

# SPONGE TYPE INTEGRATION SYSTEM OF ROAD AND GREEN SPACE

## Technical Field

The present patent belongs to the technical field of urban greenbelt and sponge urban  
5 construction, in particular relates to a sponge - type integration system of road and green space.

## Background Art

With the promotion of national sponge cities, more attention is paid to the penetration, storage  
and utilization of rainwater in sponge road construction, but the influences on vegetation on  
10 two sides of the road are neglected. According to the conventional design thought, the problem  
that the vegetation on two sides of a road is excessively irrigated at one time or is insufficiently  
irrigated for a long term occurs, and these problems affect the growth of the green vegetation.

## Summary of the Invention

15 In view of the above-mentioned analysis, the purpose of the present invention is to provide a  
sponge road and greenbelt integrated system to solve the problem that greenbelts on two sides  
of an existing sponge urban road are excessively irrigated at one time or insufficiently irrigated  
for a long term.

The purpose of the present invention is achieved in such a way.

20 Provided is a sponge - type integration system of road and green space including:  
a pavement, wherein a mounting space is arranged below the pavement;  
greenbelts, located on one side or two sides of the pavement; and  
a water supply device, arranged in the mounting space and connected with the pavement so as  
to supply water to the greenbelts under the action of an intermittent downward pressure of  
25 pedestrians on the pavement.

Further, the pavement includes a surface layer, a first buffer layer, a pressure bearing plate, a second buffer layer, a bottom layer and a foundation laid from top to bottom.

Further, a bonding layer is arranged between the second buffer layer and the bottom layer.

Further, the water supply device includes:

5 a water storage tank, wherein the water storage tank is connected with a municipal rainwater pipe network to store and collect rainwater;

a piston, wherein the piston is arranged in the water storage tank and is in sliding and sealing contact with the inner wall of the water storage tank;

telescopic spring rods, wherein one end of each of the telescopic spring rods is connected with  
10 the piston, and the other end of each of the telescopic spring rods is connected with the pressure bearing plate of the pavement; and

water outlet pipes, wherein each of the water outlet pipes is provided with a water inlet and a water outlet, the water inlet communicates with a water storage space inside the water storage tank, and the water outlet extends to the upside of each of the greenbelts.

15 Further, at least two water outlet pipes are provided so as to supply water to the greenbelts on two sides of the pavement respectively.

Further, a plurality of telescopic spring rods are provided and are uniformly distributed.

Further, the water storage tank includes a top wall, a bottom wall and a side wall; a first through hole is formed in the center of the top wall to allow the telescopic spring rods to penetrate  
20 through; and the side wall is provided with a second through hole so as to be connected with the municipal rainwater pipe network.

Further, the water supply device further includes an air pressure adjusting device so that the air pressure inside the water storage tank is adjusted.

Further, the air pressure adjusting device includes an air pressure adjusting pipe; one end of the  
25 air pressure adjusting pipe is connected with a fourth through hole in the side wall of the water

storage tank by a one-way vent valve so that air in the water storage tank flows out in one way; and an air vent in the other end of the air pressure adjusting pipe extends out of the mounting space of the pavement and communicates with the atmosphere.

Further, the air pressure adjusting device further includes a branch vent pipe, one end of the branch vent pipe is connected into the air pressure adjusting pipe, and the other end of the branch vent pipe is connected with a third through hole in the top wall of the water storage tank, so that the air pressure above the piston in the water storage tank is adjusted.

Further, the water outlet of each of the water outlet pipes is provided with a rotating nozzle.

Further, the pavement is a slow-moving walkway pavement.

Further, each of the greenbelts includes a plain soil layer and a planting soil and packing layer laid on the plain soil layer.

Further, a water-permeable geotextile is laid between the planting soil and packing layer and the plain soil layer.

Further, each of the greenbelts is provided with an overflow-type rainwater outlet.

Compared with the prior art, the present invention may at least achieve one of the following beneficial effects:

a) according to the sponge road and greenbelt integrated system provided by the present invention, the pavement is set to be in a suspended state, the suspended pavement has a load-bearing function, the water supply device is arranged in the space below the pavement, recycled rainwater is stored and collected in the water supply device, the water supply device is intermittently squeezed by the pavement by virtue of a pressure acting on the ground when pedestrians walk or jog, and then, the rainwater in the water storage tank is squeezed out by the water outlet pipes, thereby continuously spraying and irrigating the vegetation on one side of a road. Not only are the effects of improving the irrigation continuity and storing rainwater for long-acting application achieved, but also no additional energy loss is caused, the carbon

emission is reduced, and the requirement for sponge construction of cities is met; and

b) according to the sponge road and greenbelt integrated system provided by the present invention, the water supply device is simple in structure, convenient to construct and low in cost and can be widely arranged on a slow-moving walkway in a park or a residential district, the characteristic that a pedestrian walkway is capable of bearing a pressure is sufficiently utilized, not only is the function of a sponge road taken into consideration, but also the growth of vegetation on two sides of the road is promoted, carbon emission caused by additional energy loss of equipment is reduced, and a sustainable road and greenbelt system is formed.

## 10 **Brief Description of the Drawings**

In order to describe the technical solutions in the embodiments of the description or the prior art more clearly, the accompanying drawings required for describing the embodiments or the prior art will be briefly described below. Apparently, the accompanying drawings in the following description show only some embodiments recorded in the embodiments of the present description, and a person of ordinary skill in the art may still derive other accompanying drawings from these accompanying drawings.

Fig. 1 is a schematic diagram showing a structure of a pavement of a sponge road and greenbelt integrated system provided by the present invention;

Fig. 2 is a schematic diagram showing a structure of a water supply device of the sponge road and greenbelt integrated system provided by the present invention; and

Fig. 3 is a schematic diagram showing a structure of the sponge road and greenbelt integrated system provided by the present invention.

Reference numerals in the accompanying drawings:

100-pavement; 200-water supply device; 300-greenbelt;

1-surface layer; 2-first buffer layer; 3-pressure bearing plate; 4-bonding layer; 5-bottom layer;

6-foundation; 7-second buffer layer; 8-telescopic spring rod; 9-water storage tank; 10-water outlet pipe; 11-piston; 12-municipal rainwater pipe network; 13-planting soil and packing layer; 14-plain soil layer; 15-water-permeable geotextile, 16-overflow-type rainwater outlet; 17-air pressure adjusting device; 18-air pressure adjusting pipe, 19-one-way vent valve; 20-air vent; 5 and 21-branch vent pipe.

### **Detailed Description of the Invention**

In order to make objectives, technical solutions and advantages of the embodiments of the present application clearer, the technical solutions in the embodiments of the present application will be described clearly and completely below in conjunction with the accompanying drawings in the embodiments of the present application. Apparently, the described embodiments are a part of the embodiments of the present application, not all the embodiments. Based on the embodiments in the present application, all other embodiments obtained by those of ordinary skill in the art without creative work shall fall within the protection scope of the present application.

For facilitating understanding the embodiments of the present application, further explanation and description will be made below with specific embodiments in combination with the accompanying drawings, and these embodiments do not construct limitations on the embodiments of the present application.

In the descriptions of the embodiments of the present invention, it should be noted that the term “connection” should be understood in a broad sense unless otherwise specified and defined, for example, “connection” may be fixed connection or detachable connection or an integral whole, may be mechanical connection or electrical connection, and may be direct connection or indirect connection through an intermediate medium. For those of ordinary skilled in the art, the specific meanings of the above terms in present invention may be understood according to

specific situations.

Terms “top”, “bottom”, “above”, “below” and “on” used for descriptions in the full text are relative to relative positions of parts of a device, such as relative positions of top and bottom substrates inside a device. It can be understood that the device is multifunctional, which is independent of their orientations in the space.

A specific embodiment of the present invention, as shown in Fig. 1 to Fig. 3, discloses a sponge road and greenbelt integrated system including:

a pavement 100, wherein a mounting space is arranged below the pavement 100;

greenbelts 300, located on one side or two sides of the pavement 100; and

a water supply device 200, wherein the water supply device 200 is arranged in the mounting space below the pavement 100 so as to supply water to the greenbelts 300 under the action of an intermittent downward pressure of pedestrians on the pavement 100.

The pavement in the present embodiment is set to be in a suspended state, the water supply device is arranged in the space below the suspended pavement, recycled rainwater supplied by a municipal rainwater pipe network 12 is stored and collected in the water supply device, the water supply device is squeezed by virtue of a pressure acting on the pavement when pedestrians walk or jog, and then, the rainwater in the water storage tank is squeezed out by the water outlet pipes, thereby continuously spraying and irrigating vegetation on one side of a road. Not only is the irrigation continuity improved, but also no additional energy loss is caused, the carbon emission is reduced, and the requirement for sponge construction of cities is met.

In the present embodiment, as shown in Fig. 1, the pavement 100 includes a surface layer 1, a first buffer layer 2, a pressure bearing plate 3, a second buffer layer 7, a bottom layer 5 and a foundation 6 laid from top to bottom, wherein the pressure bearing plate 7 has a certain bearing capacity, thereby ensuring the safety; a bonding layer 4 is arranged between the second buffer

layer 7 and the bottom layer 5 to play a bonding role, and the pressure bearing plate 3 is connected with telescopic spring rods 8 of the water supply device 200; and the first buffer layer 2 and the second buffer layer 7 are capable of improving the buffer performance of the pavement, and the second buffer layer 7 is arranged below the pressure bearing plate 3, which not only provides a descending space for the pressure bearing plate 3, but also is beneficial to the restoration of the pressure bearing plate 3, thereby ensuring the working continuity of the water supply device.

In an optional implementation manner of the present embodiment, as shown in Fig. 2, the water supply device 200 includes a water storage tank 9, water outlet pipes 10, a piston 11 and the telescopic spring rods 8, wherein the water storage tank 9 communicates with the municipal rainwater pipe network 12 to store and collect rainwater, and the municipal rainwater pipe network is utilized to supply water so that the rainwater is recycled; the piston 11 is arranged in the water storage tank 9 and is in sliding and sealing contact with the inner wall of the water storage tank 9, a piston chamber is formed in the inner wall of the water storage tank 9, the top end of the piston 11 is connected with the pressure bearing plate 3 of the pavement 100 by the telescopic spring rods 8, and the telescopic spring rods 8 are capable of driving the piston 11 to move downwards under the action of an overburden pressure of the pavement and may be automatically restored to an original state after the overburden pressure disappears; and each of the water outlet pipes 10 is provided with a water inlet and a water outlet, the water inlet communicates with a water storage space inside the water storage tank 9, and the water outlet extends to the upside of each of the greenbelts 300 so as to spray water to the greenbelts 300 when the piston 11 is pressed downwards.

Further, a plurality of telescopic spring rods 8 are provided and are uniformly distributed between the piston 11 and the pavement 100. By arranging the plurality of telescopic spring rods 8, the piston can be stressed more uniformly, it is ensured that the piston moves in a

vertical direction, and the moving smoothness of the piston is improved.

In order to ensure that sufficient rainwater is always kept in the water storage tank 9, rainwater is complemented into the water storage tank 9 via the municipal rainwater pipe network 12 according to height information of a liquid level in the water storage tank 9, so that a certain liquid level height is always kept in the water storage tank 9 to ensure the continuity of water supply.

In order to increase the area of the greenbelts sprayed by the water outlet pipes 10, the water outlet of each of the water outlet pipes 10 is provided with a rotating nozzle, the nozzle rotates while spraying water by virtue of a centrifugal effect of a water flow and a pushing effect of a counter-acting force, in this way, the spray area is increased, and more uniform spray is achieved.

In view of the possibility that a slow-moving walkway pavement is located between the two greenbelts, in this case, for achieving the purpose that the same water supply device supplies water to the greenbelts on the two sides of the pavement at the same time, at least two water outlet pipes 10 are provided to supply water to the greenbelts 300 on the two sides of the pavement 100 respectively, and thus, the irrigation efficiency of the water supply device is increased.

In the present embodiment, the water storage tank 9 includes a top wall, a bottom wall and a side wall; a first through hole is formed in the center of the top wall of the water storage tank 9 to allow the telescopic spring rods 8 to penetrate through; and the side wall of the water storage tank 9 is provided with a second through hole so as to be connected with the municipal rainwater pipe network 12.

In order to avoid the phenomenon that the smooth movement of the piston 11 is affected due to the change of the air pressure in the water storage tank, the water supply device 200 further includes an air pressure adjusting device 17 so that the air pressure inside the water storage

tank 9 is adjusted.

In an optional implementation manner of the present embodiment, the air pressure adjusting device 17 includes an air pressure adjusting pipe 18; one end of the air pressure adjusting pipe 18 is connected with a fourth through hole in the side wall of the water storage tank 9 by a one-way vent valve 19 so that air in the water storage tank 9 flows out in one way; and an air vent 20 in the other end of the air pressure adjusting pipe 18 extends out of the mounting space of the pavement 100 and communicates with the atmosphere. Further, the air pressure adjusting device 17 further includes a branch vent pipe 21, one end of the branch vent pipe 21 is connected into the air pressure adjusting pipe 18, and the other end of the branch vent pipe is connected with a third through hole in the top wall of the water storage tank 9, so that the air pressure above the piston 11 in the water storage tank 9 is adjusted.

Specifically, the top wall of the water storage tank 9 is further provided with a third through hole, and the side wall of the water storage tank 9 is provided with a fourth through hole; and the fourth through hole is provided with a one-way vent valve 19, and the one-way vent valve 19 is connected with the air pressure adjusting pipe 18 to only allow an external gas to enter the water storage tank 9 via the air pressure adjusting pipe 18. When the piston 11 moves downwards, the external gas enters a top space of the water storage tank 9 via the branch vent pipe 21; and when the piston 11 moves upwards to reset, a gas in the top space of the water storage tank 9 is discharged out of the branch vent pipe 21, meanwhile, the external gas is capable of entering from the one-way vent valve 19 to a lower space of the water storage tank 9 in one way via the air pressure adjusting pipe 18, and thus, the balance of the air pressure in the water storage tank 9 is achieved, the smooth movement of the piston is ensured, the working stability and reliability of the water supply device are improved, and continuous irrigation of the greenbelts is achieved.

In the present embodiment, in order to avoid the phenomenon that the rainwater in the water

storage tank 9 is discharged out of the municipal rainwater pipe network 12 to affect the irrigation effect of the greenbelts when the piston 11 moves downwards, a one-way water passing valve is arranged on a position, close to the water storage tank 9, on the municipal rainwater pipe network 12, or the one-way water passing valve is mounted in the second through hole in the side wall of the water storage tank 9, and the one-way water passing valve only allows the rainwater to flow into the water storage tank 9, but does not allow the rainwater to return reversely via the municipal rainwater pipe network 12.

In the present embodiment, each of the greenbelts 300 includes a plain soil layer 14 and a planting soil and packing layer 13 laid on the plain soil layer 14. A water-permeable geotextile 15 is laid between the planting soil and packing layer 13 and the plain soil layer 14 to separate the planting soil and packing layer 13 from the plain soil layer 14.

When the rainfall is overlarge or the water supply device 200 supplies excessive water to the greenbelts, water may be accumulated on the surfaces of the greenbelts. In order to avoid the phenomenon that the normal growth of vegetation is affected by over-deep water accumulation, each of the greenbelts 300 is provided with an overflow-type rainwater outlet 16. When the water level of rainwater exceeds the height of a water inlet of the overflow-type rainwater outlet 16, the rainwater overflows via the overflow-type rainwater outlet 16, thereby avoiding the phenomenon that the water accumulated in the greenbelts is over-deep to injure the vegetation.

A working process of the water supply device in the present embodiment is described as follows:

when walking or jogging on the pavement, pedestrians may apply a downward pressure to the pavement by jamming on the ground, the pressure is conducted to the first buffer layer 2, the first buffer layer 2 is bonded with a top layer of the pressure bearing plate 3 so as to be squeezed, meanwhile, the pressure is conducted to the pressure bearing plate 3, the second buffer layer 7

at the lower part is squeezed by the pressure bearing plate 3, the second buffer layer 7 at the lower part is squeezed to deform, at the moment, the pressure bearing plate 3 moves downwards, the telescopic spring rods 8 move downwards, shrink under the overburden pressure and transfers the pressure downwards, so that the piston 11 moves downwards to compress air in the water storage tank 9, and then, the rainwater in the water storage tank 9 is squeezed by the water outlet pipes 10 to spray and irrigate the greenbelts beside the road; and when the overburden pressure on the pavement 100 disappears or is weakened, the telescopic spring rods 8 reset to an original state under the action of their restoration elasticity and resilience of the buffer layers, the pavement 100 is ascended to an original position, the telescopic spring rods 8 and the two buffer layers drive the piston 11 to reset while being restored to the original states, the space at the upper part of the piston 11 in the water storage tank 9 is squeezed when the piston 11 resets, the space at the upper part of the piston 11 in the water storage tank 9 achieves air pressure balance via the branch vent pipe 21, a lower space of the piston 11 in the water storage tank 9 is restored to be balanced with an external air pressure via the one-way vent valve 19 and the air pressure adjusting pipe 18. When pedestrians jam on the ground next time, the above-mentioned process is performed again to spray water to the greenbelts, and the above-mentioned process is repeated, thereby achieving continuous watering of the greenbelts.

In the present embodiment, the pavement 100 is preferably a slow-moving walkway pavement. The water supply device can be arranged on a slow-moving walkway in a park or a residential district. According to the water supply device, the characteristic that a pedestrian walkway is capable of bearing a pressure is sufficiently utilized, kinetic energy of pedestrians is converted into elastic potential energy by conducting a pressure generated on the ground when the pedestrians walk or jog to the water supply device, in this way, the water supply device is continuously squeezed, and then, the rainwater in the water storage tank is squeezed out via

the water outlet pipes to continuously spray and irrigate the vegetation on one side of the road, so that the irrigation continuity is improved. By adopting a step-by-step irrigation manner, water absorption of the plants is promoted, and the long-acting effect of rainwater storage is achieved. In addition, no additional energy loss is caused, the carbon emission is reduced, and  
5 the requirement for sponge construction of cities is met.

In the above-mentioned specific implementation manners, the objectives, technical solutions and beneficial effects of the present application are further described in detail. It should be understood that the above-mentioned descriptions are merely specific implementation manners of the present application, but are not intended to limit the protection scope of the present  
10 application. Any modifications, equivalent replacements, improvements and the like made within the spirit and principle of the present application shall fall within the protection scope of the present application.

## Claims

1. A sponge-type integration system of road and green space, characterized by comprising:  
a pavement (100), wherein a mounting space is arranged below the pavement (100);  
5 greenbelts (300), located on one side or two sides of the pavement (100); and  
a water supply device (200), arranged in the mounting space and connected with the pavement  
(100) so as to supply water to the greenbelts (300) under the action of an intermittent downward  
pressure of pedestrians on the pavement (100).
- 10 2. The system of claim 1, characterized in that the pavement (100) comprises a surface layer  
(1), a first buffer layer (2), a pressure bearing plate (3), a second buffer layer (7), a bottom layer  
(5) and a foundation (6) laid from top to bottom.
3. The system of claim 2, characterized in that a bonding layer (4) is arranged between the  
15 second buffer layer (7) and the bottom layer (5).
4. The system of claim 2, characterized in that the water supply device (200) comprises:  
a water storage tank (9), wherein the water storage tank (9) is connected with a municipal  
rainwater pipe network (12) to store and collect rainwater;  
20 a piston (11), wherein the piston (11) is arranged in the water storage tank (9) and is in sliding  
and sealing contact with the inner wall of the water storage tank (9);  
telescopic spring rods (8), wherein one end of each of the telescopic spring rods (8) is  
connected with the piston (11), and the other end of each of the telescopic spring rods (8) is  
connected with the pressure bearing plate (3) of the pavement (100); and  
25 water outlet pipes (10), wherein each of the water outlet pipes (10) is provided with a water

inlet and a water outlet, the water inlet communicates with a water storage space inside the water storage tank (9), and the water outlet extends to the upside of each of the greenbelts (300).

5. The system of claim 4, characterized in that the water supply device (200) further comprises an air pressure adjusting device (17) so that the air pressure inside the water storage tank (9) is adjusted.

6. The system of any one of claims 4 to 5, characterized in that the water outlet of each of the water outlet pipes (10) is provided with a rotating nozzle.

7. The system of claim 6, characterized in that the pavement (100) is a slow-moving walkway pavement.

8. The system of claim 1, characterized in that each of the greenbelts (300) comprises a plain soil layer (14) and a planting soil and packing layer (13) laid on the plain soil layer (14).

9. The system of claim 8, characterized in that a water-permeable geotextile (15) is laid between the planting soil and packing layer (13) and the plain soil layer (14).

10. The system of claim 9, characterized in that each of the greenbelts (300) is provided with an overflow-type rainwater outlet (16).

## Abstract

### SPONGE TYPE INTEGRATION SYSTEM OF ROAD AND GREEN SPACE

5 The present patent relates to a sponge - type integration system of road and green space, including a pavement, a water supply device and greenbelts, wherein a mounting space is arranged below the pavement; the greenbelts are located on one side or two sides of the pavement; and the water supply device is arranged in the mounting space and is connected with the pavement so as to supply water to the greenbelts under the action of an intermittent  
10 downward pressure of pedestrians on the pavement. According to the present invention, the characteristic that a pedestrian walkway is capable of bearing a pressure is sufficiently utilized, and a manner of watering plants step by step is adopted, so that water absorption of the plants is promoted, and the long-acting effect of rainwater storage is achieved.

15 (Fig. 3)