Blue-roof thinking

The custom has been to remove storm water from a building as quickly as possible, but there is a different way of managing rainwater, says **Carl Harrop**

The strict attenuation of storm water from developments is now commonplace, with the flow control normally taking place close to the outfall from the site.

More recently, the idea of reducing the volume of water through using a 'green roof', which also provides a habitat for wildlife, has been used. But a third, and commonly overlooked, way is gaining credence with engineers – the blue roof.

'Blue roof' is a term used to describe a system which allows rainwater to temporarily build up where it lands on the building roof, reducing or potentially eliminating the need for other downstream attenuation methods, such as tanks or oversized drains, and is particularly suited to new-build flat-roof developments. A blue roof normally has zero degrees fall, maximising the volume available for attenuating the rainfall in a relatively thin film across the maximum possible surface area. It can also be cheaper than more established methods.

So what is wrong with the current approach? All too often, barriers to a holistic surface water disposal plan are created through the number of different parties involved in the design for taking the rainwater from the roof, through the building and to its point of discharge. The timing of appointments reinforces the difficulty for any particular discipline to propose an approach that may cross several contractual boundaries.

Using traditional methods creates a concentration of flows that inevitably leads to large-bore rainwater pipework connected to the underground drainage, which is also sized to take the peak flows resulting from short, high-intensity storms. However, does removing the water based on a two-minute storm duration really provide the best value?

A typical flat roof office building will have been designed to withstand the weight of snowfall, which is usually at least 0.6 kN/sq m. Also, to help convey the rainwater to the various outlets as efficiently as possible, the roof will normally be laid to falls, often with screed weighing in at between 1.2 kN/sq m and 4.8 kN/sq m.

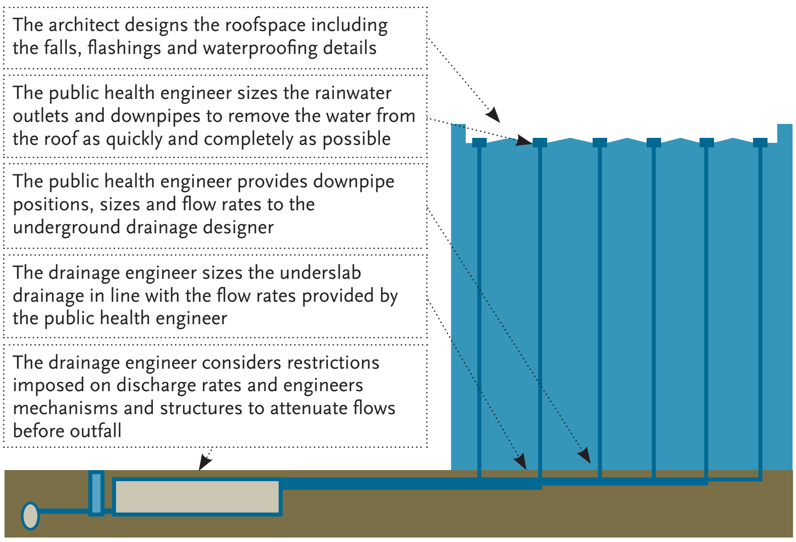
This means that if we remove the screed, there is already the structural capacity to allow more than 180mm of water to build up on the roof. So, what if we use this inherent strength to contain the peak flows from a storm, as opposed to sizing the entire system to convey it to a remote attenuation point?

The key to designing a blue roof or similar system is to understand not just the peak flow rates generated by a particular storm, but also the volumes of water delivered by the downpour.

Every building will have different requirements, and this approach would only be suitable for flat-roof buildings. But as the costed example in the box on the third page shows, if a building is well suited to the approach, there is the opportunity to actually reduce the cost of a building by adding storm attenuation.

A blue roof system needs a means to control the flow rate from the roof. Currently, however, there are very few components on the market designed to accurately restrict flows. But there are several ways of approaching this. One is to control the flow at the outlet. Although this can be difficult to calculate and control effectively due to the very small head of

The traditional approach to rainwater disposal



An example of a roof that is well suited to rooftop attenuation. Even with BS compliant falls, some ponding is common due to building tolerances and workmanship

water, Polypipe, for example, has developed and tested versions of its siphonic outlets that can give accurate reduced discharges for a range of flow rates.

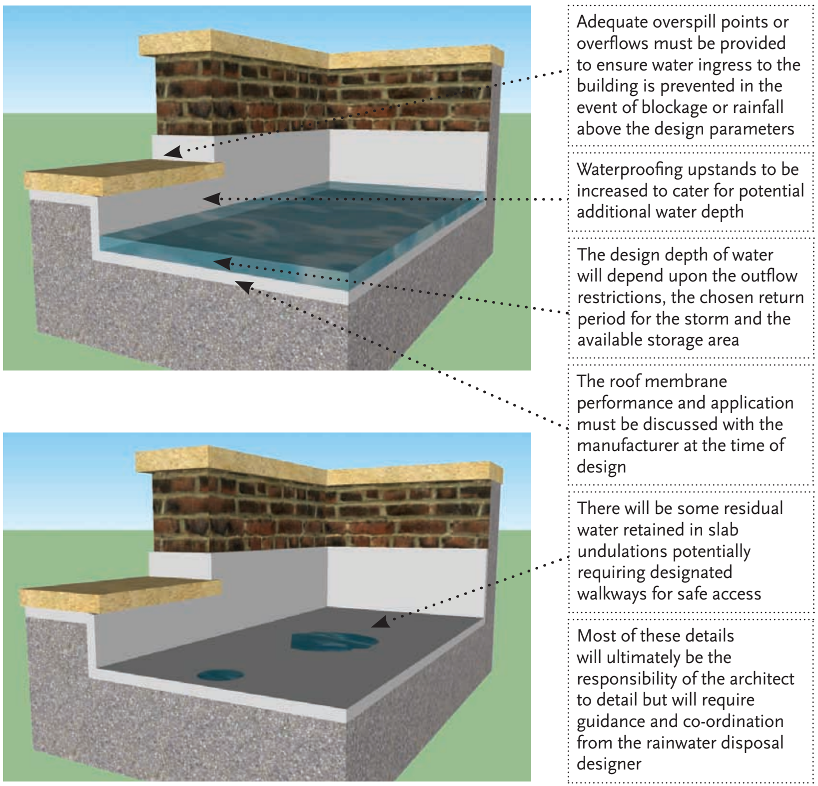
Another option is to run small-bore pipework down the building with a standing head of water in them and install an in-line flow control device located in a plant-room or somewhere similar on a lower floor, where maintenance can be undertaken safely.

The performance of any control device must be demonstrable to the sewerage undertaker, Environment Agency or other authority that has set the outflow restriction.

As with all rainwater disposal designs, the most important factor is to correctly assess and design out the risk of ingress into the building. Overspill points from the roofs to protect against blockage of the outlets or a storm in excess of the design parameters are critical. In theory, if these are provided and the flashings and tanking details are robust, there should be no additional risk of water ingress using a blue roof as opposed to more traditional approaches.

The rainwater designer must also check that all penetrations through the roof have been adequately detailed so that the reservoir is not breached at any point. An explanation of how the roof is designed to perform should also be included in the building log >

Blue roofs: some key design elements



The Society of Public Health Engineers

The CIBSE Society of Public Health Engineers (SoPHE) was set up to provide a higher profile and focus for public health engineering, and a route to gaining professional status.

Public health engineers contribute greatly to social welfare, with particular regard to facilities such as water, drainage, gas and fire engineering systems in a large range of applications. This important input is long established and essential to provide clean drinking water supplies and adequate sanitation and drainage facilities. Over the last few years, water conservation has also grown in importance, forming an important part of the drive for sustainability in homes and offices.

SoPHE aims to promote the art, science and practice of public health engineering, along with raising the awareness of the contribution engineers make to this sector. Through organised technical talks, evening events and newsletters, members are kept informed of specific developments and relevant updates on legislation, as well as having the opportunity to network with colleagues. It also organises the annual SoPHE Young Engineers Award, encouraging young engineers of the future.

The society has also created an Industrial Associates forum for leading manufacturers working within the public health industry. Through the society members are able to input into CIBSE publications and government consultations. To find out more about joining, visit **www.cibse.org/sophe**

Blue roof vs traditional method

Traditional roof

Roof type: flat roof office building, 5,000 sq m

Outflow: 15 litres per second for a one in 100 year storm

Scenario one: Category two storm intensity for a two minute storm = 0.062 litres per second per sq m (BS 12056 Part 3)
Total flow rate = 310 l/s

Conclusion: Using a traditional approach, the entire system, from the outlets through to the underground drainage, would need to be sized to remove this peak flow (although time of concentration allowances can be made on larger systems).

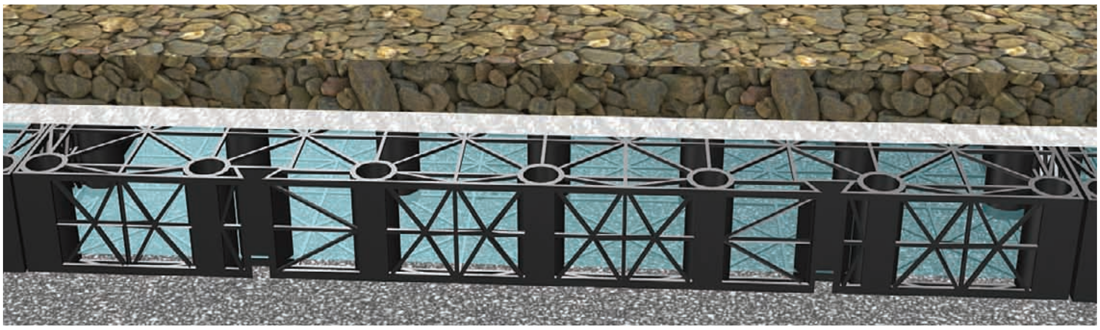
Blue roof

Scenario two: If we look at the same location and storm, but choose to install a truly flat roof with outlets (or other means) restricting the flow rate from the roof to the required 15 l/s:

Temporary available 'pond' space: 3,750 sq m (assuming 25% volume of the roofscape is taken up by plant bases or other structures)

Conclusion: Looking at a range of storm durations from one minute to several hours and an outflow rate of 15 l/s, the maximum depth of water on the roof would only reach 40mm! (Most rainwater outlet manufacturers assume 35mm head of water over their outlets to achieve the stated flow rates.)

As the storm intensity decreases and the outlet capacities begin to exceed the rainfall rate, the roof will slowly clear of water. In this example, after 3.5 hours the water will have cleared, with the exception of some minor ponding retained in any depressions in the flat slab caused by building tolerances.



A void can be used to both attenuate and store water for harvesting

> book as it will be important that the calculated volume on the roof is not reduced during the installation of tenant plant on the roof, for example.

The roof waterproofing must, of course, be carefully designed, and the suppliers/contractors happy to provide the necessary guarantees, which should be little different from those required for a green roof.

So, what could the next step be? In the example described in the panel on the left, we use only 40mm of the potential 180mm structural capacity for water storage. Could the next step be to install a shallow crate or paving pedestal system, across the flat roof to provide a storage zone beneath a pedestrian accessible area and re-use the collected rainwater?

Currently, a typical rainwater harvesting system may consist of the following elements:

- Conveyance of the water from the roof as quickly as possible in large pipework;
- Routing roof water to an underground tank in its own system of underground drainage;
- Pumping water back up to a ground-level plant room; and
- Pumping water again to distribute it through the building.

In this example, if we were to construct the rainwater outlets as standpipes, creating a storage zone of 40mm beneath it as rainwater harvesting, it would yield a storage volume in excess of 120,000 litres. The rainwater harvesting could then consist of:

- Storage at source with small bore pipework delivering water by gravity to the treatment plant;
- Pumped distribution to fittings; and
- No associated underground drainage or tanks

To use water stored in this manner for rainwater harvesting may require some additional treatment because of the higher storage temperatures and potentially less effective silt removal. However, when the energy, carbon and cost of such a simplified system are taken into account, this becomes insignificant. (Roughly speaking, the use of the pumps will be reduced by 50%, so energy consumption may be reduced by about 40%. Embodied energy/carbon would be reduced in line with the reduced materials as given in the box, top right.)

Every building is different, but the public health engineer is well placed to become the person to advise the design team on what solution, or combination of solutions, best delivers the environmental aspirations and value for the client. If we can reconsider the need to drain flat roofs quickly, with no residual water, then it will give us, as designers, significant scope for innovation, cost reduction and real sustainability benefits.

Just as the building services engineer is now an essential member of the conceptual design team, advising on building form in relation to energy and ventilation, perhaps it is time for the public health engineer to forge a role in the early design stages to add value and shape the way in which a development manages its impact on the water environment. ●

Attenuation for free?

Using a 5,000 sq m, six-storey building, the traditional approach to rainwater disposal may consist of:

Roof membrane	£225,000
Screed laid to falls	£90,000
45 rainwater outlets	£6,000
550m of 100-150mm diameter rainwater pipe	£16,000
470m of 150-450mm dia underground drainage	£35,000
Total traditional system without attenuation	**£372,000**

During the planning process a requirement for 218 cu m of attenuation is identified.

underground attenuation tank	£50,000
Total cost	**£422,000**

Blue roof approach:

Total traditional system without attenuation	**£372,000**
Add: enhanced roof membrane	+£60,000
Add: higher waterproofing detailing	+£17,000
Add: above ground flow attenuators	+£3,000
Omit: screed laid to falls	-£90,000
Omit: 39 rainwater outlets	-£5,000
Omit: reduction in rainwater pipework	-£14,000
Omit: reduced underground drainage	-£28,000
Total blue roof attenuated system	**£315,000**

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