Practice and Thinking on Application of Ecological Grid in River Engineering

Chao Zhang
Anyang College, Anyang, Henan, 455000, China
Corresponding author’s e-mail: zhangchao5162@dingtalk.com

Abstract: Ecological grid is a multi-hinged, hexagonal mesh structure woven by mechanical hinge, in which corrosion-resistant, wear-resistant and high-strength low-carbon hot-dip galvanized steel wires and aluminum-zinc alloy steel wires are coated with PVC or the above homogeneous steel wires treated with high corrosion resistance. According to the application of ecological grid structure in river basin, this paper discusses the characteristics of ecological grid combined with the use case of ecological grid structure in river.

1. Introduction
With the rapid development of economy and society, on the one hand, the river plays an increasingly important role in ensuring economic life and building a good ecological environment; on the other hand, due to the influence of human activities, the functions of rivers which are closely related to our life and production are degraded and the water quality is deteriorated. The people urgently demand the regulation of river courses and the improvement of water environment, and the whole society pays great attention to river course regulation.

Compared with some traditional technologies, ecological grid has its own advantages, and has become the preferred structural form for protecting riverbed, controlling landslide, preventing debris flow and preventing falling rocks, and taking into account environmental protection in the world, and has made remarkable achievements.

2. Application of ecological grid in river regulation project
2.1 Wall revetment
2.1.1 Wuxi High Mountain Lane and Bang Regulation Project
2.1.1.1 Project overview
Gaoshan Lane River is located in Nanchang district, Wuxi City, which belongs to inner city river and is located in residential area. The original river bank collapsed, silt accumulated and domestic garbage was seriously polluted. At the beginning of 2005, the municipal government listed the comprehensive improvement of urban rivers as the annual key work plan.

2.1.1.2 Governance plan
This river course project is located in a residential area, with a total length of about 1km. The original river course is silted up, seriously polluted and stinking. After renovation, the ecological grid retaining
wall gives full play to its superiority in ecological landscape. At present, both sides of the river bank are lush and the water flow is clear, and the rock foundation laid on the top of the shore-fixing cage adds to the natural atmosphere. The ecological grid adapts to different foundation conditions, is simple in construction and convenient in transportation, and has unique ecological functions. The silt between the gaps of the Stone in the cage is beneficial to plant growth and has good permeability.

2.1.1.3 Effect evaluation after completion.
The main material used in ecological grid structure is natural stone, which is environmentally friendly and recyclable. By setting geotextile filter layer, it can meet the needs of water and soil conservation. By comparing the photos before and after treatment, it is found that the water flow of the original silted river is clear after treatment, and both sides of the river bank are lush. The following is a comparison photo before and after river regulation.

![Figure 1. Photo before river regulation](image1)

![Figure 2. Photo after river regulation](image2)

2.2. Slope revetment

2.2.1 Qiandeng River in Kunshan City, Jiangsu Province

2.2.1.1 Project overview

The area where the project is located is flat, slightly inclined from southwest to northeast, with small natural slope. The ground elevation is mostly between 2.8 and 3.7 meters (datum plane: Wusong zero point), and some highlands reach 5 to 6 meters with an average of 3.4 meters. The river revetment and greening of this project is about 2Km long. Because of the wide river surface, gentle slope and difficult excavation, and in order to save the project cost, the form of green shore cushion slope protection is used in this project.

2.2.1.2 Evaluation of the effect after completion

The filler of ecological grid structure can be used locally, and the construction site does not need water...
and electricity, so it has low requirements on site and equipment. This project has a narrow site, which requires no mechanical equipment, but only manual construction, which is convenient for underwater construction and saves cost. Three years after the project was completed, the river plants grew well. Comparative photos of the project during construction and 3 years after completion are as follows.

![Figure 3. Under construction](image1)

![Figure 4. River greening effect after three years](image2)

3. The ecological grid in river regulation engineering application thinking

3.1 Ecological aspects

The materials filled in the ecological grid (cushion) structure adopt the earth and stone materials where the project is located, which are taken locally. Therefore, the structure will be well integrated with the local natural environment and will not cause environmental pollution. The abundant connected pores between the filling materials become the channels of water, air and nutrients, which provide space for the growth of plant roots. On the contrary, plant roots will not destroy the structural system, but will strengthen the structural system. If plants and structural systems cooperate with each other, good effects of landscape greening and ecological environment protection will be achieved.

3.2 Structural aspects

The ecological grid structure is an integral structure, and the overall ductility improves the seismic and frost resistance of the structure.

In the past, slurry masonry, dry masonry, cast-in-place concrete slab or precast concrete slab were mostly used for slope protection of canals and earth-rock dams. When there is vibration load, ice thrust, frost heaving force or large deformation of foundation, it is easy to be damaged because it can not adapt to deformation. In the severe cold area of north China, the ice thrust and frost heave force are particularly serious to the (semi-) rigid slope protection.

Ecological grid flexible protection structure is an integral structure formed by filling a large number of granular materials into the net cages (mats) made of grid. In this structure, not only the weight of granular materials (crushed stone, block stone and gravel), but also the characteristics of high strength and large flexibility of grid materials are utilized. In addition, each box body (protective pad) can be connected by tying wires, so that the protective structure can be infinite enough to adapt to large and severe deformation. Therefore, the protective function of Gebin flexible protector can be maintained for a long time.

3.3 Durability

- The ecological grid structure is often corroded by acidic air, water, soil and salt. Galvanizing on the surface of steel wire can prevent corrosion of steel wire.
- PVC protective film is coated on the steel wire to protect the steel wire during weaving, transportation and construction, and has stronger resistance to chemical, biological and corrosive media during use. [1]
- The filler is made of hard and durable stone, which will not disintegrate after long-term use.
- Through artificial or natural action, the gap between the stones is filled with soil, and the plant
root system penetrates deeply into the slope through the soil between the stones, forming a flexible whole protective surface, even if a small amount of broken wires appear, the structure will not fail.

4. Conclusion

Using ecological grid structure, the roughness of river channel will change correspondingly due to the growth of plants in the later period. In the design code of irrigation and drainage, according to the channel flow from large to small, the channel bed is rocky, overgrown with weeds and poorly maintained, and the roughness is 0.025, 0.0275 and 0.03 respectively; according to the surface dressing degree of the canal, the roughness selection is different in the stone canal, which should be paid attention to in the design process. The ecological grid structure adapts to certain deformation, which can avoid the shortcomings of keeping the straight plane and single section in the planning and design of the river course in the past design.

Acknowledgments

In river regulation, the ecological slope protection structure has been adopted by many people, and is being vigorously promoted. Based on the application examples of ecological grid in river regulation projects and the experience of ecological grid in river regulation projects, this paper puts forward the characteristics of ecological grid structure in river regulation projects, so as to provide reference for the future application of ecological grid structure in river regulation projects, and also provide ideas for technicians to study new technologies and methods suitable for the characteristics of river slope protection.

References

[1] Zhang, S.H., Zhang, C. (2013) Specification for applications of eco-mesh structure technology. China planning Publishing, Beijing.
[2] Lei, W.Q. (2019) Key exploration on the application of honeycomb grid ecological slope protection in river regulation. Engineering construction and design., 17:76-77.
[3] Xu, S.J., Cheng, S.Z., Zhou, G.D. (2019) Characteristics and quality control measures of hydraulic gabion. Shandong water conservancy., 12:7-8.
[4] Li, T. (2019) Application of ecological grid in river regulation project. Residence house., 25:176-177.