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# Head of groin local scour study

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*Abstract: Through access to a large number of literature data, found on the jetty head the understanding of the scour mechanism is divided into the horseshoe vortex theory Head of groyne unit width increase flow theory Descend flow theory Comprehensive theory, calculation method used to calculate the local impact head of groyne deep, there are three main categories of empirical formula respectively Half theoretical and half empirical formula and other formula, and the calculation formula for the representative in each category.*
*Keywords: local scour; head of groyne; Summary.*

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## 1. INTRODUCTION

At home and abroad, both in the river works and in the flood control project, the spur dike is widely used in buildings, in the flood control project, the spur dike can play the role of protecting the river bank, the narrow channel and the Deep River. In order to understand the mechanism of dam head scouring, to determine the maximum depth of the dam head and its influence factors, scholars at home and abroad have carried out a lot of experimental research.

## 2. UNDERSTANDING OF SCOUR MECHANISM OF SPUR DIKE DAM HEAD

In the study of scour mechanism of spur dike head, there are mainly the following four different viewpoints [1~3]:

The first theory is the Horseshoe vortex theory: This theory states that because the spur dikes occupy a certain width over the river, the Horseshoe Vortex is formed near the head of the spur dike and downstream of the bottom stream of the spur dike. Due to the effect of horseshoe vortex, the water flow takes the silt from the riverbed around the head of the spur dike and brings it downstream, which naturally forms the scour pit gradually.

The second theory is that the head of a spur dike has a single wide flow increase: In this theory, scholars believe that the scour of the head of the spur dike is caused by the presence of a spur dike, which hinders the flow of the current, the flow is constant, the cross section is reduced, so the flow rate increases and the water flow causes the sediment on the riverbed to start and flow downstream, In this case it is natural to gradually form a scour pit.

The third theory is the dive stream theory: The scholars who put forward the theory think that because of the existence of the spur dike, the flow velocity in the vicinity of the spur dike is different, so the pressure difference is formed nearby, so under the effect of this part of pressure

difference, quite a portion of the current will move downward to form downward flow, This part of the descending current is the main factor that causes the scour of the head of spur dike. The fourth theory is a comprehensive theory: The theory underpinning this theory is the result of the combined effects of the flow of diving and the flow of water around the dam head and the vortex system generated by their interactions, which is relatively more acceptable to most people.

## 3. CALCULATION METHOD OF HEAD DEPTH OF SPUR DIKE DAM

The research on local scour of spur dike is a difficult problem determined by multiple influencing factors, in the famous hydraulic expert H. Engels [4] Experiments, many scholars have carried out a large number of targeted experimental research. However, due to various reasons, the current calculation formula of local depth of spur dike is only in the half empirical half theory stage. In addition, some scholars put forward the theoretical formula of the calculation of the spur dike, but the correctness still needs to be tested by practice, so far the formula which has been respected by most experts and scholars has three kinds of [5~9], the first is empirical formula, the second one is half theory half empirical formula, and the third is the other formula.

### 3.1 Empirical Formula

#### 3.1.1 Makavi Formula [10]

By studying field and indoor measurement or survey data and making conclusions, Makavi also uses dimensional and harmonic multivariable regression methods to create such formulae together.

#### 3.1.2 Chingqiang Formula [11]

Chingqiang formula is to use a large number of previous data, using the feasible method of secondary analysis and the least squares to get the calculation formula of the deep dike.

#### 3.1.3 Siow-Yong Lim Yee-Meng Chiew Formula [12]

Siow-Yong Lim Yee-Meng Chiew et al. used a vertical wall type groyne to carry out experiments in the laboratory of clean water mobile beds. The dimensional analysis method and the regression analysis of experimental data were used. This formula was approved by relevant scholars abroad and considered it is a spur dike maximum scouring depth formula with reference value.

### 3.2 Semi-theoretical Half-empirical Formula

Many scholars take the theory of sediment incipient equilibrium as its theoretical basis and assume certain conditions. The parameters in the formula are determined by test data or investigation data.

#### 3.2.1 Altuning Formula and Its Revision [13]

The outstanding contribution to the erosion formula is the former Soviet scholar Altunin. The formula is based on the flow structure. After a large number of tests, the formula for the fine sand bed is finally obtained. The river power is applied like most other scholars. Learn related theories.

### 3.2.2 Fang Daxian Formula [14~17]

Fang Daxian carried out the spur dike test in the sink. Fang Daxian carefully studied the flow structure around the spur dike head and found that the scouring of the dam head was caused by the flow rate of the upstream spur dike rushing into the spur dike and the rush velocity of the bed sand. When formulating, contact the sediment to start the flow rate. Wang Desheng's formula is similar to Fang Daxian's formula.

### 3.2.3 Zhang Hongwu Formula [18]

In the process of Zhang Hongwu's research, he assumed that there are two factors that cause a decisive effect on the local scour of a grooving head. One is the flow erosion and the other is the impact of the riverbed. The experiments selected the orthogonal upright round spur dam of the Yellow River fine sand riverbed as the experimental object. On this basis, the spur dike was further developed to the general situation. The formula for calculating the maximum scouring depth was obtained. This formula is applicable to the partial scouring of the fine sand fluvial dam.

### 3.2.4 Shen Bo Formula [19]

The results of the Shen Bo formula clean water dynamic bed test were carried out in a linear flume with a length of 22 m and a width of 2.4 m.

### 3.2.5 Yu Wenchuang, Zeng Jingxian Formula [20]

This formula is applicable to the local scouring of the spur dike in the middle and lower reaches of the Yangtze River. Yu Wenchou and Zeng Jingxian base their research on the erosion of the spur dike in the middle and lower reaches of the Yangtze River. There is a fixed bed test and the formula is obtained. This formula is developed on the basis of Shamof's formula. Formulas, and include factors for riverbed coarsening.

### 3.2.6 Amade Formula [21~24]

Amade formula is expressed in a single-width flow formula. Formulas expressed in single-width flows are a general consideration. People have not known the cause of local scour, and it is often thought that the scour depth of a spur dam is closely related to the single-width flow. Moreover, even after a certain understanding of the structure of the water stream that causes local flushing, due to the complexity of this water flow structure, its effect is often considered in the single-wide flow factor. Therefore, this type of formula has a relatively simple form, but its physical pattern reflects relatively ambiguity, and important factors such as the riverbed shape and spur dike geometrical characteristics have not been considered. But considering the practical Amadee formula can be used as an empirical formula. In addition, formulas expressed in terms of single-width flow include the Eschchaft formula Tsuchiya Akira formula Hagen formula.

### 3.2.7 Tage Formula [25~30]

The formula of the Fudge's number expressed by the Tage formula above the water flow, the Taiji formula takes into account the influence of the proportion of bed sand in the Frouded number, and uses the data of light sand. To a certain extent, the physical meaning of the Taiji formula reflects the interaction between water flow and riverbed. However, there should be a

problem of flow scales in addition to describing the water flow characteristics. The equations for the expression of the Froude numbers in the above-mentioned swimming flows include the formulas of Pound, Liu, Chen, and Chatson. Liu's formula is simple and takes into account the effect of spur dike length and depth.

### 3.3 Other Types of Formula

#### 3.3.1 Correction of The Formula of the Scouring Dam Scouring Pit with Reference to the Local Erosion Formula of Bridge Pier [31]

Roger A. Kuhnle et al. proposed a formula based on the formula for the local pier depth of the pier and the results of a bath experiment at the Oxford National Laboratory. The formula is applicable to the partial scour of an orthogonal spur dike.

#### 3.3.2 Formula Expressed in Terms of Shear Force: Gill Formula [32]

Regarding the local scour mechanism of the groyne head, Gill agrees with the horseshoe vortex theory. He believes that the obstruction of the spur dike creates a complex vortex that is the main cause of scour, and he believes that the horseshoe vortex has three-direction scour, given the complexity of the horseshoe vortex, The model of the long-contracted section of the Sterling Road was used, and the general formula for the sediment transport rate of the bed load was used to obtain the formula for the scour depth. The Gill formula also takes into account the effects of water depth and grain size. Gill pointed out that the flushing of fresh water and the loader movements are calculated according to the maximum scouring depth. However, Gill's formula has certain limitations. First of all, its model is based on the fact that the long-shrinkage segment is based on the fact that it is far from the reality. Secondly, its experimental particle size is also limited to two kinds of natural sand experimental data.

#### 3.3.3 Formula Based on Flow Structure: Muhamidov et al. [33]

The author believes that the bottom deformation directly depends mainly on the flow of water, measuring the pulsation flow velocity at the relative depth of 0.95 in the near-pit of the scour hole, and taking into account the geometric characteristics of the spur dike and sediment characteristics derived. The Muhammed's formula is a function of the maximum flow velocity, number, sediment non-uniformity, sediment concentration, spur dike angle, and dam head slope angle, and beam narrowing rate. The only deficiency is the lack of a factor for the size of the river bed. But overall, the formula includes more comprehensive factors and is relatively ideal.

## 4. SUMMARY AND OUTLOOK

At present, the calculation of local scour depth in China's engineering design is often unable to obtain a uniform calculation formula. In foreign countries, the research on scoria dam head scouring often uses orthogonal spur dikes, and the form is relatively simple. In terms of foreign research, domestic research Due to the greater influence of the former Soviet Union, in the actual practice of water conservancy projects, there are many preparatory measures for the use of coarse sand rivers. The considerations are more comprehensive and the types of spur dikes are more abundant. For example, Zhou Yinjun et al. [34] studied the local rushing of permeable

concrete dams. law. Yu Tao and others studied the unsteady flow and summarized its laws. In terms of the depth of erosion, Tian Weiming et al. of Chang'an University studied the influence of parameters such as groyne pick angle on the depth of scour. The Markaviev formula of the Soviet Union [35], and the revision of the norm also tend to follow the old version without much exploration. If the river is dominated by fine sand, then the Altuning formula or Zhang Hongwu formula [36] is often used for calculation. After a detailed comparative analysis of the calculations of various formulas and the exploration of the spur dike at the lower reaches of the Yellow River, Mr. Zhang Baishan concluded that the calculation results of the Makaviiev formula are small, while the rivers with moderate flow rates, Altuning formulas and The correction formula is in line with reality. In addition, Zhang Hongwu's formula can be used for calculation of spur dike in the Yellow River in China, because the factors considered by Zhang Hongwu's formula are more comprehensive, and the calculated results are consistent with the measured data.

Since the 1920s, many scholars at home and abroad have conducted a large number of experiments from shallow to deep on the local scour of spur dikes. The in-depth research and theoretical discussions have been conducted on the mechanism and local erosion calculations. In terms of obtaining valuable results, for example, there are more than a dozen formulas for calculating the local scour depth. However, due to the complexity of the problems and limitations of the research conditions, the local scour mechanism and scouring calculations of spur dikes have not been able to reach a unified conclusion so far, and only remain at the qualitative interpretation level. And most scholars only use orthogonal spurs as the experimental object, and rarely use other types of spurs as the research object. There is still a certain gap in solving practical problems. Designers should design spur dikes based on experience and physical model test methods, and most scholars often study non-submerged spurs as a research object when studying scouring scouring, but often flooding dams in practice. appear.

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