Aylesford Project Smart Roof 2.1

SuDS used

- *Polypipe Blue Roof Passive Irrigation System with integrated smart cloud water control system and rainwater harvesting*

Benefits

- *Energy Efficiency improvement of existing building*
- *Health, Well Being, Social Benefits for Staff*
- *Biodiversity Net Gain*
- *Source Control SUDs and reduction of potable water use for irrigation of the green infrastructure atop the roof*
- *Building on research from first smartroof project with Amsterdam City Council and Dutch Water Authority*

1. Location

New Hythe Business Park, College Rd, New Hythe, Aylesford ME20 7PJ

Address include post code

2. Description

When Polypipe's offices in Aylesford, Kent, required roofing renovations, the decision to create a Blue-Green roof was an easy one, and provided the opportunity for the design and development of a new, intelligent water management system. The goal of the research was also to get an even better understanding of the functioning of blue-green roofs in the UK, supplemental to all knowledge already compiled at the parent roof in Amsterdam.

Recognising that the health and survival of a green roof can be dependent upon unpredictable weather patterns and require ongoing maintenance, we worked to create a system which automatically manages water supplies to provide optimum soil moisture conditions, allowing the green roof to flourish – maximising its benefits.

The Project SmartRoof 2.0 research project started in April 2017 and aimed at determining hydrological, thermal and biodiverse functioning of blue-green roof systems in the urban environment. The goal was to harvest and store as much rainwater for capillary plant irrigation as possible and use drinking water only in cases of extreme prolonged droughts.

The hypothesis was that plants in blue-green roof systems have a higher urban cooling capacity, can enable a wider plant species selection due to improved water availability, as well as reduce the precipitation lost to sewer discharge.

One plot was constructed like a conventional extensive green roof, equipped with a 25mm drainage mat and a 4cm substrate layer. The other two plots were equipped with an 85mm drainage, storage and capillary irrigation system, with water storage maximised (by overflow) to 30mm out of the available 80mm capacity (due to weight restrictions on the roof). One was covered with a 4cm substrate and the other with an 8cm substrate. Surface and air temperatures on an adjacent reference black bituminous roof were also monitored.

A complete array of sensors was installed to measure heat fluxes (incoming sunlight, reflected light, surface temperatures, soil and air temperatures). Weather data was gathered with an on-site weather station (rainfall, solar radiation, air temperature, relative humidity, wind speed and direction). A weighing lysimeter was built into each research area to determine actual plant evaporation in relation to time. Soil moisture and water levels in the units were monitored and recorded. A second temperature monitoring station was placed on an adjacent black roof.

After placement of sedum mix blankets, 40 plant species native to Europe were sown on the sedum carpet/substrate to increase the biodiversity and to give insight in the change in plant species distribution over time. All plots received the same initial vegetation and seed mix as well as the same maintenance and fertilisation regime throughout the entire research period.

3. Main SuDS components used

In this application the system is used to create a volume void where rainwater is stored at roof level before being returned to the underground drain through the Flow Control Outlet. The system can be installed in both warm and cold roof build ups and because the system forms a structural raft, the build-up above the units can be as little as 50mm for un-trafficked paved areas. In addition, as the connected cells form a structural raft, the locking system allows for roof furniture - railings and plant, such as photovoltaic cells, to be fixed to the structural raft without detriment to the roof waterproof membrane.

The system is capable of being used in both a blue roof and a blue green roof system. At it’s core are two polypropylene attenuation cells of 85mm and 150mm depth which allow for shallow attenuation at roof level; the void ratio of each cell is 95:5. The cells come as individual units but can be connected together to form a structural raft where the water is to be stored. They can be stacked to form deeper areas of attenuation or weir areas and, once the attenuation build up is complete the roof area can be given over to amenity spaces such as pathways, mechanical/ electrical plant such as PV cells (with our unique bolt down attachment) or green environments – or a mixture of all 3.

4. How it works

Controlled and monitored remotely online via a smartphone, tablet, or computer, the Cloud Water Control System combines monitoring sensors, remote valve operation technologies and cloud computing software to provide adaptive irrigation, creating the ideal conditions for plant life, while maximising water usage efficiency.

Using our Capillary Cones – which draw water upwards – stored rainwater irrigates the green roof, while sensors within the cells monitor available water levels. If a pre-determined ‘low set-point’ is reached, the system will open a solenoid valve to add water from the Rainwater recovery tank until the correct level is reached.

During high-rainfall events, excess water in the wet cell spills over into the raft. When the tank reaches capacity this water overflows to the drain.

5. Specific project details

6. Maintenance & operation

Details of maintenance and operation

Please see maintenance schedule for the blue Aylesford below:

Green Roof:

- Twice a year rake sedum through
- When raking in summer remove any leaves and make sure outlets are clear of debris. Cut back any excessive growth and remove from roof.

Cloud Water:

1. Recommended maintenance

Within the first 12 months, it is recommended that the system is visually inspected quarterly to ensure the system operating effectively, to observe if there are any signs of excessive wear and tear on system components and to ensure the level sensors are clean and free of obstructions. Quarterly servicing may be carried out by a competent local operative using the issued O&M manual as a reference guide.

2. Required servicing

Servicing is required annually, with the first service due 12 months after the completion of the installation. Subsequent services to be arranged once every 12 months thereafter. Servicing may include, but not limited to:

- Clean and inspect sensors
- Document flow meter readings
- Clean flow meters
- Clean and inspect valves and pumps for visual signs of damage. Normal wear and tear to be expected.
- Test and inspect all electrical connections.

Service intervals may be reduced or increased based on the condition of the system, and the local environment of the system.

3. Remote Maintenance & Support

As part of the control subscription, the team will provide a remote maintenance and support service which includes remote diagnostics and monthly checks of the system performance. Monthly checks involve observing live data to monitor for normal/abnormal operation, and analysis of monthly historical data to ascertain normal/abnormal trends.

7. Monitoring and evaluation

Undertaken in collaboration with SEL. We are able to monitor a wide range of metrics from soil moisture levels to monthly average storage volumes.

8. Benefits and achievements

After the initial month of establishment, the plots did not receive any water other than rain. The vegetation started as a sedum-dominated mix and quickly developed into a grass- and herb-dominated vegetation on the capillary irrigated plots.

The plant cooling capacity is directly linked to the amount of water plants can evaporate during growth. Water availability for plant growth directly determines or limits plant cooling and with that their urban heat island reduction capacity.

The three research plots showed distinct differences in actual plant evaporation rates. The capillary-irrigated plots show evaporation fluxes of ca. 3mm/day (3 l./m2 per day) on average during summer, with up to well over 4mm/day especially in late spring 2018. This is very much in line with the potential evaporation of normal natural vegetation at ground level in the Netherlands.

Observations on the roof indicated that the sedum vegetation on the conventional green roof ran out of water after six to seven days of no rain, where the blue-green systems with grasses and herbs ran out of water after a dry spell of 15 days.

The results show that on a conventional green roof with sedum vegetation, total growing season water shortages can be reduced from 28 to 4% by increasing the amount of water stored in the drainage layer from 0 to 80mm. For a grass- and herb-dominated vegetation, water shortage is reduced from 29 to 12%. This lesser reduction is caused by the fact that the modelled potential evaporation of a grass/herbs vegetation is higher than that of the sedum-dominated vegetation.

To achieve maximum evaporation to maintain the growth of roof vegetation and to generate the urban cooling effect, based on 80mm of water storage, 70mm of extra irrigation water would be needed for a grass/herbs vegetation and 15mm for the sedum-dominated vegetation.

9. Lessons learnt

During the research period, the hydrological performance – in the sense of evaporating precipitation water instead of discharging this water to the sewer – was also greatly improved by the blue-green roof system: total average precipitation water evaporation for sedum increased from 290 to 386mm and for the grass/herbs vegetation, from 414 to 515mm.

The storage of precipitation and capillary irrigation of the roof vegetation proved to be an effective measure for increasing total annual evaporation. Moreover, due to the higher water efficiency of sedum vegetation, it takes longer before the water runs out in the system and evaporation declines. The results showed that when storing up to 80mm of water, sedum vegetation is sustainable in the long-term.

Not only is a blue-green roof relatively simple to install and maintain on a large enough flat roof area, but the spaces created can offer more benefits for the end-users of the site, by increasing usable green spaces for amenities, which, in turn, increases biodiversity and can assist with climate cooling. The research from Project SmartRoof 2.0 demonstrates that in order to have the urban environment benefit of green roofs, we have to add water to these systems so that plants can flourish. A blue-green roof system also enhances how urban space can be better used in a multifunctional way.

10. Interaction with local authority

This was constructed on a building already owned by Polypipe Group.

11. Project details

Construction completed: *2017*

Cost: *Of overall project if known and of SuDS part of project if known* £x

Extent: Xm^2 / Ha *of entire scheme and of SuDS part if separate to entire project* - A total of three research plots (4.2 x 4.2m each) were constructed within a 440m2 blue-green roof garden in Amsterdam.

12. Project team

Funders	• Polypipe	
Clients	• Polypipe	
Designers	• Polypipe	
Contractors	• Polypipe	
Other	• Polypipe