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Study on application of active composite soil high storage rainwater garden technology in sponge city

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ABSTRACT : *In accordance with the principle of "water conservation priority, space balance and systematic treatment", the rainfall will flow to the rainwater garden area through the slope through comprehensive consideration and overall research from all aspects of infiltration, stagnation, storage, purification and use. The detention pond of the rainwater garden will be set with planting layer, active composite soil layer and drainage layer from top to bottom, and a water storage module will be set below the drainage layer. The rainwater will be purified through the active composite soil layer and drainage layer and flow to the water storage module, Subsequently, the water pump is used for landscape water or other municipal purposes. The activated composite soil stores a certain amount of purified rainwater and regulates the amount of irrigation water for plant growth through transpiration.*

Keywords -*Sponge city; Rainwater and flood management; Rainwater garden;*

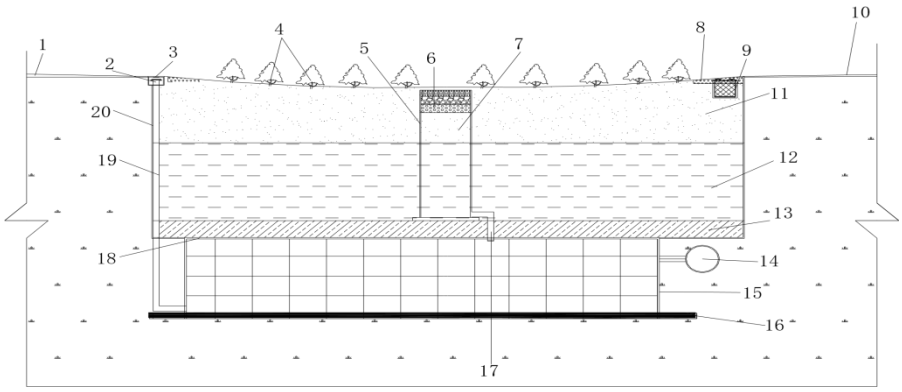
I. INTRODUCTION

Rainwater garden is used to gather and absorb rainwater from the ground, purify rainwater through the comprehensive action of plants and sand, and gradually infiltrate into the soil for landscape water supply or other municipal purposes. It is an ecologically sustainable rainwater flood control and rainwater utilization facility. With the rapid construction of the sponge city, it has received extensive attention. However, the existing rainwater garden module not only has poor water storage effect, difficult maintenance and other technical problems; At the same time, the pollutants in the rainwater collected are still high, and the rainwater recycling rate is low; Moreover, due to the poor permeability and water retention of the existing rainwater garden, it is not conducive to the timely drainage of rainwater, which has damaged the greening vegetation of the rainwater garden and caused a waste of water resources. In this context, in accordance with the principle of "water conservation priority, space balance and systematic management", the rainfall will flow to the rainwater garden area through the slope through comprehensive consideration and overall research from all aspects of infiltration, stagnation, storage, purification and utilization. The detention pond of the rainwater garden will be set with planting layer, active composite soil layer and drainage layer from top to bottom, and a water storage module will be set below the drainage layer. The rainwater will be purified through the active composite soil layer and drainage layer and flow to the water storage module, Subsequently, the water pump is used for landscape water or other municipal purposes. The activated composite soil stores a certain amount of purified rainwater and regulates the amount of irrigation water for plant growth through transpiration. It can effectively solve the local rain flood problem of sponge city system and improve its environmental and economic utilization efficiency.

II. ANALYSIS ON TECHNOLOGY OF HIGH STORAGE RAINWATER GARDEN WITH ACTIVE COMPOSITE SOIL

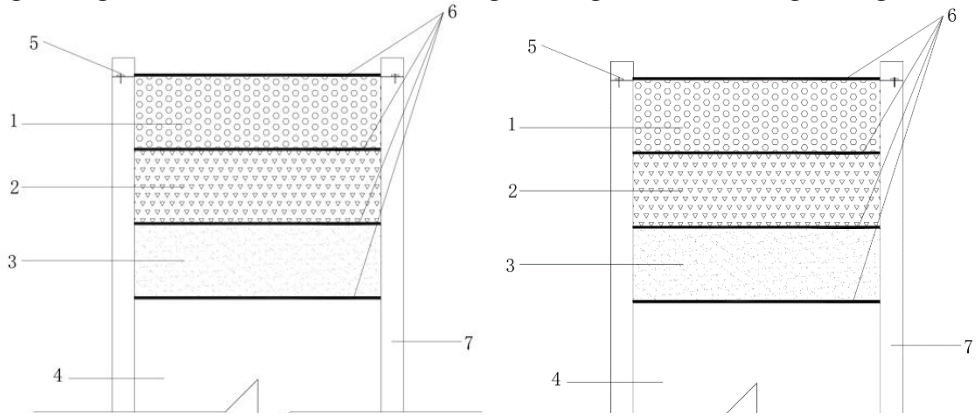
The active composite soil high storage rainwater garden system in sponge city mainly includes two parts: the active composite soil detention pond and the water storage module; During construction, the water

storage module shall be constructed first. From the perspective of landscape science, the ash spraying line shall be used to determine the excavation scope of the rainwater garden. The prefabricated HDPE modules shall be combined to form water storage modules of appropriate shape and volume, and the surrounding, top and bottom of the water storage module shall be sealed with composite geotextile; Then the drainage layer of detention pond, active composite soil layer, planting layer and anti blocking drainage ditch are constructed in turn. The structure of rainwater garden is shown in Figure 1.1.



1. Lawn; 2. Pumping interface; 3. Simulated lawn cover; 4. Green plants; 5. Waterproof layer; 6. Filtering device; 7. Overflow well; 8. Pebble boundary; 9. Anti blocking drainage ditch; 10. Road side; 11. Planting soil layer; 12. Active composite soil layer; 13. Drainage layer; 14. Municipal pipe network; 15. Impervious geotextile; 16. Cushion; 17. Drainage pipe; 18. Filter geotextile; 19. Pumping pipe; 20. Waterproof layer

composite soil and filter layers with different particle sizes. The first filter layer is active composite soil, the second filter layer is gravel with different particle sizes, and the third filter layer is activated carbon bag, as shown in Figure 1.2. During rainfall, part of the rainwater is filtered and purified by the active composite soil layer and stored in the water retaining layer to regulate plant growth, while the other part flows into the water storage module through the drainage layer; In case of extreme rainfall, the rainwater that cannot be stored in the detention pond flows to the water storage module after being filtered by the overflow well, and the purified water in the water storage module is used for landscape water or other municipal purposes through the water pump. A drainage ditch is set at the municipal road side of the detention tank boundary and cobblestone boundary is paved, so that part of the rainwater is discharged into the municipal pipe network through the anti blocking drainage ditch, and the rainwater is discharged through the anti blocking drainage ditch.



1. The first filter layer; 2. The second filter layer; 3. The third filter layer; 4. Overflow well; 5. Fixing bolts; 6. Filter geotextile; 7. Block

1. The first filter layer; 2. The second filter layer; 3. The third filter layer; 4. Bolt hole; 5. End ring plate

Fig. 1.2 Structural Diagram of Overflow Well Filter

1.1 Analysis on technical control of earthwork excavation

1）Determine the excavation scope of rainwater garden from the perspective of landscape, measure the elevation, calculate the excavation depth, and find out the underground pipelines and obstacles before excavation to avoid or protect during construction, as shown in Figure 1.3.

Figure 1.3 Determination of Excavation Scope and Excavation by Ash Spreading

2）Level the site, remove humus, construction waste, etc. from the original surface, determine the excavation line, axis positioning point, bench mark, etc. of the water storage module on site according to the design drawings, and protect them properly after setting.

3）Earth excavation shall be carried out at the designated location according to the design requirements, and the excavation shall be carried out to the bottom of the water storage module. Vibrating machinery shall be used for compaction, and the plane position and elevation shall be re measured.

4）After the excavation of foundation trench is completed, the construction, design, survey and supervision units shall be notified to inspect the trench.

1.2 Water storage module construction

1） Determine the size and position of the cushion of the water storage module after the tank inspection is qualified, carry out the construction of the cushion of the water storage module and do a good job of maintenance.

2）The base course shall be leveled with fine sand and the sand layer shall be kept damp.

3）Cut the waterproof geotextile according to the size of the water storage module, and lay the waterproof geotextile on the cushion in the foundation trench of the water storage module.

4）Assembled HDPE water storage modules are combined on the cushion to form a design shape according to the planting conditions of green plants, and water pipe channels are reserved on the water storage modules.

5）Wrap the top of the water storage module with inverted filter geotextile. After the installation of the water storage module, check the waterproof layer wrapping of the water storage module.

6）The surrounding area of the water storage module shall be backfilled. The backfilled earthwork shall meet the design and specification requirements. Each layer shall be backfilled in layers with a thickness of 500mm and compacted mechanically, as shown in Figure 1.4.

Figure 1.4 Water Storage Module Construction and Backfilling

1.3 Drainage layer and pipeline construction

1）According to the design elevation requirements, the reserved pipes at the side of the water storage module are connected to the municipal pipe network, and the reserved pipes at the top are connected to the overflow well water guide pipe. The upper and lower ends of the water guide pipe are wrapped with a filter screen.

2）The reserved pipeline shall be completely sealed with the composite anti-seepage membrane and sealed with waterproof glue.

3）The drainage layer shall be constructed, the graded crushed stone with the particle size of 3-10mm shall be paved and rolled.

1.4 Overflow well masonry

The construction of overflow well cushion and foundation shall be carried out. After the cushion reaches the specified strength, the well body shall be built according to the design requirements. A water guide pipe shall be installed at the bottom of the overflow well to connect with the water storage module. When the masonry reaches a certain height, cement mortar shall be used for internal and external plastering. The well body shall be well treated for waterproofing and anti-seepage, as shown in Figure 1.5.

Fig. 1.5 Masonry of overflow well

1.5 Installation of overflow well filtering device

A filtering device is installed on the top of the built overflow well. The diameter of the bottom of the filtering device is the same as that of the overflow well. The first filter layer, the second filter layer and the third filter layer are set inside. The first filter layer is active composite soil, the second filter layer is gravel with different particle sizes, and the third filter layer is activated carbon bag.

1.6 Preparation of active composite soil

1）12h before mixing, take an appropriate amount of coconut bran and slowly spray water for foaming for 4-12h. The control standard is that the volume of foam will be 3-5 times of the original volume, and no water will be squeezed out by hand.

2）According to the proportion of 1m3 active composite soil mixed by one bottle of active soil composite biological medium, take 10L tap water to dissolve the powder 80 min before mixing, mix for 15 min, and then stand for 1h.

3）Mix river sand, coconut bran, volcanic sand and planting soil in the proportion of 5:3:1:1 by volume, and mix them manually for the first time.

4）Mix the prepared soil composite biological medium solvent with river sand, coconut bran, volcanic sand and planting soil for the second time, as shown in Figure 1.6.

(a) Coconut bran foaming (b) mixing ratio (c) biological medium dissolution (d) secondary mixing diagram

Fig. 1.6 Preparation process of active composite soil

1.7 Filling active composite soil

1）Before backfilling with active composite soil, the sideline of the backfilling range shall be measured to ensure that the planting soil is beautiful and comfortable, and local areas shall be shaped manually.

2）For active composite soil backfilling, dump truck shall be used to unload the soil to the destination, and then bulldozer shall be used to push the soil forward. During soil paving, special personnel shall be assigned to supervise and inspect, strictly control the soil paving thickness within the design requirements, and the soil paving shall be divided into sections every 10m.

3）When filling, take 10m as a section and fill according to the design thickness. No special tamping is required during the filling. Use a small bulldozer to push the soil back and forth and then naturally compact it, as shown in Figure 1.7.

4）In the process of active composite soil backfilling, anti blocking drainage ditches shall be constructed close to the roadside backfilling sideline. The drainage ditches shall be spliced and buried underground, and grid plates shall be installed above the drainage ditches.

Fig. 1.7 Active Composite Soil Paving

1.8 Green planting

1）Check the type and particle size of the backfilled planting soil, whether there are any impermissible sundries, and whether it meets the requirements of planting soil. Test and analyze the physical and chemical properties of the soil in the planting area, and take corresponding disinfection, fertilization and other measures.

2）The soil planting layer shall be backfilled and leveled according to the requirements of the drawings and the characteristics of the site.

3）According to the local rainfall and planting conditions, select appropriate green plants to plant in the detention pond, give priority to local plants, and properly match with exotic species. The plants to be planted should not only adapt to the aquatic environment but also have certain drought resistance.

5）The green plants shall be planted according to the construction scheme, and the cultivation work shall be done well.

6）After planting green plants and seedlings according to the design scheme, lay pebbles around the green plants to increase the beauty and artistry, and reduce the loss of planting soil.

Figure 1.8 Green Planting

III. TECHNICAL CHARACTERISTICS OF HIGH STORAGE RAINWATER GARDEN WITH ACTIVE COMPOSITE SOIL

Rainwater garden technology is applicable to the construction of commercial and residential housing communities, municipal roads, park roads and landscape greening projects in sponge cities. The active composite soil detention pond is used to solve many problems existing in the existing rainwater garden in terms of pollutant removal and soil permeability, and improve the permeability and purification performance of the rainwater garden. The water storage module adopts prefabricated HDPE module, which can be assembled randomly in large and small gardens, lawns and municipal road green belts according to the site conditions, with fast construction speed, high efficiency and wide applicability. The active composite soil detention pond can reduce the drainage pressure during the flood peak period, and the active composite soil layer can maintain the

water content in the planting soil layer for a long time, which is more suitable for the growth of plants. The rainwater flows into the storage module through the detention pool, which improves the rainwater utilization rate, and is purified through the detention pool, improving the water use effect. The overflow well on the surface of the active composite soil detention pond can quickly filter and recover the rainwater during the rainstorm, so as to avoid excessive water accumulation in the low-lying area of the road, thus reducing the damage of the original green vegetation and water and soil loss caused by rainwater. A drainage ditch is set at the boundary of the detention tank and cobblestone boundary is paved. A filtering component is added in the drainage ditch to filter the debris when the water flows. The debris will not be piled up, and it is convenient to take out the filtering component and remove the filtered debris.

IV. APPLICATION ANALYSIS OF ACTIVE COMPOSITE SOIL HIGH STORAGE RAINWATER GARDEN TECHNOLOGY

The active composite soil rainwater garden ecosystem is adopted. The active composite soil has good purification and filtration performance and water retention performance, without additional water retaining layer and filter layer, which reduces the construction period and the loss of sand and gravel and other related materials, and can reduce the project cost by 4~9%. Assembled water storage module is adopted, with simple construction steps and high installation efficiency. The labor cost and equipment cost are reduced accordingly, which can reduce the project cost by 2~5%. The rainwater is filtered and purified by the active composite soil rainwater garden, stored and reused, which reduces the rainwater and sewage treatment process, and the rainwater storage can reduce the consumption of municipal water, increase the utilization rate of rainwater, and reduce the project cost by 1-3%. It can effectively reduce the project cost by 7~17%. At the same time, the rainwater filtered by the active composite soil detention tank can be stored through the regulation and storage system for plant irrigation or other landscaping purposes, with significant economic benefits.

Sponge city active composite soil high storage rainwater garden is adopted. During rainfall, part of clean rainwater is directly discharged into the water storage module through overflow well and part of it is filtered into the water storage module through detention pool, which reduces the drainage pressure during the peak rainfall period, avoids excessive water accumulation in low-lying areas, reduces the damage to original green vegetation and reduces water resource waste, improves safety, and improves the utilization rate of rainwater; The active composite soil layer stores part of the rainwater in the soil, which can be used as the water supply for plants, providing a good growth environment for plants, and increasing the vitality of the green landscape; In addition, the water storage module structure of this method is simple, the number of layers of detention tank structure is small, the construction speed is fast, and the technical level is high; A drainage ditch is set at the boundary of the detention tank and cobblestone boundary is paved. A filtering component is added in the drainage ditch to filter the debris when the water flows. The debris will not be piled up, and it is convenient to take out the filtering component and remove the filtered debris.

V. PROJECT CASE ANALYSIS

The road greening and water storage project involved in the infrastructure upgrading project of Wujin National High tech Zone Industrial Park uses this technology to flow the rainfall through the slope to the rainwater garden areas on both sides of the road. The rainwater garden detention pool is set with planting layers, biological media soil layers and drainage layers from top to bottom, and a water storage module is set below the drainage layer. The rainwater is purified through the biological media soil layers and drainage layers and flows to the water storage module; During rainfall, part of the clean rainwater is directly discharged into the water storage module through the overflow well and part of it is filtered into the water storage module through the detention tank, reducing the drainage pressure during the peak rainfall period, avoiding excessive water accumulation in low-lying areas, damaging the original green vegetation and causing water and soil loss, improving the safety and improving the utilization rate of rainwater; The biological medium soil layer stores part of rainwater in the soil, which can be used as the water supply for plants, providing a good growth environment for plants, and increasing the vitality of the green landscape; In addition, this method has simple water storage module structure, few layers of detention tank structure, fast construction speed and high technical level.

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