Using SuDS close to buildings

In this fact sheet Steve Wilson summarises the role of the designer in overcoming any potential challenges related to using SuDS components that rely on infiltration close to buildings.

The author

Steve Wilson is a Chartered Civil Engineer with 30 years' experience of geotechnical engineering. He has a Masters Degree in geotechnical engineering and has wide experience of foundation design and construction. Steve provided advice to the former Commission for New Towns on subsidence and settlement issues with their housing stock in the south east and this often involved in the investigation and assessment of subsidence and heave caused by trees in clay soils (especially London Clay). He has extensive experience in the design and construction of infiltration drainage and has investigated many soakaway failures. He has also provided advice on settlement of foundations caused by water consolidation of loose sand infill to Chalk solution features.

Introduction

Permeable pavements are a widely used SuDS approach that can allow water to infiltrate into the ground. They allow source control to be included in dense developments. Similarly rain gardens are one of the simplest ways of retrofitting SuDS to existing buildings. However space constraints mean that both approaches often need to allow water to soak into the ground near to building foundations.

The Building Regulations state that *"Infiltration devices should not be built within 5m of a building or road or in areas of unstable land"*. This is to prevent water that soaks into the ground from affecting the stability of foundations. Complying with this guidance means that it often proves difficult for designers to locate permeable pavements, small basins and similar infiltration systems close to buildings and the benefits of allowing water to soak into the ground are lost (groundwater recharge, water availability to nearby trees, etc). Some SuDS methods such as rain gardens do not have to rely on infiltration to work, but will allow some water to soak into the ground if they are not lined. Similarly shallow tanks and permeable pavements may be designed as leaky or partial infiltration systems even on clayey soils.

Unlined rain garden close to building foundations (deliberately filled for research)

Many designers do not realise it is possible to override the crude rule of thumb in the Building Regulations with appropriate geotechnical assessment. In some instances SuDS infiltration systems and unlined storage systems (such as rain gardens) can even be located immediately next to buildings. This is useful if disconnecting downpipes as it makes the process easier and less costly.

However, allowing water to soak into the ground close to foundations should always be done in consultation with a Geotechnical Adviser or Registered Ground Engineering Professional[i].

The "5m rule" in the Building Regulations was originally devised as a rule of thumb to be applied to traditional soakaways that are relatively deep in relation to foundations and concentrate runoff into a quite small area of ground. Many SuDS methods differ to the traditional soakaway in that they are shallow and act as a blanket or plane infiltration system. They keep infiltrating water spread out over a wider area, unlike traditional solutions. Also remember that in some areas of the UK a traditional soakaway at 5m may be too close to foundations, for example where solution features are present in Chalk (CIRIA 2002).

The Building Regulations – what is the objective of the 5m rule

In 2002, as part of a research project by CIRIA, advice was sought from the Department for Transport, Local Government and the Regions (DTLR) Building Regulations Division (now Communities and Local Government) regarding the statement in the Building Regulations that soakaways should be located at least 5m from buildings. They provided the following statement in relation to permeable pavements that allow dispersed infiltration and evaporation of rainwater:

"As pervious paving permits dispersed absorption of rainfall it should not create any problems with concentrated outflow of water gathered over an area but discharged at a single point as in the case of soakaways. If the paving is combined with a storage system the outlet must be at a sufficient distance to ensure that discharged water does not impair the stability of any building. 5 metres is given as a guideline, if foundation details and geotechnical data are available to show that a shorter distance is safe then it can be used."

It is clear that the "5m rule" was intended to be a guideline and that infiltration or unlined attenuation can be allowed closer to building foundations if it can be demonstrated that it is safe to do so.

Permeable pavement with infiltration close to house foundations

Further evidence that rainwater can be allowed to soak into the ground close to building foundations is given in a response to an appeal made by an applicant against the enforcement of Requirement H3 in the Building Regulations. The Department for Communities and Local Government considered the possible effects of rainwater in foundations and concluded that distributed rainwater soaking into the ground will reduce the risk of saturation and erosion (Appeal against refusal in respect of a 5 bay aircraft hangar port –DETR, 1998 Reference 45/3/125). As part of this assessment they also considered the risk of collapse without warning of the structure. Where there is the potential for this (eg where solution features could develop unnoticed below the surface) a rigorous geotechnical assessment would be required even a normal soakaway located 5m from a building.

Comparison of SuDS to traditional soakaways

Well-designed shallow SuDS that are at or close to the ground surface are quite different from traditional soakaway drainage. They are designed on the principle of source control and the roof area draining to these SuDS features (or area of hardstanding) should not be that large compared to the infiltration area.

A traditional soakaway will typically drain between 30m^2 and 300m^2 of impermeable area to every 1m^2 area in the base of the soakaway (ie a ratio of between 30:1 and 300:1). SuDS features close to buildings should normally be designed with a ratio of impermeable area to base area of less than 10:1 and the depth of the stored water should not be greater than 300mm. Thus the flow of water from the base of the SuDS features is much less concentrated than in a normal soakaway.

A traditional soakaway will have a ratio at the higher end of scale where it drains a road or several houses. Therefore it is a concentrated point source of water in the ground and the height of these types of soakaways means that water also flows out sideways. As a result the risk of water affecting the soils under shallow foundations can be quite high if the soakaway is located close to buildings. Because infiltration from a plane feature is much more dispersed, has a shallow height and has a short retention time there is less potential for flow to occur laterally in any significant quantities.

It is possible to analyse water flow into the ground using computer programmes. This is known as numerical modelling. A model of water flow from a SuDS permeable pavement that was constructed close to foundations is shown in Figure 1. The water flows vertically (shown by the black arrows) and the velocity is low until it meets the groundwater table just below the foundations.

How can infiltrating water cause problems?

Freeman et al (2002) identified the most common causes of settlement or subsidence to buildings. Those that can be associated with infiltrating water are listed below:

- Erosion - soil can be washed by infiltrating water into open features such as broken pipes, gullies, joints, solution features or faults. Water flow through the ground on its own does not wash soil particles out – the particles need somewhere to go. SUDS will not cause erosion if there is nowhere to wash soil particles out to.

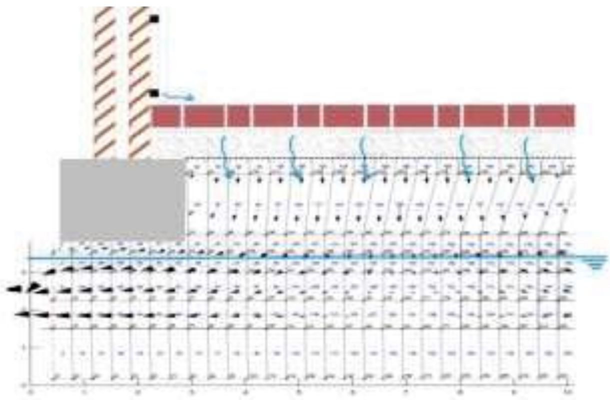

Figure 1 Numerical model of water flow from a SuDS permeable pavement

- Settlement of filled or loose ground by water flow (made ground or infill to solution features[ii]). This is most likely in low density material with high void ratios. It is less likely to occur in well compacted or dense fill, especially where infiltrating water is spread out.

- Collapse of mine workings and natural cavities – this can be caused by infiltrating water.

- Soil softening - clays in particular that can be softened leading to reduced strength and increased settlement. The effects on slope stability may also need to be assessed if the foundations are close to the top of a slope. Softening of clay soils will occur if the moisture content increases. Clay has a very low permeability and in normal circumstances the softening caused by water does not extend to a great depth. For example this normally occurs for 200mm to 300mm or so below the surface of clay with a perched water table above it.

susdrain

Softening of clay soils next to broken drainage pipes has been reported. However in these cases the pipe has been located very close to the foundations and most of the runoff from every rainfall event from a large drained area (typically at least half of the roof of a house) has been collecting and standing in contact with the clay for a long period of time. This is different to shallow plane infiltration where the water is soaking into the ground at around 300mm to 400mm depth and the foundations are typically at least 1m below that. Most of the rainfall in a correctly designed plane infiltration or attenuation system will be held in the shallow surface soils or blocks and will evaporate. Thus there will be limited softening of clay at depth and it is not likely to affect the foundations.

- Variations in groundwater level – this relates to a loss of bearing capacity in granular soils where the groundwater level increases. Groundwater mounding (an increase in water level) can occur below soakaways. This rarely happens to any great degree under normal small soakaways and is even less likely to occur below shallow plane SuDS, again because of the dispersed nature of the water storage and the effects of evapotranspiration.

- Shrinkage and heave - clay soils that are desiccated (dried out) can heave when the moisture content is increased or the soils can be dried out by trees for example and cause subsidence. Heave is generally only a problem where trees are removed prior to construction of buildings.

- Swelling occurs when a clay soil has a suction in the soil pores that draws water into the soil and it increases in volume. Swelling only occurs in response to suction pressure, ie the clay must be dry and below its equilibrium moisture content, or where soil overburden has been removed (eg heave in basement excavations). Clay at its natural equilibrium moisture content will not swell signifcantly. Heave is normally a major problem when trees have been removed from a site prior to constructing a building.

  Thus water from small rain gardens or similar features will not cause swelling over and above that which occurs over the natural cycle. The water from shallow plane SuDS will actually reduce the soil moisture deficit caused by trees and potentially reduce the adverse effects. Where rain gardens are located in areas already affected by trees they may reverse some of the shrinkage that has occurred. This may cause some heave of the foundations, but again because of the dispersed nature of the water the effects will not be concentrated locally at one point. Instead any effect will be uniformly distributed over a wide area. This reduces the risk of cracks occurring in the building due to localised differential ground movement.

For adverse effects to occur as a result of water soaking into the ground, the foundations also need to be of a form that can be affected (for example piled foundations are likely to be far less susceptible to any adverse impacts of infiltrating water, if at all). Permeable paving that only collects and drains rainwater falling directly on it can be used against any building providing there is no point source of water from any other impermeable surfaces connected into it.

Conclusion

The “5m rule” in the Building Regulations is a guideline and many designers do not realise it is possible to override the crude rule of thumb when using shallow SuDS infiltration systems and unlined storage systems (such as rain gardens). The problems caused by large volumes of water from relatively deep point soakaways are not likely to occur with shallow SuDS draining small areas and with appropriate design and assessment they can be located closer to buildings than 5m. This is useful if disconnecting downpipes as it makes the process easier and less costly.

References

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Freeman TJ, Driscoll RMC and Littlejohn GS (2002). Has your house got cracks? Second Edition. BRE and ICE, Thomas Telford Publishing, London.

Her Majesty's Government, (2010). The Building Regulations. Approved Document H. Drainage and waste disposal DTLR, London

CIRIA (2002). Engineering in Chalk, CIRIA Report C574.

[ii] A Geotechnical Adviser is defined by the Site Investigation Steering Group as a Chartered Engineer or Geologist with a minimum of 10 years post charter experience in geotechnical engineering (5 years acting as a geotechnical specialist).
The Register of Ground Engineering Professionals is administered by The Institution of Civil Engineers.

[ii] Solution features are common phenomena within Chalk areas. They are formed by dissolution of the Chalk as a result of chemical weathering, probably during the Quaternary period. This results in sinkholes in the chalk surface or pipes within the chalk mass. These features are often infilled with soft or loose materials. (For more information see CIRIA, 2002).

For further information on designing SuDS schemes close to bulidings please contact Steve Wilson, Technical Director, EPG Ltd on: 07971 277869 or email: stevewilson@epg-ltd.co.uk