Practice Papers

Flooding in buildings

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Abstract

Climate change will inevitably mean more rainfall and more floods in the UK. Integrated planning and more enlightened land management policies are required to reduce and mitigate the impact of the problem. Sources of information are available to surveyors involved in due diligence but surveyors need, more than ever, to be alert to the possibility of flooding affecting a property both from river systems and from surface water. Conventional remedial strategies following flood damage may not be the best approach. Properties that are prone to repeated flooding can be made more resilient by a range of measures. The prospect of higher rainfall calls for a rethink of important aspects of building design.

Keywords: flooding, due diligence, pluvial, fluvial, climate change, dredging, dehumidifier, mitigation, resilience

DO WE HAVE A PROBLEM?

Setting aside the opinions of oil industry-funded climate change deniers, global warming is well and truly with us. The 'warming' bit of it may not be too obvious to us in the UK but if we consider the poles, sub-Saharan Africa and the sharply increasing incidence of monster cyclones and hurricanes it becomes more evident.

Why is climate change relevant to flooding? More CO_2 and other greenhouse gases (GHGs) equals enhanced warming. Warmer temperature equals increased atmospheric H_2O vapour. Water vapour is a potent GHG, which causes further warming. This is what is known as a positive feedback loop.

With a temperature rise in our climate comes increased rainfall. This is not new science. The Clausius-Clapeyron relation evolved out of work first published as long ago as 1834. It calculated the physical relationship of atmospheric temperature and vapour pressure. In simple terms, a warmer atmosphere can hold more water vapour (eg, the polar regions are technically deserts and only snow a couple of inches per year while the tropics are very wet). While the Clausius-Clapeyron relation is non-linear, a 1°C average change in earth's temperature translates to a 6–8 per cent increase in water vapour in the atmosphere.

More water vapour in the atmosphere equates to heavier rainfall events due to the enhanced carrying capacity of water vapour in the atmosphere. This leads to more flooding, both from flash floods and flooding caused by excessive rainfall after soils reach saturation levels. The issue is actually a bit more complicated; a warmer atmosphere will draw that

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additional water vapour via evaporation (from oceans and land-based water, and technically sublimation from ice as well) and from evapotranspiration from soil and plants. Evapotranspiration can lead to drought conditions as soils can become harder. Harder soils have a diminished capacity to absorb heavy rains quickly and this exacerbates water run-off in intense rainfall events leading to higher flood risks. If plants and trees die due to prolonged droughts and pests (both of which are made worse by climate change for a variety of reasons), the lack of root systems diminishes both the stability of the soil and its ability to soak up rainfall, which again further increases flood and landslide risks.

WHAT DO WE MEAN BY FLOODING?

It has been said that a flood is a pond in the wrong place. We live in a country once full of wetlands and marshes teaming with wildlife. Modern agricultural engineering can make short work of a nutrient-rich area of wetland, turning what may have existed, more or less, since the last Ice Age into valuable arable land in a trice. When they are permitted to build on flood plains developers can do likewise, although it is noteworthy that Scotland has succumbed far less to the pressure for such development than the south of England. Where is all the water that once soaked slowly into the ground supposed to go?

There are three basic types of flooding namely pluvial, fluvial and coastal. There are, of course, hazards like burst water mains that cause flooding too.

Coastal flooding is a topic all on its own. As we know the coastline, like most things in nature, is dynamic and this gives rise to a whole series of issues when it comes to the built environment. Coastal erosion, rising sea levels and the increasing incidence of storms threaten property, sometimes dramatically, but this paper will concentrate on the two other sources of flooding: pluvial (rain) and fluvial (flooding from rivers, etc.).

The management of river systems, including integrated whole watershed planning is, to an extent, within the remit of the Government agencies and it is increasingly recognised that human activity from the floodplains to the high ground watersheds that feed them should be considered as an integrated whole if flooding is to be managed and mitigated. It costs vast capital resources to build flood defences in downstream urban areas threatened by flooding from the inland hinterland, but it costs a lot less to allow controlled flooding of agricultural land before the water reaches low ground.

Drained wetlands, rivers and streams turned into fast-flowing and featureless agricultural ditches, hills denuded of trees, over-grazing by sheep and deer and the conversion of land to golf courses can all give rise to downstream flooding. The antidote to flash flooding is soggy areas of land that can absorb water and hold it for a while, slowly releasing it. The prolonged and devastating flooding of the Somerset levels in early 2014 served as something of a wake-up call for more joined- up thinking, but campaigns for more and more dredging have, instead, found political favour.

> We all know what's gone wrong, or we think we do: not enough spending on flood defences. It's true that the government's cuts have exposed thousands of homes to greater risk, and that the cuts will become more dangerous as climate change kicks in. But too little public spending is a small part of problem. It is dwarfed by another factor, which has been overlooked in discussions in the media and statements by the government: too much public spending.
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> Vast amounts of public money – running into the billions – are spent every year on policies that make devastating floods inevitable.[1]

The nub of the problem . . . is an unbreakable rule laid down by the Common

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Agricultural Policy. If you want to receive your single farm payment – by the far biggest component of farm subsidies – that land has to be free from what it calls 'unwanted vegetation'. Land covered by trees is not eligible. The subsidy rules have enforced the mass clearance of vegetation from the hills.[1]

HELP FROM A SURPRISING QUARTER

A particularly interesting prospect is the return, after an absence of some centuries, of the indigenous European beaver (*castor fiber*). Now widespread in the Tay catchment and with a small population beginning to emerge in Devon, these amazing natural engineers restore wetlands and slow and filter the flow of floodwater through the landscape. Indeed some flood prevention strategies have involved the creation of barriers similar to beaver dams but at considerable cost when compared to the free environmental services provided by beavers. That is not quite the full story because there are also costs associated with beavers, as they can come into conflict with humans by blocking culverts and undermining flood embankments. But, while it will become another subject that surveyors will need to know about in the future, a detailed discussion of beaver benefits and mitigation is a topic for another paper.

DUE DILIGENCE

For the surveyor the first priority is where to find information. In Scotland the Government agency with responsibility for water systems and flooding is SEPA. In England DEFRA have a similar, but not identical, role. In England it is relatively easy for a surveyor undertaking due diligence on behalf of a client to find out about the likelihood of flooding at a particular location using a service such as that provided by GroundSure.[2] In Scotland SEPA does not allow any of its data to be sold commercially. It does provide online maps that are reasonably useful but they make no claim to being able to predict pluvial flooding that can, in practice, be quite devastating. It is possible to obtain more information on this in England.

In carrying out a building survey it has always been good practice to take a note of the overall topography surrounding the subject property. It is also worth making inquiries, where possible, about previous flooding episodes. In the case of a property that is below a long stretch of sloping ground, it is also worth trying to ascertain how well-draining the soil is although, in certain weather conditions, once reasonably well-draining soil has become waterlogged after prolonged rainfall, there is a risk that a further heavy downpour will result in a flash flood. It should be noted that woodland and rough grass can absorb much more water in these conditions than, say, mown grass. Sometimes place names such as Marsh Lane or Lochside Cottage can provide a clue to landscape features that have disappeared but which nature might be trying to reinstate.

The author surveyed a large country house in Scotland for a purchaser. Behind it the ground rose steadily for miles. Inquiries revealed that flash flooding had occurred some 60 years earlier causing quite a lot of damage but it seemed that this exceptional event had not re-occurred. A few months later history repeated itself causing severe damage, although closer examination revealed that a large field drain had been crushed by a tractor and this was the principal cause.

Fluvial or river flooding can, to an extent, be predicted by reference to past episodes of flooding but it is important to consider that what were once 50 and 100-year events are starting to occur much more frequently with climate change. Surveyors would do well to check their facts before glibly dismissing the

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possibility that a river that appears to be a considerable distance below the subject of their survey could rise up and flood it.

MAKING GOOD FLOOD DAMAGE

The routine typically followed by the industry that mobilises in the wake of a flood is to rip off wall plaster, plasterboard, lath and plaster, timber panelling, skirtings and often door frames and architraves on all affected walls. Out comes plumbing, electrics, kitchens, etc. Up come floors. Then dehumidifiers are plugged in and the long, slow process of drying out commences. This is the conventional approach. But is it the best approach? Dehumidification works best at relatively high temperatures and is particularly ineffective at low temperatures. The damage done by 'stripping out' is considerable and costly to reinstate and it can take months to complete the whole process. Where it happens in the case of an old building it is particularly regrettable to see historic building fabric casually discarded. An alternative technology, which goes under the name of 'hydrothermic' uses hot air. The leading exponent of this technology describes the process as follows:

> The system heats fluid to a very high temperature. This is pumped around the property in insulated hoses, which run to heat exchangers. These in turn pump large quantities of (controllable) hot air into a vented 'chamber' (the wet area). The cooler fluid coming from the wet area returns to the boiler to be reheated so the process can continue. The system runs economically and independently, ensuring that the security of the property is not compromised.[3]

Where the damage is to a limited part of the building, the affected areas can be 'tented' off from the rest with temporary screens of timber framing and polythene.

This approach to drying out buildings can rapidly remove moisture from building fabric and it often eliminates the need, unless the building fabric itself has been physically damaged by the water, to remove it. By contrast, hacking off plaster wholesale and replacing it can result in it taking far longer to dry the building out because the construction water that comes with new plaster has to dry out as well.

In many situations the combined use of heating and dehumidification also works well and the most cost-effective approach can be to get the heating system up and running as quickly as possible. The conventional approach of ripping out the interior fabric can get in the way of this approach by putting the existing heating system completely out of action for much longer. As well as drying out it will also be necessary first to decontaminate and wash down the affected building fabric and it may sometimes be necessary to remove some material if it cannot be effectively cleaned.

PREVENTION AND MITIGATION

Properties that are prone to flooding can be made more resilient. The first obvious line of defence is to try to divert flood water away from a building before it gets there, but this may not always be possible. Care should be taken in erecting sandbag or similar barriers because when they fail under pressure of water the water may surge and do more damage than a steady rise in level over time. When diversion has failed, plastic barriers are available that can be fitted to external door openings to prevent water getting in, along with floor vent covers and non-return valves for drains that pop up in the building. However, one problem with trying to keep water out is that walls are not generally designed to withstand much lateral pressure, particularly so in the case of brick cavity walls. Serious structural damage

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could result from attempting to turn the walls of a building into a dam. So sometimes it may be better to allow the water simply to flow through.

In one property that the author was called in to reinstate after a flood, the water had come rushing down from a golf course after prolonged heavy rain, scoured out the fill on a Victorian railway tunnel on its way down and filled up the ground floor of the early eighteenth-century house to about three metres. The house was on a hill and the owners opened the back doors to let the water flow through, but the force of the water closed them again. In the panic of the moment with the house filling up with water within a matter of minutes and with valued possessions bobbing around in it, they simply did not manage to get the doors open again.

For buildings that will, inevitably, be subject to regular flooding, bespoke strategies may be devised to enable the owners to recover as quickly as possible. Typically these may include raising electrics up the walls and making use of water-resistant materials. Plasterboard is notoriously weak when affected by water but tile backer boards are designed to cope with water. Acetylated MDF is unaffected by water and acetylated timber is also very resilient to water so might be a good choice for joinery that will inevitably be subject to periodic soaking.

Careful thought needs to be given to floor design. A tiled floor on a floor slab could be quickly washed down and recovered, but if it was insulated and had, say, underfloor heating in it, considerable care would need to be taken. It would be worse than useless if floodwater with sewage in it were to soak into the interstices.

Sump pumps in basements can be a useful fall-back. Recently, following exhaustive failed attempts to eliminate the cause of intermittent flooding in the chamber below a newly refurbished church organ, the author instructed the installation of a sump pump. The particular pump recommended for this application actually required no sump as it could be placed straight onto the floor.

MORE AND MORE RAIN

As episodes of heavier and heavier rainfall are with us to stay, the whole basis for the design of rainwater disposal needs to be re-thought. Larger gutters and downpipes will form part of this strategy but also fail-safe arrangements should be considered that accept the occasional overload and direct the resulting flood out of harm's way.

Experience gained through working on buildings in areas prone to prolonged driving rain means that it is now becoming apparent that some water penetration is almost impossible to resist. Leaking buildings have become the bane of the author's life and the problems are not necessarily concentrated in traditional buildings. In a recent case it became clear that the designer and builder of a new house built with a thick (about 350mm) outer skin of stone backed by 200mm of dense concrete block work, a cavity and then a timber frame with sheathing ply on the outer face, had assumed that the walls would be more or less impermeable and omitted to include cavity trays over the windows. On a west-facing wall water poured in around every opening. If water is going to get in by whatever route, it will appear internally around window and door openings and the only way to prevent it is to have a properly designed cavity tray.

A widely applied strategy when hard landscaping is required is the use of Sustainable Urban Drainage Schemes (SUDS), paving that is designed to allow water to drain down through the joints in the paving into a soakaway below. This takes careful design and execution.

CONCLUSIONS

We should all redouble our efforts to reduce the carbon emissions that are accelerating global warming. Realistically, however, we

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must accept that the battle is, to an as yet unknown extent, lost, and we will all be faced with the consequences of flash flooding from relentless periods of wet weather and the consequences of decades and indeed centuries of disastrous land management. It will not just be wet weather that we face but droughts, too, and when droughts are followed by heavy rain there will be more trouble. When all else fails surveyors will need to be on hand to repair flood-damaged buildings and to make them more resilient in the face of inevitable flooding. Working with nature instead of against it will be part of the answer. Wetland and riparian restoration and re-wilding with the help of our ally *castor fiber* will also have an important part to play.

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