Rainwater Collection System Based on Resident Landscape

Hengshu Ye
School of North China Electric Power University, Baoding 071000, China.
yehengshu@outlook.com

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Abstract: In this paper, we introduce a rainwater collection system based on resident landscape. It includes roof rainwater delivery system, purification system and underground stored system. Rainwater can be collected and purified through plant shallow groove, rain pipe and high flower bed. It can also be stored in underground storage box and be used to irrigation during dry seasons. It will exert remarkable effect in somewhere rainy. What's more, the economic cost is low enough.

1. Background

In 2009 at the Copenhagen climate change conference, the 'Low Carbon Economy' was put on the agenda, which is a new economic model based on low energy consumption, low population and less emission. With the global climate becoming more and more warmer, it is commonly believed that the environmental resource destruction and fossil fuel utilization have been important factors restricting sustainable development. What's more, economic and social development now is also faced with a lot of serious challenges, such as environmental and resource problems. WWF, Climate Group and other international organizations are now making more plans to promote 'low carbon city' construction and development. Therefore, developing a low carbon city has been a new sense of development all around the world.

2. Introduction

Compared with traditional devices, this system can filter and collect rainwater through plant shallow groove, drainage, rain pipe, high flower bed, abandon box and storage box. When the climate is dry, we can use water in boxes to irrigate. In Gui Zhou, Gui Yang Province, for example, an ordinary residential area could save 57000m^3 water a year, which equal to 160000 yuan, since the domestic water charge is 2.8 yuan/m^3.

3. Structure of the system

The rainwater firstly flows down the plant shallow groove, then filtration and drainage. Secondly, it goes into the abandon box along the rain pipe. In the abandon box, impurities in water can be deposited. Next, clean water is stored in storage box.

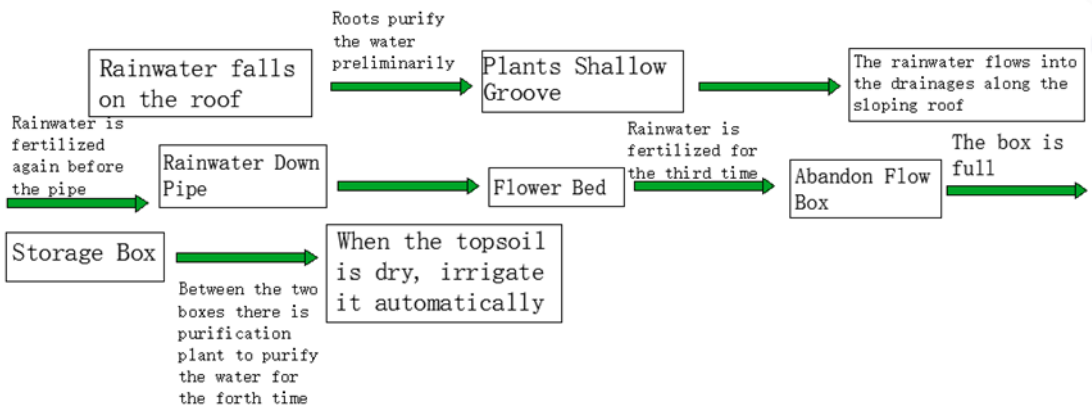

Fig. 1 Progress of the System

4. Design

4.1 Structure of the Building

It is supposed that the gradient of roof is 2%,[1] there are three units in every building, and the drainage is installed at the end of the slope roof. The drainage is higher on the side of building, so that rainwater can fall to the rain pipe by gravity. What's more, there are four rain pipes outside every building.

Rooftop garden and plant shallow groove are combined well on the roof, while flower beds stand outside the building closely. At the bottom of the flower bed, small diameter metal mesh which could resist erosion can intercept pieces of leaf and soil perfectly; it is stuffed in artificial soil in the middle, which could purify and filter water efficiently; on the top of it are pebbles, [2] which can protect soil from driving away.

4.2 Rainwater Collecting system

When the rain falls down the roof, it is mostly collected, filtered, deposited, seeped and purified by plant shallow grooves. Then it flows along the drainage, falls down the rain pipe. At the bottom of the pipe, it has been purified twice.

4.3 Rainwater Convey and Storage System

There is one set of storage system in every building--two abandon boxes and four storage boxes. The former is smaller than the later. There are also a set of filtration between them. Every abandon box has one rainwater import connected to storage box and two rainwater exports connected to municipal drainage. Every storage box has two rainwater imports connected to abandon box and municipal water pipe, two rainwater exports connected to municipal drainage and irrigation.

Let rain stand in the abandon box for a while, precipitates deposit and clean water flow into the storage. If storage box is full enough, extra water goes into the municipal drainage directly. Only when the soil sensors alarm it is dry, can irrigation devises be operated automatically.

4.4 Blueprint and Model

To express the system more intuitively, we draw them by CAD:

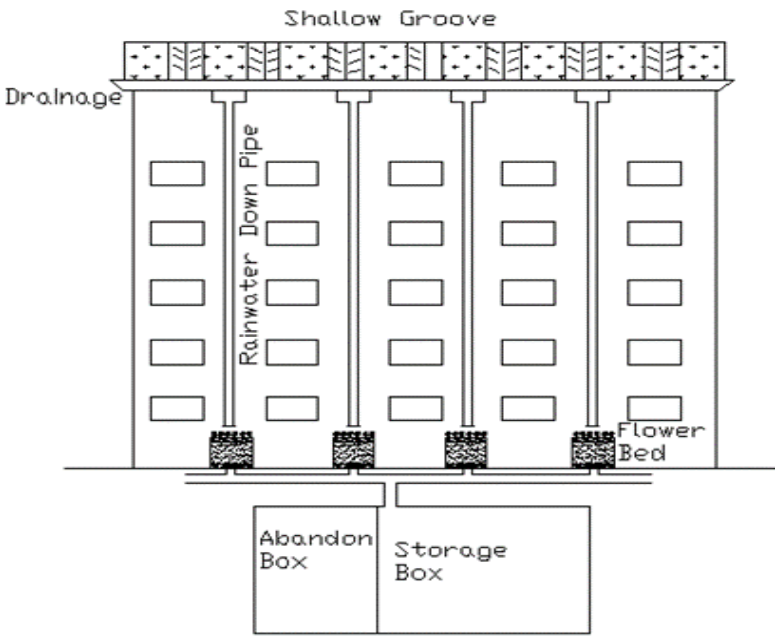

Fig. 2 The Front Sight of System

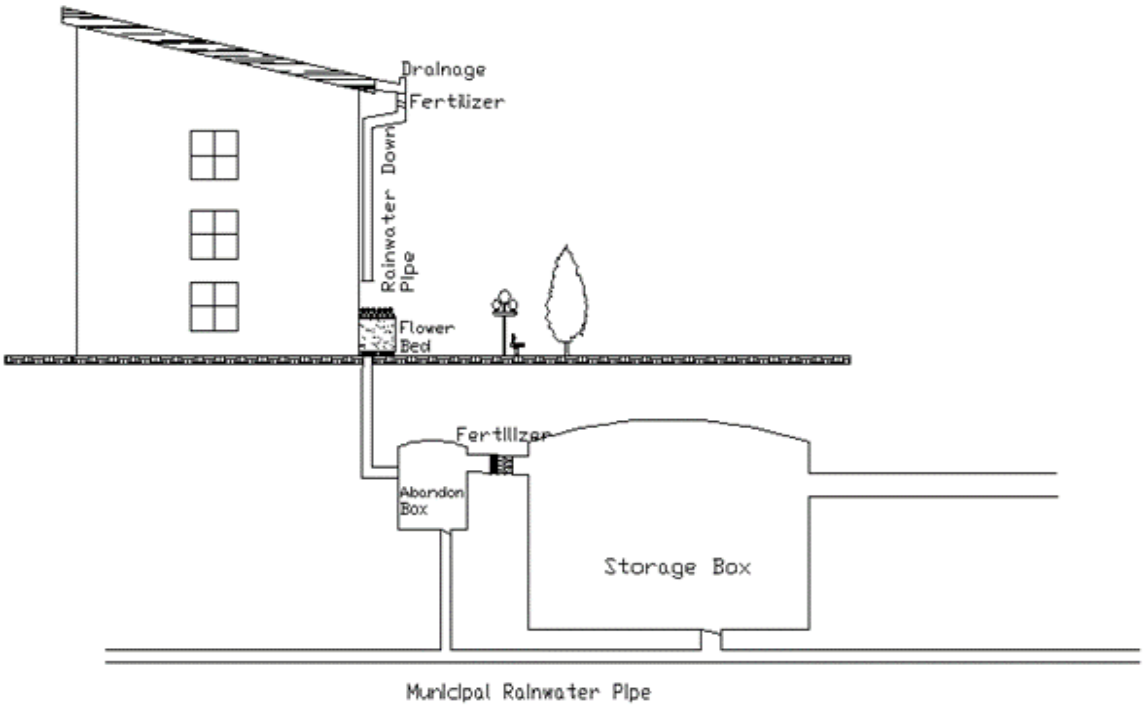

Fig. 3 The Side Sight of the System

5. Feasibility Analysis

Since the roof is effected more slightly by human activities, there are less waste in water. This system combines plant shallow groove and rooftop garden perfectly. The most important maintenance work is draining. Fortunately, plant shallow groove can extend the life expectancy of rooftop garden. After several times of filtering, the water is clean enough to irrigate. What's more, rooftop gardens and plants can make buildings more beautiful.

5.1 Background of City

We select Gui Yang, Gui Zhou Province, as an object. It belongs to humid subtropical climate

and the annual average temperature is 15.3℃; total rainfall per year is 1129.5mm; 235.1 cloudy days; 1148.3 sunny hours and 11.3 snowy hours. The rain is abundant in summer, about 500mm.[3]

5.2 Cost Analysis

Table 1 The Cost of Rainwater Collection System[4]

Subject	Unit Price	Quantity	Total Prices
Abandon Box and Storage Box	5000 yuan/piece	50 pieces	2.5×10^5 yuan
Rain Pipe Underground	80 yuan/m	90m	1.8×10^5 yuan
Rain Pipe	7 yuan/m（PVC,∅110mm）	2500m	1.75×10^4 yuan
Roof Waterproofing Materials	26 yuan/m^2	$1.5 \times 10^4 m^2$	2×10^4 yuan
Drainage	13 yuan/m（5 inches wide）	50m	3.25×10^4 yuan
Total		7.4×10^5 yuan	

In Gui Yang, for example, the effectively area of collection in a common resident area is $50000m^2$, [5] so the rainwater we can collect every year is up to:

$$50000 \times 1.1295 = 57000\ m^3$$

Now the domestic water charge in Gui Yang is 2.8 yuan/m^3, so we can save around 160000 yuan per year.

From the calculation above we know that this system costs 7.4×10^5 yuan. Thus we will get our profits from the fifth year. If the life expectancy of system is 10 years, we would save at least one million!

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