sandstone, with good roundness and particle size ranging from 0.01 to 0.05m.

9. Design of Sub Projects for 9 Governance Engineering Schemes

9.1 Anti slip Pile Support Engineering

The strong deformation zone section I-I 'is equipped with A-type anti slip piles and B-type anti slip piles. When designing these two levels of anti slip piles, the resistance of the piles needs to be distributed in stages. the remaining sliding force in the middle of section I-I' is calculated separately as 250KN, and the remaining sliding force at the leading edge of section I-I 'is calculated separately as 400KN. According to the principle of graded distribution of resistance, the remaining sliding force at the leading edge of section I-I' should be distributed as 150KN. On this basis, a safety reserve should be increased, so the remaining sliding force at the leading edge of section I-I 'should be distributed as 250KN. the remaining sliding force of A-type anti slip pile is calculated to be 250KN, and the remaining sliding force of B-type anti slip pile is calculated to be 250KN.

(1) A-type anti slip pile

a Engineering layout

According to the calculation of stability and residual sliding force, under rainstorm conditions, the safety reserve of the rear edge I-I 'profile in the strong deformation area is insufficient, and it is proposed to use A-type anti slide piles to support the rear edge of the rear edge I-I' profile in the strong deformation area.

(2) B-type anti slip pile

a Engineering layout

According to the calculation of residual sliding force based on graded allocation, it is proposed to use B-type anti slip piles for support in the front part of the I-I 'section at the rear edge of the strong deformation zone.

(3) C-type anti slip pile

a Engineering layout

According to the calculation of stability and residual sliding force, the safety reserve of Wuyuanjunjiaqian Yuexing National Rear II - II 'section at the front edge of the weak deformation area is insufficient under rainstorm conditions. It is proposed to use C-type anti slide piles at the rear edge of Wuyuanjunjiaqian Yuexing National Rear II - II' section at the front edge of the weak deformation area for retaining.

9.2 Drainage Ditch Engineering

The drainage ditch is arranged on the west side of the strong deformation zone, with a weir in the middle. It is discharged from the east side of the slope and has a total length of 210m. It has a trapezoidal cross-section, with an upper bottom width of 0.9m, a lower bottom width of 0.6m, a height of 0.6m, and a thickness of 0.2m. Experience meets the requirements.

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