

# A Review on the Research Progress of the New Anti Slide Structure

Jun YANG

Chongqing Jiaotong University, School of Civil Engineering, Chongqing, China

**Abstract:** Because of its high stiffness, good stability, convenient construction, strong resistance to the advantages of landslide control and slope protection are widely used. The anti slide pile work principle is mainly from the surface to a certain depth of the pile body, by means of rock socketed end rock soil system and passive resistance to balance sliding body of rock and soil landslide thrust or the slope of the pressure to maintain the landslide slope stability state. Firstly, the analysis of the existing ordinary anti slide pile anti slide mechanism, there are insufficient, which leads to two important anti slide structure, i.e., H type anti slide structure, and composite type ladder structure.

**Keywords:** New anti slide pile; H type anti slide pile; Composite ladder key structure; Anti sliding mechanism

## 1. Introduction

Anti slide pile anti slide effect is mainly the stable formation of anchoring effect and passive resistance to balance the landslide thrust. With other anti slide projects such as anti sliding retaining wall, compared to the anchor, its anti sliding ability, wide applicability, is not easy to deteriorate landslide state, safe and easy construction and further verify the geological conditions and other prominent advantages. And anti sliding pile can and other slope flexible measures with. Because of the anti slide piles in landslide treatment and maintenance advantages of slope stability, anti slide pile is widely used in mine slope, railway, highway landslide, industrial and civil building foundation pit shoring, port equilateral slope engineering. In the current anti slide pile design, mostly dominated by vertical pile structure, to post rock and soil can be fully utilized and the spatial structure optimization of knowledge and use knowledge is not deep. When the landslide thrust increases usually take increase anti slide pile section size and reinforcement or in pile setting pre anchor cable force and other measures, in order to improve the anti slide pile retaining performance.

## 2. Analysis on Anti Sliding Mechanism of Ordinary Anti Slide Pile

At present landslide anti slide pile optimization design study, scholars generally focuses in against sliding pile type parameters (pile section size and reinforcement ratio) and layout parameters (such as the pile spacing) in a parameter to carry out related research, but for each factor superimposition system optimization research is seldom discussed.

Engineering of slope; mechanical engineering according to the rock. Yu Xuewen analysis. In the anti slide pile

single factor optimization design, mainly including the pile spacing, the anchorage length and cross section size of three separate optimization of anti slide pile pile spacing optimization research, in order to overcome the pile spacing on the basis of engineering experience value of disadvantages, scholars through the pile soil mechanics and soil arching effect of the anti slide pile spacing calculation formula of soil mechanics principle, the establishment of inter pile soil wedge model, the pile soil stress analysis derived anti slide pile spacing formula [1] Zhou Culture of anti slide pile soil arching effect analysis foundation, proposed should to pile Between the condition of static equilibrium, cross section strength condition and arch foot section strength conditions common control to determine the pile spacing, and deduces the pile spacing formula [2]. Wang Qiankun (2005) in the anti slide piles soil arching mechanics characteristic analysis based on proposed to the soil between the piles of the Mohr Coulomb failure criterion, the mechanical equilibrium of soil and pile soil between the resistance of flow around the common control calculation to determine the critical pile spacing method. Under such as (2006) from the laterally loaded pile soil arching mechanism and mechanical properties of, according to the static balance of soil arch between piles and the arch of the foot at the soil strength Conditions for the establishment of the corresponding pile spacing calculation model. 3, such as Huang Runqiu (2006) using reasonable arch axis geometric features and compression rupture azimuth, through the analysis of the concept of mechanics, the anvil of soil arch calculation of strength and balance conditions are integrated and simplified to the arch of the foot arch axial pressure stress expression form. And using the Mohr Coulomb strength criterion, the lower and upper bounds

on the derivation of the arch curve and pile spacing of simple calculation. In anti slide pile length of anchoring section optimization research, Zhou Chunmei is proposed change of pile section of the structure and size to determine the different length of anchoring section, but has not considered the lithologic characteristics of anchorage segment Effect. Hu Xiaojun proposed the rigid anti slide pile anchorage depth are discussed, but did not relate to the commonly used elastic anti sliding pile case. In the anti slide pile section size optimization study, Hu Xinli, Chang Dong Li, etc. through the research found that concrete and locking retaining cost increases linearly with the height of the cross section and the width of the cross section, steel costs with the section height and the width of the cross section increases and decreases nonlinearly. So there must be the lowest point of the total cost curve of single pile, the single pile total cost to minimum, and the section size is the most reasonable section size. In the establishment of anti slide Pile Optimization Model Based on the Two-dimensional gold segmentation algorithm against slide pile section size of optimization research. In the anti slide pile optimization research aspects, the main use of various optimization algorithms to carry out anti slide Pile Optimization Design and research. Cui Zhiguang and Cao Lanzhu (1986) pointed out that large reinforced concrete anti slide pile design parameters is the reciprocal restriction and influence each other and of large reinforced concrete anti slide pile design parameters were optimization research. Zou broadcasting (2003) comprehensive application of anti slide pile theory of ultimate bearing capacity and resistance of flow around the concept, through the transference, from the surface to the establishment of space and safety coefficient, established a Set of non numerical parallel algorithm of simulated annealing algorithm of anti slide pile design method. Zheng Shuning etc. (2003) using mathematical programming method of complex method known load and internal force of anti slide pile, to cost structure as the objective function to meet the engineering requirements of constrained optimization design based on, Visual Basic 6.0 compiled corresponding program. Zhou Haiqing and Wang Gongxian etc. (2003) defined based on a new kind of object oriented genetic algorithm was developed based on genetic algorithm of anti slide pile optimization design program. Zhang Jie and Shang Yue congruent (2004) pointed out that the anti slide pile design model contains a large number of fuzzy parameters, according to relevant norms in the anti slide pile normal optimization model based on the established anti slide pile practical fuzzy optimization model is given to solve the fuzzy optimization. The calculation method of the model in landslide reinforcement scheme optimization, Yin shunde. and Feng XiaTing, (2004) proposed evolutionary neural network method [J]. Zhu Shaorong (2004) needle anti slide pile theory and design on the lack of study from

the anti slide pile and rock and soil interaction of by soil arch theory of landslide thrust transmission mechanism analysis, using the soil arching theory combined with the limit equilibrium method. The optimized design of the anti slide pile, the finite element analysis of the landslide after the control of the slide pile [16].

### **3. The Principle of New Anti Sliding Structure**

#### **3.1. H type anti slide pile**

Not too narrow scope of ordinary single row anti slide pile, the flexural capacity is limited, the pile top horizontal displacement is large and difficult to control, construction and so on. For some residual slide force of landslide, the ordinary anti slide pile in large section size, the excavation into the hole on the slope disturbance effects, unfavorable to the construction period, the slope stability and the construction period is longer, and the anti sliding ability is limited, to resist the landslide thrust, pile spacing, which will cause the project cost increased. So that separate the structure becomes not economic or even security seriously restricts the development of prestressed anchor cable anti slide pile, the pile top set of anchor cable, anchor The tension of the cable to improve the pile body stress condition, can be appropriate to reduce the section size of the pile body. However, in recent years, the engineering practice found this kind of structure has a certain degree of risk, the significant defects in cable of candle rust and loose him, laying cable long-term life were not verified due to its durability and reliability in exist obvious disadvantages, such structure makes use frequency is more and more small.

Node node due to H type combined anti slide pile durability and reliability are good and the cross-section size, but also has a strong ability to resist landslide thrust, so can overcome the above problem. The so-called H-type combined anti slide pile is used before and after the two rows of piles in certain interval arranged a number of columns) retaining landslide in each corresponding to the column and row of piles by coupling beam which is connected into a whole, coupling beams with the front row piles in a pile top, and the rear pile pile in the pile below the top of the site, so that each row anti slide pile in slope body cross section is "H", H type combined anti slide pile, referred to as H type anti slide pile.

H type anti sliding column as a kind of new structure form, due to the structural design of the reinforced concrete beam to strengthen, back row pile overall connectivity can give full play to the overall space combination pile stiffness and space effect, and work collaboratively with the inter row soil and retaining landslide, up to maintain the stability of the slope, deformation control to meet the purpose of construction and safety of surrounding environment. Using the space effect, the formation of

double row piles supporting structure system, greatly increasing the overall stiffness of the structure and the stability, significantly enhance the anti slide retaining ability.

### 3.2. Compound ladder key structure

Small amount of key ladder ladder ladder at the top of the ladder ladder compound called ladder type key structure is composed of key units and key unit comprises a horseshoe shaped cross arm, rectangular legs vertical and lateral locking button, horseshoe shaped cross arm end is exposed out of the sliding body and the rigid connection is fixed on the rectangular vertical legs, horseshoe shaped

cross arm and the other end is placed in the bedrock and the transverse lock key fixing vertical and the rigid connection; adjacent key unit is connected between a ladder shaped, the upper part of the key unit of rectangular vertical legs and lower key unit of horseshoe cross arm vertical cross linking and the rigid connection. As a result of the combination of ladder type structure has the unique structure of the whole body, thus having a sliding resistance performance is good, engineering, construction is simple, low cost, and A good supporting effect and other advantages, as Fig.1.

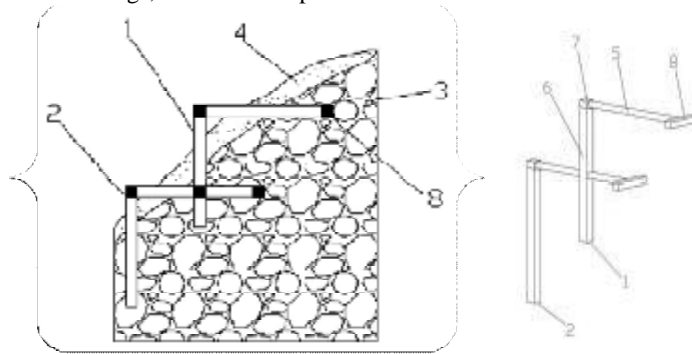


Figure 1. Ichnography and vertical view of compound ladder key structure

The study shows that the key structure of composite type ladder in addition to its structure can affect the slip resistance performance, but also by many other factors influence. For example specific dimensions of the structure, as well as changes in the geotechnical and structural parameters are of the anti sliding performance have great influence. So on the ladder like complex bond structure stress characteristics of; structure and size optimization of; and geotechnical and structural parameters of numerical simulation and sensitivity analysis of has important theoretical research value and practical significance.

### References

- [1] Yu Xuewen. Research on the calculation of anti slide pile spacing [J]. railway operation technology, 2004,10 (2): 1 3,5.
- [2] Zhou Depei, Xiao Shiguo, Xia Xiong. Discussion on the reasonable pile spacing of anti slide pile in slope engineering [J]. Journal of geotechnical engineering, 2004, 26 (L): 135-132
- [3] Wang Qiankun. Discussion on the soil arch and critical spacing between piles with anti slide piles [J]. Journal of Wuhan University of Technology, 2005,27 (8): 63-67
- [4] Zhou Y H, Zhou Depei, Fengjun. Thrust piles soil arching geometric mechanics characteristics and pile spacing were determined by [J]. Rock and soil mechanics, 2006,27 (3): 455-457.
- [5] Huang Runqiu, Jiang Zhong Xin. Bo. Aoil between piles soil arching effect and calculation of pile spacing and analysis[J]. Rock and soil mechanics, 2006,27 (3): 445-450
- [6] Yin Kunlong, Zhou Chunmei. Study on anchorage depth of anti slide pile in landslide treatment of the Three Gorges Reservoir Area [J]. Journal of Wuhan University of Technology, 2006,28 (2): 41-38.
- [7] Hu Xiaojun, Wang Jianguo. Determination of the anchorage depth of rigid anti slide piles based on strength reduction [J], 2007,40 (L): 68- 65
- [8] Hu Xinli, Li Changdong, Wang Liangqing. Discussion on economic optimization design of anti slide pile section [J]. geological science and technology information, 2007, (3): 87-90
- [9] Li Changdong, Hu Xinli, Tang Haoye, et al. Application of the two dimensional golden section method in the cross section optimization design of anti slide pile [J]. geological science and technology information, 2007,26 (5): 94-91.
- [10] Cui Zhiguang, Cao Lanzhu. Optimization of design parameters of large reinforced concrete anti slide pile [J]. open pit mining technology, 1986 (4): 28-34
- [11] Zou Guangyi, Chen water. Journal of design method of stabilizing piles and its optimized numerical model of geotechnical engineering [J], 2003,25 (L): 17-21
- [12] Zheng Shuning, Sun Xiaosan, Lv Qing, et al. Application of optimum design theory in anti slide pile engineering [J]. engineering geology journal, 2003,11 (3): 28-33.
- [13] Wang Gongxian, Zhou Haiqing, Chen Zhenghan. The development of anti slide pile optimization program based on the object oriented Genetic Algorithm [A].Beijing: the ninth session of the China Society of civil engineering and geotechnical engineering academic conference proceedings,2003,1358-1361
- [14] Yuequan, Zhang Jie, Lu Qing. Fuzzy optimal design of anti slide pile [J]. Journal of mountain science, 2004,22 (2): 220-223
- [15] Yin Shunde, Feng Xiating, Zhang Youliang, et al. Study on the optimization of the parallel evolutionary neural network method

for the slope reinforcement scheme [J]. Chinese Journal of rock mechanics and engineering, 2004,23 (16): 2698-2702.

[16] Zhu Shaorong. Optimal design of anti slide piles and finite element analysis of landslide treatment [D]. (Wuhan) Master of Science (China University of Geosciences)Thesis, 2004.