Research on Technical Framework Construction of Rainwater System in Sponge Airport

MingkaiLIU
Binzhou University, China

ABSTRACT : *The design method of rainwater management system and wastewater management system for sponge airport was systematically studied.The characteristics of rainwater management in sponge airport and traditional airport were analyzed. On the premise of clear objectives and principles, a set of design method of technical framework of sponge airport rainwater system suitable for the overall ecological rainwater management of Chinese airports is systematically put forward.The components, technical characteristics, functions and benefits of LID facilities of various subsystems are analyzed in detail, and a set of optimum technical facilities for rainwater system of sponge airport is screened out. According to the characteristics and requirements of each functional area of the airport, the technical framework of the rainwater system of the sponge airport is designed. At the same time, the types and pretreatment facilities of wastewater produced by each water unit in the airport are described, and a set of technical framework for sustainable management of wastewater from airports is put forward.*

KEYWORDS -*hydraulic support, ADAMS, dynamic characteristics, optimization*

I. INTRODUCTION

Civil airports usually cover a large area, and impervious pavement underlying surface accounts for a high proportion. Some airports are also near mountains, rivers, or low-lying terrain. Therefore, the airport must have perfect drainage facilities, so that no seepage can be formed in the field during rainfall. In addition, it is required to have certain flood resistance and to remove groundwater under the road surface.Traditional airport drainage system is divided into two parts: outdoor drainage system and in-site drainage system. Among them, outdoor drainage system is mainly for flood prevention and drainage. Interception and drainage of surface water and groundwater flowing to airports in adjacent areas need to be combined with the revamping and renovation of airport raw water system. The off-site drainage system mainly consists of ditches for intercepting and discharging slope water, drainage ditches for diverting and discharging flood water from natural river ditches, and artificial drainage structures such as flood dikes, diversion dikes and culverts.

In-site drainage system aims at ensuring the safe operation of aircraft and prolonging the life of pavement structure. On the one hand, if the rainwater on the runway surface is not removed in time, it will form too thick water film, which will make the high-speed taxiing aircraft drift and endanger its operation safety.On the other hand, poor drainage in pavement area will soften the soil foundation and pavement material and cause premature damage.Therefore, it is necessary to design a good drainage system.

II. RAINWATER SYSTEM CONSTRUCTION OBJECTIVES

2.1 Total runoff control

China is a vast country with large regional climate differences. Therefore, airports in different regions should reasonably select planning and control objectives according to local conditions, such as rainfall characteristics, hydrogeological conditions, runoff pollution, waterlogging risk control requirements, rainwater resource utilization needs and economic rationality.

Airports in humid areas with abundant water resources in South China should adopt LID technology facilities with stagnation and net dominance, and focus on runoff pollution control as the main objective. Among them, the control of runoff pollution and the utilization of rainwater resources can be achieved by controlling the total amount of rainwater runoff. Therefore, the

construction of the rainwater system of sponge airport takes the total amount of runoff control as the primary goal.In order to keep the peak runoff flow unchanged, measures such as seepage and detention should be taken to reduce and reduce the peak runoff. However, considering that the green rainwater facilities are restricted by the frequency and type of rainfall, facilities construction and maintenance management conditions, the peak reduction effect is generally better for the mid-rainfall events, and the effect is worse for the extraordinarily heavy rainstorm events. Therefore, the traditional municipal drainage pipe network system in the site area cannot be completely replaced to organize the drainage of the site area.

2.2. Utilization of rainwater resources

Sponge Airport, as a sustainable concept of rainwater management in airports, emphasizes that rainwater is a kind of resource, and realizes the direct, indirect and comprehensive utilization of rainwater through various methods. Especially in the background of our country's increasingly scarce water resources, rainwater as a renewable water resources. After simple treatment, it can be reused as recharge water for air conditioning system of energy center, sanitary ware washing for terminal building and resident unit. The greening of the working area, the sprinkling of the site and road, the washing of special vehicles, firefighting and municipal miscellaneous water use can alleviate the waterlogging at the airport, save water resources and have good economic, environmental and social benefits.

Sponge airport rainwater system is not the only goal to alleviate the waterlogging, runoff pollution and other rainwater problems. Through reasonable arrangement of green roof, grass planting ditch, concave green space, landscape water and other green rainwater facilities in the field, the runoff of rainwater is connected from the source, the middle and the end in series, and the ecological sustainable rainwater management system of airport is constructed. While enhancing the ecological aesthetic value of the airport, it can alleviate the local heat island effect of the airport area, restore the damaged hydrological cycle of the airport, and realize the multi-functional and multi-objective sustainable development of the airport.

III. OMPOSITION AND FUNCTION OF RAINWATER SYSTEM

3.1. Partition of the system

According to the movement process of rainwater runoff, the rainwater system of sponge airport is further divided into four subsystems: osmotic detention system, transit system, filtration and purification system and collection and storage system. Among them, the source of osmotic retention system is distributed in the functional catchment areas of the airport, which mainly seeps to supplement groundwater and retains rainwater, and has the function of water purification. The midway transfer system is the intermediate link between the series detention infiltration facilities and the collection and storage facilities, and plays an important role in connecting the point, line and surface integrated rainwater management system network of the airport. The filtration and purification system is used in the whole process of runoff movement, and is combined with the retention and infiltration, transfer, collection and storage system to purify and treat rainwater runoff. Collection and storage system is at the end of rainwater management. It usually combines with the construction of water landscape in airport. It plays an important role in rainwater storage and plays an important ecological and aesthetic value.

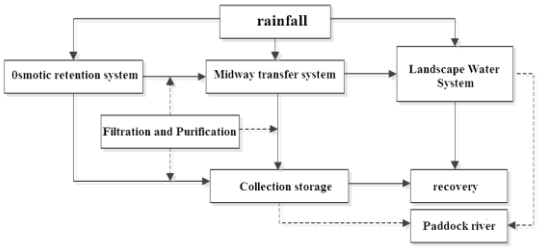

Fig.1Composition chart of rainwater system at sponge airport

Usually, a LID facility has a variety of ecological functions, such as grass planting ditch, which not only has the function of collecting and transporting, but also can be used as filtration and purification unit. Reasonable selection of LID facilities can form a multi-functional, multi-level, multi-modal airport water system pattern. It can not only reduce the total amount of runoff, control runoff pollution, retain rainwater and stagger peak discharge, but also improve the airport ecological environment and alleviate the local heat island effect. It can not only maximize the utilization of resources, but also optimize its ecological benefits, with remarkable comprehensive benefits.

3.2. Composition of green roof

Generally speaking, the structure of green roof is composed of vegetation layer, planting base layer, filter layer, drainage (storage) water layer, roof protection layer, roof waterproof layer, building roof, drainage outlet and drainage pipe from top to bottom. The vegetation layer is one of the main functional layers of green roof for ecological benefit and rainwater runoff control. Planting substrates are light artificial substrates with certain permeability and water storage capacity to meet the needs of plant growth, as shown in Fig.2. The filter layer mainly prevents soil erosion and filters particulate matter in excess rain water. The drainage and storage layer is located between the filter layer and the protective layer. Generally, it adopts the form of water storage plate, which can collect and store some roof rainwater. Overflow rainwater is centralized through drainage pipes to water storage facilities.

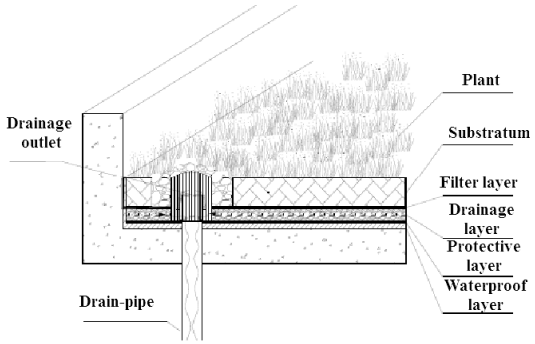

Fig.2A sketch of green roof structure

3.3. Permeable pavement

Permeable pavement can make rainwater seep rapidly, replenish groundwater, maintain soil moisture, and maintain the ecological balance of groundwater and soil. According to the different surface materials, permeable pavement can be further divided into permeable brick pavement, permeable cement concrete pavement and permeable asphalt concrete pavement, all of which have the permeability of the material itself. In addition, grass-embedded bricks, pebbles, gravel and so on are also permeable pavement, which is infiltrated through the structural space of materials.

Initial rainwater discarding refers to the use of some methods or devices to abandon the rainwater runoff with initial scouring effect and high pollutant concentration in order to reduce the difficulty of subsequent treatment of rainwater, as shown in Fig.3. Abandoned rainwater is discharged into sewage treatment plant by sewage pipe network for centralized treatment. Initial rainwater abandonment facilities have the advantages of small area and low construction cost, but the discharge of pollutants from runoff should not be controlled. Initial rainwater abandonment facility is an important LID pretreatment facility, which is mainly applicable to the front end of rainwater pipes on roofs such as airport terminal buildings and centralized entrances of runoff rainwater in functional catchment areas of the airport area.

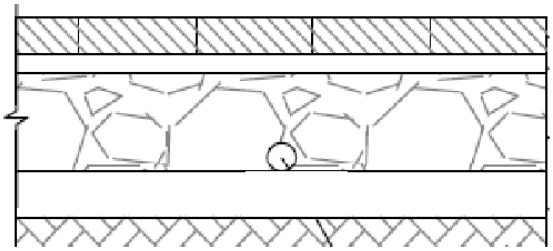

Fig.3Typical structural diagram of pervious brick pavement

3.4 Seepage pipe

Seepage pipe refers to rainwater pipe with permeability function. It can be made of perforated plastic pipe, sand-free concrete pipe, gravel and other materials. The design of seepage pipe should meet the engineering and technical requirements of certain opening rate and burial depth, as shown in Fig.4.But its construction cost is high, it is easy to jam and difficult to maintain. Pretreatment facilities such as grass planting ditch and sedimentation tank should be set up at the front end of seepage pipe. It can be used in airport freight area and working area to replace the traditional municipal rainwater pipeline system. It can make the rainwater infiltrate further and supplement groundwater while transferring the rainwater in the airport area.

Fig.4Typical structure sketch of seepage pipe

IV. SYSTEM COMPREHENSIVE BENEFIT ANALYSIS

4.1. Effectiveness of wastewater management system

In addition to realizing the sustainable management of rainwater, the rainwater system of sponge airport should also manage the wastewater

generated by water use units in all districts as a whole, so as to realize the reuse of reclaimed water and save water resources.It supplied water for air conditioning system of energy center. Sanitary ware washing for terminal building and residential units, greening of working area and sprinkling of site and road, washing of characteristic vehicles, firefighting, municipal miscellaneous water, etc. Usually airport rainwater storage facilities and landscape water are combined to create a beautiful environment for the airport. At the same time, a large amount of water area can also improve the local heat island effect. It has good economic, environmental, aesthetic and social benefits to regulate microclimate, reduce summer atmospheric temperature and reduce air conditioning consumption.

4.2. Effectiveness of wastewater management system

The traditional gray rainwater infrastructure of airport directly discharges precious rainwater resources, resulting in serious waste of rainwater resources. The ecological rainwater technology facilities of sponge airport can supplement groundwater by infiltration, and the stored rainwater can be recycled to fully realize the efficient utilization of rainwater resources.Compared with the traditional gray rainwater infrastructure of airport, the LID technology facility of sponge airport has certain cost advantages of investment, operation and maintenance, and can also reduce the proportion of gray infrastructure construction, energy consumption and airport development and construction costs.

V. CONCLUSION

The airport relies solely on the traditional gray rainwater infrastructure to organize drainage, which often causes the short-term peak of runoff in the downstream area of rainstorm events to be unable to be discharged in time, thus causing the airport waterlogging disaster. The ecological rainwater facilities of sponge airport can effectively reduce the runoff coefficient of the airport area through infiltration, storage and other ways, and reduce the total amount and peak of rainstorm runoff. Value, prevent soil erosion, and have the function of regulating and storing rainwater and flood, can significantly reduce the frequency of flooding disasters. The ecological rainwater facilities of sponge airport, such as grass planting ditch and concave green space, have good removal and purification effect for surface runoff pollutants and decompression for downstream water body.

VI. ACKNOWLEDGEMENTS

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