

Study on combining flood control with rainwater utilization of airports in China

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Abstract. For an airport, on one hand it is necessary to make flood control and drainage in rainy seasons; on the other hand, it is also often faced with the shortage of water resource problem. Therefore it is very important to study on combining flood control with utilization of rainwater resource for airports. This paper makes analysis and study on the present situation of flood control and rainwater utilization of airports, and then proposes to combine engineering measures with non-engineering measures for the airport flood control and rainwater utilization. The applications of Changbei Airport and Qingyang Airport are analysed, both of them locate in the south of China. Based on establishing relevant policies and increasing investment, some feasible methods are adopted, such as building storage tanks for collecting rainwater. That not only can control the flood and drainage effectively, but also provide water for the airport grassland and landscape and achieve beautification of the airport surrounding landscape. Application of these measures provides practical solutions to flood controlling and rainwater collecting problems of airports, therefore has certain reference significance to other airports for flood control and rainwater utilization.

1. Introduction

Drinking water demand is getting more and more important with the increasing population, especially to some district in the world, people are suffering a desperate shortage of water [1,2]. The balance of supply and demand of water resources is changed with the rapid development of cities. Water scarcity has become a major problem in many place of China [3]. The change of city underlying surface affects the hydrological cycle, the contradiction of water resources shortage and rain flood disaster is becoming more and more serious.

And with the shortage increased, finding an alternative water resource is urgent, and the sustained water resource should fit the city development, especially in the drought weather [4].

In recent years, some places in China, such as Beijing, Tianjin, Wuhan and so on, are often subjected to heavy rains, which makes the city subway flood, and airport road waterlogging, flight delay and brings a great impact on the normal operation of the airport. That not only affects the safety of passengers and workers, but results in varying degrees of damage to the social order, city function, environment and resources. For an airport, on one hand, it is necessary to control flood and drainage in the rainy season in order to keep the normal operation of the airport, the safety of passengers, the worker's lives and airport property. On the other hand, with the scale and passenger traffic of the



airport gradually increasing, the situation of water shortage in airport becomes progressively worse, while the environmental and ecological problems also become synchronous expansion.

Rainwater is one of the most fundamental, direct and economical water resources, it is an important link of water circulation system in nature; it not only plays a crucial role to adjust and supplement the area of water resources but also improves and protects the ecological environment. In order to solve the series of contradictions of water shortage, flood control and the airport ecological environment, people began to focus on how to turn crisis into opportunity, changing wastes into valuables, and better rainwater utilization. Because it has less activity in the airport, the quality of rainfall runoff is good. Meanwhile most of water used by the airport does not require much quality, such as washing the floor, flushing toilet, landscape irrigation, etc. That can directly use the rainwater [5,6]. Therefore, it is necessary to study on combining the flood control with rainwater utilization of airports, changing the flood disaster into an available resource to achieve rainwater utilization effectively.

In the rainy season, if there is no effective drainage water system, a great quantity of rainwater will become a disaster. On the contrary, if rainwater is collected effectively, it will help control flooding and be utilized as a useful resource with many benefits. Because of large amount of impervious area in the airport, it is great potential to collect and store rainwater during the rainy days, and then using stored rainwater for non-potable activities in the dry season.

At present, the urban rainwater utilization rate is very low in China. There are many difficulties in rainwater collection. The airport does not have business sales value, and only has the service function. The economic benefits of rainwater collection and utilization are not obvious, because many people do not aware rainwater utilization can be used to solve problems Due to the economic reason, people do not want to spend extra money to add devices for water utilization [7]. Therefore, the research of how to take effective measures to protect airport from rainstorm, and effectively collect rainwater utilization is imminent.

2. Measures of flood control and rainwater utilization

Nowadays, the research and practice of urban rainwater utilization has gradually become a hot spot. In some developed countries, a relatively complete system of urban rainwater utilization and management has formed through a series of rain flood problem research and practice [8-10]. Germany has committed to the research and development technology of rainwater utilization for a long time, now it has become one of the most advanced countries in the world. At the new German Munich airport, rainwater was harvested from roofs and rowed downstream drainage system by pipeline. At the same time the underground water seepage system was constructed between runways and taxiways, which can ensure the rapid infiltration of precipitation [11].

Changi Airport is a typical example of rainwater collection. It has two big reservoirs in the airport, which collect rainwater from the runways and the surrounding grass. The reservoirs have high efficiency to collect the rainwater, and the usage of rainwater is mainly for non-potable usage, like flushing toilet or firefighting drills, the rainwater usage accounts for 28 to 33% of the total water usage, and it can save \$390,000 per year[12,13]. America has also done a lot of research on rainwater utilization[14,15]. Los Angeles Airport is a well-known busy airport, because the drainage capacity of choose uses the “Baihai” row matrix storage system solving the problem of quick drainage successfully.

In some developing countries such as China, India, Kenya, Mali, Bangladesh, Botswana, rainwater is being used mostly to solve water shortages for potable and non-potable water [16,17]. India is a country with a lack of water resource. Its environment is hot, dry and little rain, which makes people having strong water-saving consciousness. Some large airports in India, rainwater was drained into the reservoir nearby the airport by building about two feet wide, one inch deep drainage channel, then realizing the rational rainwater utilization.

In China, the traditional rainwater system made the fast drainage as the main principle. The research and application of rainwater utilization start relatively late. In recent years, the research of urban rainwater utilization in cities such as Beijing, Shanghai, Wuhan has spread far and wide [18,19].

China also gradually began to build urban rainwater utilization demonstration project. The quantity of rainwater recycling accounts for 60% of daily water consumption in Shanghai Hongqiao Airport. It is the first time to use the rainwater for toilet flushing water, supplement water of cooling and other non-potable water users, which is a typical engineering example of airport rainwater utilization [20].

Generally, the measures combining flood control with rainwater utilization of airports in China can be divided into two categories: engineering measures and non-engineering measures. Engineering measures include building sedimentation tank, artificial wetlands, storage tank, etc. Rainwater collection system is built mainly in the terminal roof, the airfield, the workspace and the surrounding area of airports. In these places the impervious surface is more concentrated. The rainwater can infiltrate into the underground by infiltration system, or be reused after been treated by using engineering measures. Non-engineering measures mainly include making policies and regulations, increasing the proportion of investment by the national finance, strengthening the consciousness of rainwater collecting, etc. Formulating relevant policies and regulations means that it will make mandatory provisions on rainwater utilization, establish rewards and penalty mechanism by promulgated laws and technical specifications. These ensure the effective utilization of rainwater in the airport. Increasing investment means that the capital system and special funds of rainwater utilization should be established, this is a key measure to improve the quality of rainwater utilization. Enhancing the level of understanding of rainwater utilization means that management department should review rainwater as the resource rather than the disasters and step up the rainwater utilization according to the basic principles of the comprehensive utilization of rainwater in front and emissions behind.

It is most necessary to combine two measures effectively in the aspects of flood control and rainwater utilization. The double purpose of flood control and rainwater utilization can be realized in under the premise of policy, funding and other non-engineering measures, coupled with the corresponding engineering measures, such as establishing reservoir, rainwater collection project and so on. This pattern has been applied in Qingyang Airport and Changbei Airport, and remarkable accomplishments have been achieved.

3. Flood control and rainwater utilization examples

3.1. Overview

Qingyang Airport and Changbei Airport, which are both located in the south of China. In recent years, the contradiction of water resources shortage and flood control in these two airports has become more and more serious. That caused strongly influence on people's lives and economic development. In order to solve this contradiction, the government combines engineer and non-engineer measures effectively to control flood and utilize rainwater. The results indicate that it can ensure the normal operation and drainage, rational utilization of rainwater in the airport and beautify the landscape around the airport by combining engineering and non-engineering measures effectively. The experience of these two airports has great significance to others. So this paper takes Qingyang Airport and Changbei Airport as examples to analysis.

3.2. Rainwater utilization project at Qingyang Airport

Qingyang is located at Gansu province of China. Its climate is dry and the rainfall is very little. In order to use of natural precipitation rationally, and make the rainwater disaster into rainwater resources, some departments propose making collection and utilization of natural precipitation as an important way to solve the water shortage.

Qingyang Airport rainwater harvesting and utilization (North Lake) Project can collect rainwater from 1.14 km² impervious area, and build a storage tank, water-saving irrigation area of 6,000 acres. The distance is 1km between the North lake project and the south border of Qingyang Airport.

The gross investment of this project is 134 million yuan; it covers an area of 384.5 acres. The lake water surface area is 150 acres, and the volume is 92,500 m³, yearly repeat accumulating rainwater is

470,000 m³, with landscaping area of 220 acres (figure 1). The first phase of North Lake landscape project's investment is about 24.38 million yuan, which has been basically completed, and a second phase is currently being constructed. The completion of this project can solve the drainage problem of Qingyang Airport. The Collected rainwater can be used by surrounding 6,000 acres of irrigated farmland. This project beautify the surrounding environment which can also effective regulate the small regional climate and improve the ability of the region to combat natural disasters.



Figure 1. The rendering of Qingyang Airport rainwater collection and utilization engineering.

3.3. Rainwater utilization project at Changbei Airport

Changbei international Airport is located in the north of Nanchang city; it connects to the expressway from Nanchang to Jiujiang (airport expressway). The airport covers an area of large, while rainfall is abundant. There is less personal activity, so the quality of rainwater is better. Along with the increase of impervious surface within the airport, it is extremely limited to use the drain ditch adjusting the rainstorm runoff in the airport. In order to solve this contradiction, the administrative department increased the investment and designed the impounding reservoir for collecting rainwater on the original system. The system project of rainwater storage pool and surrounding greening is 494 m long, north-south width of 170 m, and the total area is about 20.75 acres. The bottom elevation of water inlet channel in the lake is 25 m. The bottom elevation of the lake is 23.5 m. The elevation of constant water level is 25.5 m. The elevation of highest water level is 27.0 m. In the rainy seasons, the space which is between the water level and the highest water level is used to store heavy rainstorm peak flow. The project adopts the natural curve type layout, planting suitable shrubs around the lake, building a rugged lakeshore landscape, which can not only reduce flood peak, also make effective gathering up rainwater at the flood seasons and improve the local ecological environment landscape around the airport. The floor plan of the project is shown as follows (figure 2).

The investment and construction of rainwater storage tanks of Changbei Airport drainage system bring many aspects of notable benefits. That can reduce the rainwater runoff and flood peak flow, ease airport waterlogging, improve the rainwater utilization and efficient use of valuable land resources. That also can create airport beautiful landscape and improve the ecological environment of the airport. The project is a typical case, which is a combination of reducing flood drainage, improving airport landscape and ecological environment and the use of rainwater rationally.



Figure 2. The rendering of Changbei Airport rainwater collection and utilization project.

4. Conclusions

With the rapid economic development, plane has become one of most important transport tool. The water consumption in the airport is increasing, so the contradiction between supply and demand of water resources is more and more prominent. For airports in China, heavy rain occurs frequently but rainwater utilization rate is very low at present, so research on flood control and rainwater harvesting in airport is becoming very important. Based on the analysis of the present situation of flood control and rainwater utilization of domestic and international airports, this paper put forward the engineering measures and non-engineering measures for flood control and rainwater utilization of the airport in China.

These two kinds of measures are applied in Qingyang Airport and Changbei Airport, which are both located in the south of China. The results indicate that combining these measures effectively not only can realize flood control and rainwater utilization rationally of the airport, ecological environment construction around the airport, but can organize drainage effectively. That can make water use and waterscape into a coherent whole. That can implement the flood control and recycling use of the rainwater. This model can be as a reference for other airports and has important directive to production practices.

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