

# Ecological slope protection and its practice in the regulatory of Qinhuai newly river

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**ABSTRACT:** Qinhuai New River is the entrance to the Yangtze river in the hydrographic net of Nanjing Qinhuai River. From the flood of Yangtze river in 1998, the total length of Qinhuai new river is 4.0 km and the slope protection was built gradually on the both banks. The structure were masonry, precast, pouring concrete slab and fabric concrete and several kinds of composite geotechnic material were used such as geotechnic membrane and geotechnic cloth. In 2002 a 1.0 km ecological lawn slope protection was constructed at the south bank. It is first used in Nanjing. In the paper, it is compared that the characteristic of the non-ecological rigid and ecological slope protection. Through this example, it is discussed the function of ecological slope protection technique at stream way in the mound construction preventing of flood in city. Besides it embodies the requirement for garden-sight and environment protection in cities.

## 1 INTRODUCTION

Qinhuai River is the most major river and the famous landscape of Nanjing. Since the deluge in the region of Qinhuai River in 1969, the Qinhuai newly river was cut in order to solve the flood diversion and improve the flood protection ability of Nanjing. Qinhuai newly river flows around Nanjing, enters Yangtze River and carries 80% flux of the whole river area.

As a most important part of city, the city-streams had been limited for flood protection, draining, navigation and irrigation for a long time. The concrete hard-materials slope protection have been built up more and more to prevent flood, while these action damaged the rivers' ecological balance severely and overlook the relationship between rivers and cities. The regulatory of rivers should be combined with the environmental virescence and culture sight, to make "beautiful water, bank and scene" as the lightness for the city, to make it as a closing-to-water space gathering with irrigation, ecology, sports, pleasure and traveling.

## 2 THE IMPACT OF TRADITIONAL SLOPE PROTECTION ON RIVERS' ECOLOGICAL ENVIRONMENT

From the flood of Yangtze River in 1998, the total length of Qinhuai New River is 4.0 km and the slope

protection was built gradually on the both banks. The structure were masonry, precast, pouring concrete slab and fabric concrete and several kinds of composite geotechnic material were used such as geotechnic membrane and geotechnic cloth. Nowadays the harmony between human beings and nature being urged, to change the destroy of concrete slop protection on rivers, the ecology rehabilitating theory and building ecological slope protection have been put up. On the basis of the ecological slope protection on Qinhuai New River for rehabilitating the destroyed river ecological system, a new way for regulating city river stream was studied.

### 2.1 *The impact on the ecological environment*

The traditional hard-materials slope and bank protection closes down the bank ground, cut off the passage of the water and soil, and curtains off the touch between biology and the earth, which breaks the environmental balance and the whole ecological system in the rivers, and destroys the self-cleaning ability of the rivers.

### 2.2 *The impact on the human beings' environment*

The manmade-materials flood protection walls built in the rivers demolished the nature environment, and brought negative influence on the water quality and

environment, furthermore made a severe influence on the human beings' living quality and health.

### 2.3 The impact on the sight environment

Although the sections of rivers are in order, straight and showing the quality of modern cities after regulation, all of those convert the requirement of modern human beings that belonging to nature again and could not meet the beautiful dream of living in fresh environment as "wild flowers bloom around Zhuque bridge, sunset lights on the Wuyi alley".

## 3 THE PRESENT OF ECOLOGICAL SLOPE PROTECTION

When having realized the negative impact of concrete hard-materials slope protection on the river ecology, experts put up with ecology rehabilitation theory and advise to rebuild river ecological environment by setting up ecological slope protection.

Ecological slope protection, which considers the harmonious development of "water safety, environment, source and sight", is natural pattern that considers ecology effect enough at the same time of meeting the need of flood prevention, draining and navigation, changes the concrete bank to the kind of slope which is suitable for the living of biology, the soil, the water and their co-existent.

Recently, the domestic departments learn the experience from the foreign research, and pay attention to the ecology protection and the sight effect in the regulatory o rivers to do best to make the river scenery closed to nature. In many cities, like Beijing, Shanghai, Hangzhou, Chengdu, the rules are obeyed in the regulatory, which including: firstly respect the co-existent of history, tradition and modern society; secondly consider more for people and provide the communication flat; thirdly rehabilitate the variety of biology and belong to nature again; the forth design the scenery harmony with cities to closing to water; the fifth protect water quality and extent water surface, and the effect is good. In 1998, a aim "fresh water, green bank, fluency and opening to navigation" was proposed clearly in the regulatory of Kunyu river in Beijing. The Suzhou River in Shangha, Dong River in Hangzhou and Cheng River in Shaoxing all show different situation by ecology regulatory. The regulatory of Funan river in Chengdu has obtained benefit of society, economic and environment protection which combined flood protection with draining, traffic, virescenery, ecology and culture, and wined three international award including world inhabitation award.

## 4 THE PRACTICE OF ECOLOGICAL SLOPE PROTECTION IN QINHUAI RIVER OF NANJING

Many things have done in the research and application of ecological slope protection in Nanjing. Combining the regulatory of city rivers with culture scenery, the regulatory of Qinhuai river has been carried out for three years, and rebuilt the rivers' ecological sight by dredging, cutting off pollution water, greening banks.

The ecological slope protection in Qinhuai river is an experimental project, aiming on providing experience for ecological regulatory of city rivers. The whole length of the project sums to 1000 m, several rectangular meshes are set along the dike, each of which is 15 m in the length. The area is about 7200 m<sup>2</sup> from the surface to the foot with the elevation from 9.5 m to 7.0 m of the dike. The design of dike section is shown in Figure 1. Greensward is laid on the flat of the slope protection structure. The aperture, excluding sand precast concrete block is used on the slope under flat, in which many aperture have been set for the plant to grow. This type of slope protection has the function of protecting ecological environment, building bank scenery and purifying water.

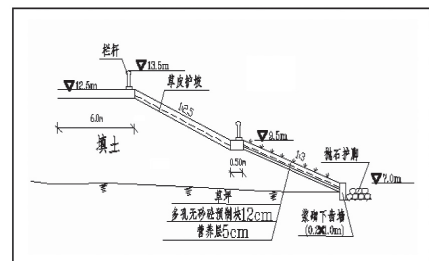


Figure 1. The dike section of the ecological slope protection.

### 4.1 The construction of ecological slope protection

Firstly, clean off the spall and cluttering plants, build inferior walls, mesh banks along the longitudinal bank, then build latitudinal banks every 15 m, at last make sure the earth volume meeting the design requirement. Secondly build the precast concrete block. Aperture concrete is comprised of excluding-sand concrete, water retention agents, plant nutritional agents and other additional agents, the diameter of inside stones is about 3-4 cm and maintenance after pouring. The thirdly, a layer of nutritional about 5 cm should be set on the slope surface, then lay aperture, excluding-sand precast concrete block from the foot to top along the slope surface, use sand pulp on the edge. A thin layer of nutritional earth of 1cm should be scattered after the layout and seed, keep maintenance.

#### 4.2 *The selection of the grass and its effect on the project*

Based on the research of experts, two kinds of grass are selected, one is creeping summering grass – Perennial ryegrass (*Lolium perenne*) and the other one is wintering grass – Bermudagrass (*Cynodon dactylon*). After 15 days of maintenance, most grass begin to sprout, 25 days later a primary lawn has formed. Discovering the concrete block, it is found that the roots have gone into the deep earth and the force against pulling will be enhanced. The concrete block becomes hard to discover 40 days later, which shows that the grass roots have weaved together. In summer, the lawn grows quickly upside water, due to dunk in water for long time after flood tide, part of the lawn under water becomes falling over. However after the tide ebb, most come to relive. In the middle of Nov, reseed the winter grass before the summer grass begins to wilt. In the whole winter, the 90 m length experimental segment keep in green.

### 5 THE COMPARISON BETWEEN ECOLOGICAL SLOPE PROTECTION AND TRADITIONAL CONCRETE SLOPE PROTECTION

It is proved that the project of ecological slope protection in Qinhuai river has received good effect. (shown in Figure 2). It will be compared between the ecological slope protection and the traditional concrete slope protection in technique and economic aspects:

#### 5.1 *The comparison of cost*

The cost is about equivalent for the two types of slope protection. Due to the scale being small in the project, the cost will decrease as the scale becomes larger and the arts becomes improved. The arts of aperture, excluding-sand, concrete blocks is more complex than that of the normal concrete units, while once they have been finished, they could be directly laid on the slope and seed on them. In the other hand,



Figure 2. The comparison between ecological lawn slope protection and the concrete slope protection.

for the normal concrete blocks, a layer of textile should be laid under them and 10cm layer of spall should be laid on them.

#### 5.2 *The comparison of effect*

The protection effect of ecological slope protection is not reduced, for the function on the facing-water side is mainly to protect the crash by wind and wave while the function of textile and spall layer is to filter, the earth will be pull out by tide-ebbing force and wave. The concrete precast blocks are dependent on their own weight to protect wind and wave, however the ecological slope protection's force against pull is enhanced because of the grass taking roots into the earth under the excluding-sand concrete. As the same while, duo to the anchoring by the grass, the soil under the grass will not be strapped by waves, which reduces the aperture water pressure and stabilizes the slope structure. Through the test in flood season, the ecological slope protection proved to be efficient in flood protection.

#### 5.3 *The comparison on the ecology effect*

Ecological lawn could rehabilitate and improve the ecological environment. It could restrain ground surface stream and keep garbage from rivers to prevent pollution; and it could greening the environment and provide people with comfortable scenery; and it could control the soil loss and rehabilitate the destroyed ecology environment. All of which are the traditional hard-material concrete slope protection could make.

### 6 CONCLUSION

- (a) The experiment in Qinhuai River proved that, ecological slope protection is more efficient in keeping bank stable, flood protection and draining than the normal concrete slope protection, and it has the advantage of the normal one.
- (b) Compared to normal concrete slope protection, in the project cost and slope protection effect, the ecological slope protection is more feasible, while in the scenery effect and ecology rehabilitation, the ecological one has the advantages that the normal one could meet.
- (c) In the later project practice, several kinds of local hydrophile fixed plan could to be used to make the plant easy to grow, rehabilitate, maintain and reduce the project cost.
- (d) The ecological slope protection not only meets the requirement of flood protection and draining, but also improves the ecology environment in river and meet the requirement of people on the city scenery, which possess wonderful prospect.

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