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# A Movable Roof Greening Device

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**Abstract.** With the development of garden technology and the construction of ecological environment, roof greening has become one of the new ways to improve the urban environment, which can increase greening rate, improve living environment and help build sponge cities. The existing roof greening method is to make the vegetation into greening module units and then assemble them into a whole greenbelt on the roof, which is inconvenient to move and easy to be damaged during transportation. In addition, many outlets for discharging rainwater account for the loss of the matrix layer, and it is inconvenient to clean. Therefore, a movable roof greening device is invented, which has the characteristics of easy to operate, sealed, non-slip, stable and so on. It can effectively solve the defects in the existing devices, at the same time, it helps to solve environmental problems such as heat island effect and poor air quality.

## 1. Introduction

Germany is the most advanced country for roof greening technology [1]. The driving force for rapid development of roof greening comes from its ecological benefits and its significant contribution to energy conservation, effective conservation of biodiversity, and maintenance of urban ecological balance. At the end of the 20th century, with the development of technology, various countries began to learn the concept and technology of roof greening, and put it into practice [2].

In China, Liu Yefen and others have investigated the roof greening situation in Hangzhou [3] and Wen Zhijiang has studied the roof greening form of Wuhu [4]. The results show that the current green roof utilization rate is not high, and it has great development potential.

## 2. The benefits of roof greening

### 2.1. Increasing greening rate

At present, while cities around the world are pursuing maximum benefits, urban greening is decreasing and air quality is declining. The contradiction between economic efficiency and living environment is becoming more and more serious, scarce urban land is used to meet the needs of various urban functions, but less and less for greening. The roof area accounts for about 20% to 25% of a city's area. It can be seen that in a limited urban space, roof greening is the most effective way to increase green coverage.

### 2.2. Improving the Human Settlement Environment

As an emerging green space in recent years, the roof not only provides people with a place to rest and entertain [6], but also plays an important role in further improving the ecological environment and air quality. It can also beautify the urban landscape and effectively improve the quality of the human living environment [7].



### 2.3. Building Sponge City

The device can optimize the regulation of rainwater, intercept 20%~70% of roof rainwater, which slow down water penetration and let more water slowly infiltrate into the ground [8] When the rainfall is the same. It collects and purifies rainwater resources, and also solves the problem of untimely urban drainage, which is truly committed to the construction of sponge cities.

## 3. Introduction of the device

### 3.1. Idevice schematic

The structure sketch and top view of the device are as follows.

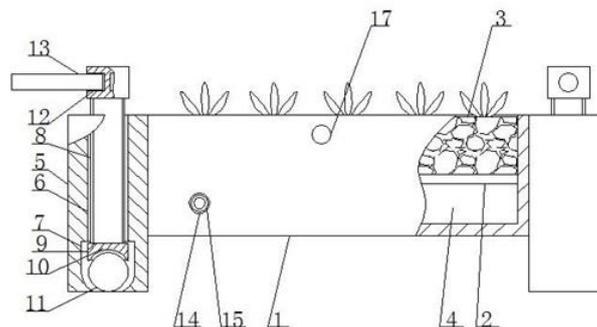


Fig 1. Structural sketch

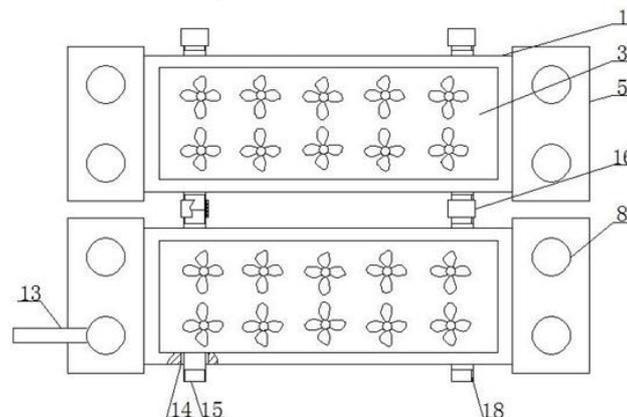


Fig 2. Top view

### 3.2. Specific implementation methods

In order to make the purpose, technical scheme and advantages of the optimal design example clearer, the technical scheme in the optimal design will be described in the following section in conjunction with the drawings in the optimal design, and this embodiment is not all of the implementations.

The movable roof greening module, as shown in the figure, includes the top opening box 1, the inside of box 1 is equipped with filter 2, the front and rear sides of filter 2 are fixed with the inside of box 1, the top of filter 2 is matrix 3, the bottom of filter 2 is water storage 4, the top of matrix 3 is planted with green planting, the left and right sides of box 1 are fixed with square block 5, and the front and rear sides of square block 5. Thread hole 6 is provided on both sides, groove 7 is provided on both sides of the bottom of square block 5, groove 7 corresponds to thread hole 6 and communicates with the inside of thread hole 6. The bottom side of groove 7 is circular arc, bolt 8 is fixed with bolt 8, the bottom of bolt 8 is fixed with square plate 9, the bottom of square plate 9 is provided with arc groove 10, and the surface of arc groove 10 is smooth. Ball 11 and ball 11 are arranged in groove 7. In combination with the arc groove 10, the diameter of ball 11 is smaller than the diameter of arc at the bottom of groove 7. Four first slots 12 are arranged around bolt 8. Rotary rods 13 are arranged in the first slot 12, through holes

14 are arranged on both sides of box 1, through holes 14 are fixed to install circular tube 15, external thread 18 is arranged at one end of circular tube 15, and screw sleeve 1 is arranged at one end of circular tube 15 at the back. 6. The sleeve 16 matches the outer thread 18. The utility model has the advantages of convenient movement and stable moving process, multiple green modules are spliced together, excess rainwater is discharged from a drainage outlet, and the matrix layer 3 in the drainage process is discharged from a fixed drainage outlet to facilitate roof cleaning; when using the utility model, the rotating rod 13 is inserted into the first slot 12 on the left side, the rotating rod 13 90 degrees are twisted, and the rotating rod 13 is pulled out and inserted into the left after the twisting. At the same time, bolt 8 moves downward along thread hole 6, bolt 8 drives square plate 9 to move downward, arc groove 10 contacts ball 11, continues to twist rotating rod 13, square plate 9 drives ball 11 to move downward, the lower side of ball 11 passes through groove 7, square block 5 no longer contacts with roof, and promotes green module unit to appropriate position and reverse direction. Turn the rotating rod 13, the rotating rod 13 drives the bolt 8 and the square plate 9 to move upward, the ball 11 enters the groove 7, and the square block 5 contacts the roof. The device is placed in the designated position of the roof. Repeat the above process and move the next greening module unit. Correspond the two adjacent greening module units to the circular tube 15, twist the screw sleeve 16, the screw sleeve 16 and the external thread 18, and the screw sleeve 16 from the front side. The first green module unit and the last green module unit have drainage outlets. The excess rainwater is discharged from the first green module unit and the last green module unit's circular pipe 15, which facilitates the drainage process. The discharged matrix layer 3 is cleaned up to ensure the clean and sanitary roof.

## 4. Conclusion

### 4.1. *Comfort Optimization*

A second slot 17 is arranged on the upper side of the front and rear sides of the box 1, and the slot 17 is oblique cylindrical. When the device is moved, the rotating rod 13 is twisted, the lower side of the ball 11 is moved out of the groove 7, the rotating rod 13 is removed from the first slot 12, the rotating rod 13 is inserted into the second slot 17, and the rotating rod 13 is pushed to move the device without bending to push the device, so as to increase the comfort of the operator.

### 4.2. *Leakage-proof Design*

A sealing ring is fixed at one end of the circular pipe 15 according to the present embodiment. There is a gap between the two circular tubes 15 when they are connected by the bolt 16. By fixing and installing the sealing ring, the sealing ability of the two green module units is ensured and the leakage phenomenon is prevented.

### 4.3. *Antiskid Design*

The anti-skid layer is fixed at one end of the rotating rod 13 according to the present embodiment. The anti-skid layer increases the friction force between the rotating rod 13 and the hand, prevents slipping and improves efficiency.

### 4.4. *stability optimization*

The bottom of the square block 5 described in the present embodiment is fixed with an anti-skid layer. The roof greening position is higher, and the greening module is easy to be moved by wind in windy weather. There are some hidden safety hazards. The anti-skid pad increases the friction between square block 5 and the roof, increases the stability of the greening module, and makes the device more stable.

### 4.5. *Appearance Design*

As shown in the figure, the green plant described in the present embodiment is verbena. Sedum is a perennial herb with strong adaptability to cold, drought, salt and alkali, barren, pest and disease resistance, juicy stems, green leaves like jadeite, neat and beautiful, strong adaptability and ornamental.

In summary, the device optimizes many problems such as inconvenient operation, poor stability, easy to leak and slip during the use of traditional greening modules, improves the comfort of operators, and beautifies the appearance of the device.

### **Acknowledgments**

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