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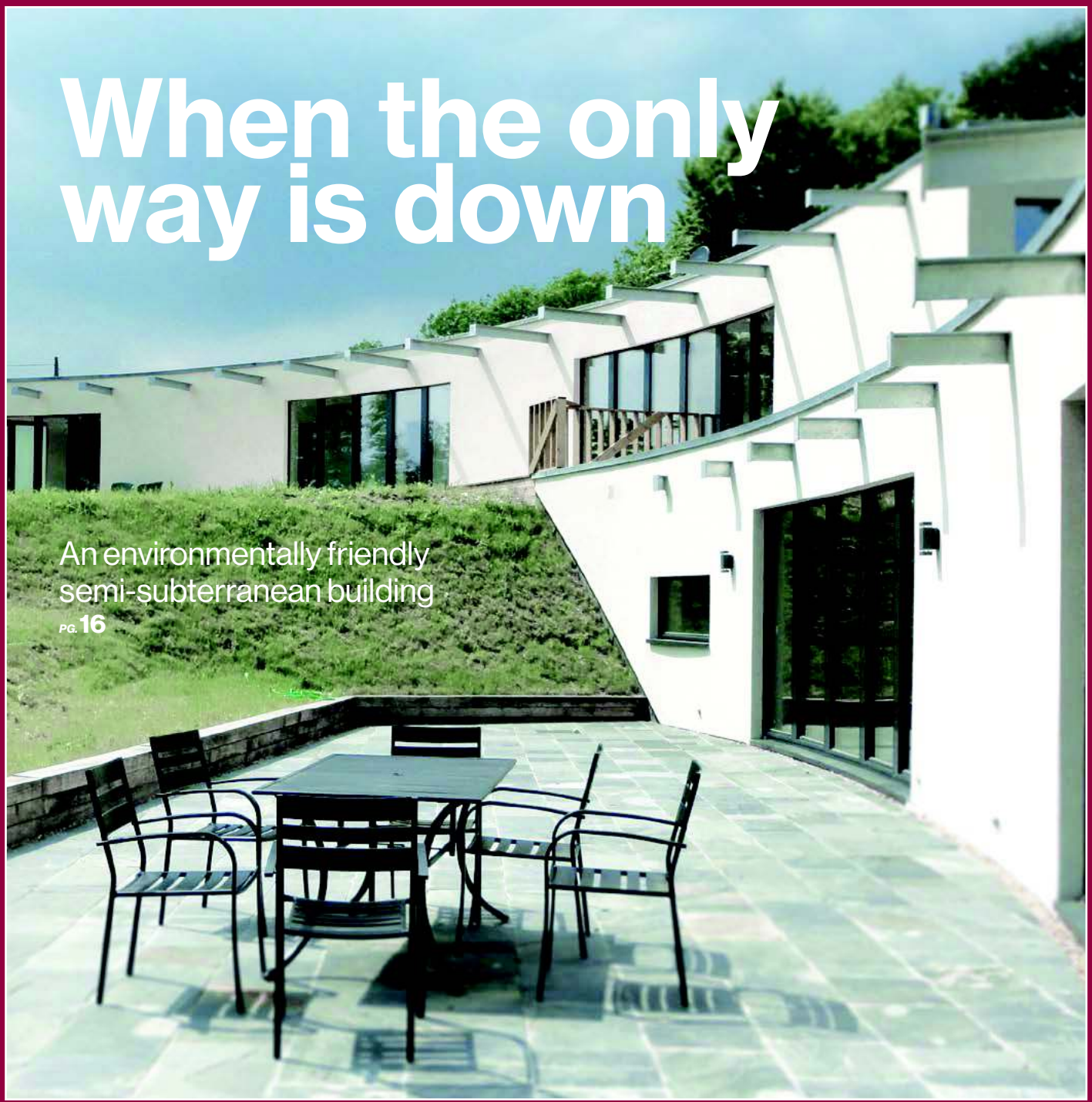

When the only way is down

An environmentally friendly semi-subterranean building

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May 2013
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Martin Freeman warns of a new risk as homeowners are increasingly choosing to extend their properties

Something in the air

The stagnant property market has made moving a limited option for those wishing for increased living or working space, contributing to a growth in newbuild basements and conversions. Specific design requirements for basements include the need for them to be 'light' and 'dry', to which should now be added 'healthy'.

BS 8102 is the code of practice for protection of below ground structures against water from the ground. It provides guidance for basement waterproofing but crucially, since the most recent version was published in November 2009, it includes the need to take account of radon in the design and implementation of the work. Property professionals who ignore this may be sleepwalking towards a time bomb of liability claims.

Radon is a naturally occurring gas produced during the decay of uranium present in minute quantities in the ground, which can escape and accumulate in buildings. Current statistics estimate that in the UK 1,000 to 2,000 lung cancer deaths every year are attributable to radon exposure (visit *www.radonkit.co.uk/blog*).

To an extent, the underlying geology impacts on the amount of radon in a given location and there are maps available to indicate the likelihood of high levels being found in particular geographic regions. There are, however, many instances where high levels of radon have been found in areas not designated as at risk by the maps. Radon enters buildings via the process of advection, which is the movement of a gas from a point of high pressure to a point of lower pressure. In other words, gas in the soil beneath a building is 'sucked' into structure. The greater this pressure difference, the greater the rate at which gas from the soil is drawn inside.

Cellars and basements are particularly at risk from radon; they have a number of surfaces in communication with the ground, which increases the sources of entry for the gas, and a basement will naturally have low pressure and draw radon from the surrounding area. The Health Protection Agency advises: *"From data collected in workplaces it is clear that high radon concentrations can be found in basements anywhere in the country, regardless of Affected Area status."*[1]

This stance is also adopted by the Health and Safety Executive, which requires employers to carry out a radon risks assessment on workplaces in affected areas, as well as premises anywhere in the country with basements.

Although radon testing in existing properties is advisable, it is not appropriate to test a redundant cellar that is yet to be converted into habitable accommodation. The radon level before and after the works is likely to be significantly different. Sealing draughts, installing insulation and using heating could all potentially increase radon levels within the finished basement. A test carried out in a draughty former coalhole might show low levels of radon, while the levels in the finished room may be much higher. Similarly, where a new basement is to be created, either by digging out under an existing property/garden or as part of a whole new building, it is not possible to test the ground to assess whether radon will be present in the finished basement.

The British Standard for waterproofing requires designers to assume that even if the cellar is not currently wet, there may well be future ingress of water and appropriate protection should be built into the design. This same presumption should also be made about radon gas. Protecting a cellar from radon intrusion can be very difficult; if it is not designed correctly, it can lead to increased radon levels within the basement and the accommodation above.

The current best practice and most commonly used method of waterproofing is Type C drained-cavity membrane systems, but the very theory that makes them so effective is in direct conflict with the management of gas intrusion.

Cavity drain membranes are dimpled sheets of high-density polyethylene that provide an air gap between the internal face of the wall and the front of the membrane. This allows moisture to

Basement before conversion (left) and after completion (right)

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Type C drained-cavity membrane system

penetrate the basement walls and then fall behind the membrane into a drainage channel. Other than at the baseline, the membrane does not need to be perfectly jointed or sealed to work, because the water penetrating the walls will depressurise when it enters the air gap due to the lower pressure. Unfortunately, this is conducive to enhancing the draw of radon towards the basement.

As the membrane joints cannot be expected to remain gas-tight over time, radon would be free to pass through them into the basement. Similarly, as the head of the membrane is not usually sealed, a pathway for gas is readily available behind it up to the ground-floor accommodation, potentially raising radon levels throughout the entire building.

Other forms of waterproofing such as externally applied adhesive membranes or cementitious coatings are also inappropriate. A landmark ruling in 1999 (*Outwing Construction v Thomas Weatherald*) found that external membranes were undesirable because they required perfect workmanship, which is unlikely under building site conditions, and they were not repairable should a defect occur. For the same reasons, they should not be considered suitable for gas protection. Cementitious coatings have also fallen out of favour with designers because they often crack or debond after time, leading to leaks and flooding.

Although a flooded basement will cause severe decorative spoiling, at least the problem can be seen. Radon permeating the basement cannot be seen or smelt, so occupants would be unaware that it could be entering and accumulating in the property. The results could be far more devastating than flood damage, yet many designers and installers continue to overlook the issue.

Professionals and non-professionals alike, although increasingly aware of radon, are oblivious to the risks; professionals responsible for the design or implementation of works to a property have a duty of care to their clients and must ensure that they are up to date with current guidance and legislation.

This increased awareness means that it is less likely that the problem will go unnoticed. In property transactions, pre-contract enquiries about radon are standard; surveyors, valuers, lawyers and buyers generally recognise that basements everywhere are considered at risk and may require a radon test. An employer has a duty to test for radon if a workplace has a basement.

> “Radon permeating the basement cannot be seen or smelt, so occupants would be unaware that it could be entering and accumulating in the property

Some specialists involved in the basement waterproofing industry have tried to include radon protection into their designs. However, some methods that were recommended or even installed have, or could have, increased the risk. For example, a workman installed an extractor fan in a cellar in a domestic property in the Cotswolds, thinking that this would rid the basement of radon. In fact, it simply drew more gas into the basement from the surrounding soil. Care must be taken to avoid placing reliance on ‘radon-proof’ materials. Although the membrane sheets and tapes may have been tested for permeability in a laboratory, installation of these components can lead to radon entry because the fixings will not be gas-tight, the joints will not remain gas-tight over time and the membrane may form a pathway for gas to travel to other areas.

Using the right techniques, it is possible to create a dry and healthy basement. Consideration should be given to likely radon sources and dynamics of entry and configuration of the accommodation. The system design should include a combination of physical barriers and active air management. Consideration must also be given to ensure that the displaced gas will be diverted safely away from the rest of the accommodation.

On completion of any scheme involving a basement, testing should be carried out to confirm that no areas are affected by elevated levels of radon. The designers will be liable if they cannot show that they have taken appropriate steps to protect the property from radon intrusion. Some three years after the publication of the revised British Standard, those involved in the design, construction or conversion of basements must include appropriate systems that will not potentially endanger their clients’ health.

The World Health Organisation Radon Handbook places clear responsibility for radon risks on architects and builders and other property professionals, and clarifies that indoor radon concentrations are not naturally occurring, but are “profoundly influenced by the way homes are designed and built”.[2] No client would accept a new basement that was damp or had water leaking in; why accept one that is being permeated by radioactive gas that could damage their health?

Further information

[1] Tracy Gooding, Health Protection Agency, Environmental Radon Newsletter Issue 53
[2] http://bit.ly/VE1ICG

Further +info

Related competencies include
T013, T051

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