# Research Status and Progress of anti-slide pile in Pan-Xi highway Landslide

Qian ZHANG[1, a], Lixia HE [2, b]

[1] Department of Civil Engineering and Architecture, Panzhihua University, Panzhihua, 617000, China

[2] Department of Civil Engineering and Architecture, Panzhihua University, Panzhihua, 617000, China

[a]email: 418677556@qq.com, [b]email: 915103348 @qq.com

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**Abstract.** Based on the careful study and summarize of several major landslides and the construction technology of anti-slide pile in Pan-Xi Highway, from the perspective of the construction quality control and summarized, taking into account the general technical guidelines to be followed by anti-slide pile, we try to analyze status and development of anti-slide pile used in highway landslide governance. It has direct significance in the construction highway; it also has a reference for anti-slide pile construction quality control of other proposed mountain highways.

## Introduction

Pan-Xi Highway located along the Pan-xi rift zone, which is the main area of the landslide distribution，This region is not only large in scale and types, but also widely distributed, occurring frequently and serious harm. As a national key construction projects of ADB loans Landslide has become one of the important tasks of the Highway Construction. Poor governance is not only cannot stop the decline, reducing harmful levels of landslides, but also because the excavation induced new or more large-scale landslide blocked the river, destroying transportation facilities, burying villages, seriously affect the safety of the future highway operations （Figure 1）. Pan-Xi Highway distributed along the valley slope of Anning River valley and parallel with the Chengdu-Kunming railway（Figure 2）, measures and construction quality Landslide highway not only related to the safety or not, the impact on the Chengdu-Kunming railway is also crucial significance. Therefore, in China there is not a unified standard anti-slide pile construction technology, so we should research and study the status and development of landslides about Pan-Xi Highway.

Figure 1 One section of Pan-Xi highway bridge

Figure2 Anning river section of Pan-Xi highway

 

## Introduction of Landslide

Pan-Xi Highway Walks through the valley slope of Anning River ， along the formation, it mainly outcrops the Aurora basement rocks, Jurassic, Triassic clayey sandstone and shale of silty and a lot of exposed Xigeda Tertiary soil, Quaternary heap-based slope sediments, a variety of folds, faults, joints, fractures are well developed, inherited activity faulting frequent seismic activity at different depths and different magnitudes have occurred, coupled with the steep terrain in the area, the larger catchment area, rich surface water and groundwater, and therefore a potential landslide slip lure many factors against sliding pile of construction are higher, the difficulty of construction, high technology content.

There are different types and large-scale of landslides in Pan-Xi Highway. Summed up with the following basic characteristics: apparent landslide perimeter, with multi-level landslide wall, the wall tens of centimeters to several meters high, ranging mostly armchair looks like or muddy park-like, cut export or slip of the tongue than outstanding, and accompanied by a large number of tension cracks, fissures and shear cracks bulge along the landslide fissures have more groundwater seepage, survey shows that there is a partial pressure of water. Slide belt Triassic and Jurassic clay-based, thickness 0.40 ~ 2.0m range, soft and slightly wrinkled surface very slippery and development, composed of many different sizes and mixed hard and soft oval-shaped flexible body structure, and most are middle-deep rock landslide, mostly caused on the of the construct landslide, there are a few traction landslide. The following characteristics for the Pan-Xi Highway numerous landslide, the status and development of anti-slide pile will be discussed.

## Development of Anti-slide Pile

From the mid-19th century abroad began research on landslide disaster prevention, but early due to the variation of the nature and landslides does not understand, for those large and medium-sized landslide only bypassing. Until after World War II, with the development of national economies and the development and utilization of land, landslides encountered more and more, the employer is a large landslide supporting and retaining project management really began [1].

Development of support and retain engineering has undergone several stages: 60 to 70 years, in order to apply the main drainage works and skid retaining walls, while vigorously developing applications of stabilizing piles to solve skid pile retaining wall construction difficulties. For example, European countries and the former Soviet Union, more use of reinforced concrete bored piles, diameter 1. 0 ~ l. 5 m, depth of 20 ~ 30 m, Japan, more using drilling steel pipe piles, drilling diameter 400 ~ 550 mm, depth 20 ~ 30 m, in order to increase the bending capacity of the pile and pile group by force, often two or three rows with the top row of the pile cap connection, forming rigid frame by force. The late 1970s, Japan began to apply in diameter digging 1.5 ~ 3.5m of anti-slide pile. Since the 1980s, at the same time, anti-slide pile of small diameter applications for management of large landslides, large-diameter hole to start using anti-slide pile. Domestic systematic study of landslide hazards and governance is only the beginning of the 1950s. According to China Studies has developed a series of effective prevention measures, summed up the principles and methods of bypassing, drainage, retaining, weight loss, anti-pressure and other governance landslides, especially in the railway sector experiencing the largest landslides and governance. China started research and development and application of anti-slide pile is far more foreign nights, but due to the need for the construction of governance landslide [2], the development process is basically synchronized with foreign countries.

## Problems in the Current Study

Anti-slide pile has become a major engineering measure in landslide remediation projects. In the calculation of anti-slide pile, due to the inherent flaws displacement method and finite element method, there is still pressure in the engineering design process based, and complete a variety of slope stability analysis method was used to design anti-slide pile pressure method computing

provides the necessary preconditions find the most dangerous slip surface position. According to stability analysis method, calculating the landslide thrust on anti-slide pile, thus stabilizing piles internal force calculation, it is essential to calculate anti-slide pile process. However, in the calculation of the anti-slide pile that still has many deficiencies, mainly in the following aspects.

1. Some studies abroad are mainly about calculations of soft soil and anti-slide pile dam engineering. The slope is considered to be an ideal elastomeric or plastic material, which is more difficult to determine the role of the load on anti-slide pile, and these experiences and methods were limited scope. While a few methods to calculate the effect of stabilizing piles of earth pressure limit, but in general, anti-slide pile slope corresponding body may not meet these extreme conditions, only as a method of control design were checking. For the load on the anti-slide pile, which calculated by the landslide thrust in our country, this is a better way to stabilizing piles associated with the stability of landslide, but on the landslide thrust calculation, often regardless of the conditions shall be calculated using the transfer coefficient method [3], it would make the landslide thrust that calculated inconsistent with the actual.

2. Whether foreign or domestic, it is an effective method that researching transfer process of landslide thrust between anti-slide piles by Arch theoretical soil[4], although now a preliminary study, but they were rougher, there is no action that landslide thrust transfer mechanism between the slope of the pile under the soil arching effect. As for the biggest pile spacing is determined, the current method does not fully consider the effects of soil arching between piles, piles slip before stabilizing body and may limit the carrying capacity of the pile.

3. Existing interaction model of anti-slide pile and landslide substantially all belong to the category of pressure method, the load values and distribution of anti-slide pile are determined based on the general engineering experience, and cannot consider the impact of the relative displacement between pile and soil. In fact, due to the anti-slippery piles are passive pile, it is through the relative deformation of soil to load on the pile, so the force of anti-slide pile is closely related with the relative deformation of soil, which is also one of the main disadvantages of calculating internal forces of stabilizing piles used by pressure method.

4. Internal force calculation method of stabilizing piles, the rock mass is calculated as an ideal isotropic elastic material, the practical engineering rock mass, especially it’s broken rock slope, which is a far cry from the ideal elastomeric, and because of the complexity of the calculation , the method is rarely used[5]. The calculation method of rock and soil deemed elastic foundation model Winkler, due to its simplicity and engineering experience and has been widely used, its main drawback is not considered continuous of foundation, Winkler foundation model in describing the actual state of the continuity of the soil defects and elastic continuum model mathematically inherent complexity of the existing calculation methods need to be improved.

5. Soil arching effect has gone through 100 years of history from concept to theory development, but there are still some issues worth exploring, such as existing form of the arch foot, shape of the arch, geometric parameters of arch, and mechanism of interaction between landslide parameters and soil arching, and so on.

## Conclusion

Although we have achieved more results of theoretical studies on the anti-slide pile, but it not yet mature, the urgent needs of the majority of scientific laboratory workers more in-depth study and exploration on its real force performance and working mechanism. On the basis of security, we can maximize the ability of anti-slide pile in order to achieve reasonable economic purpose.

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