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RICS

MODUS

LAND PROPERTY CONSTRUCTION | **THINKING**

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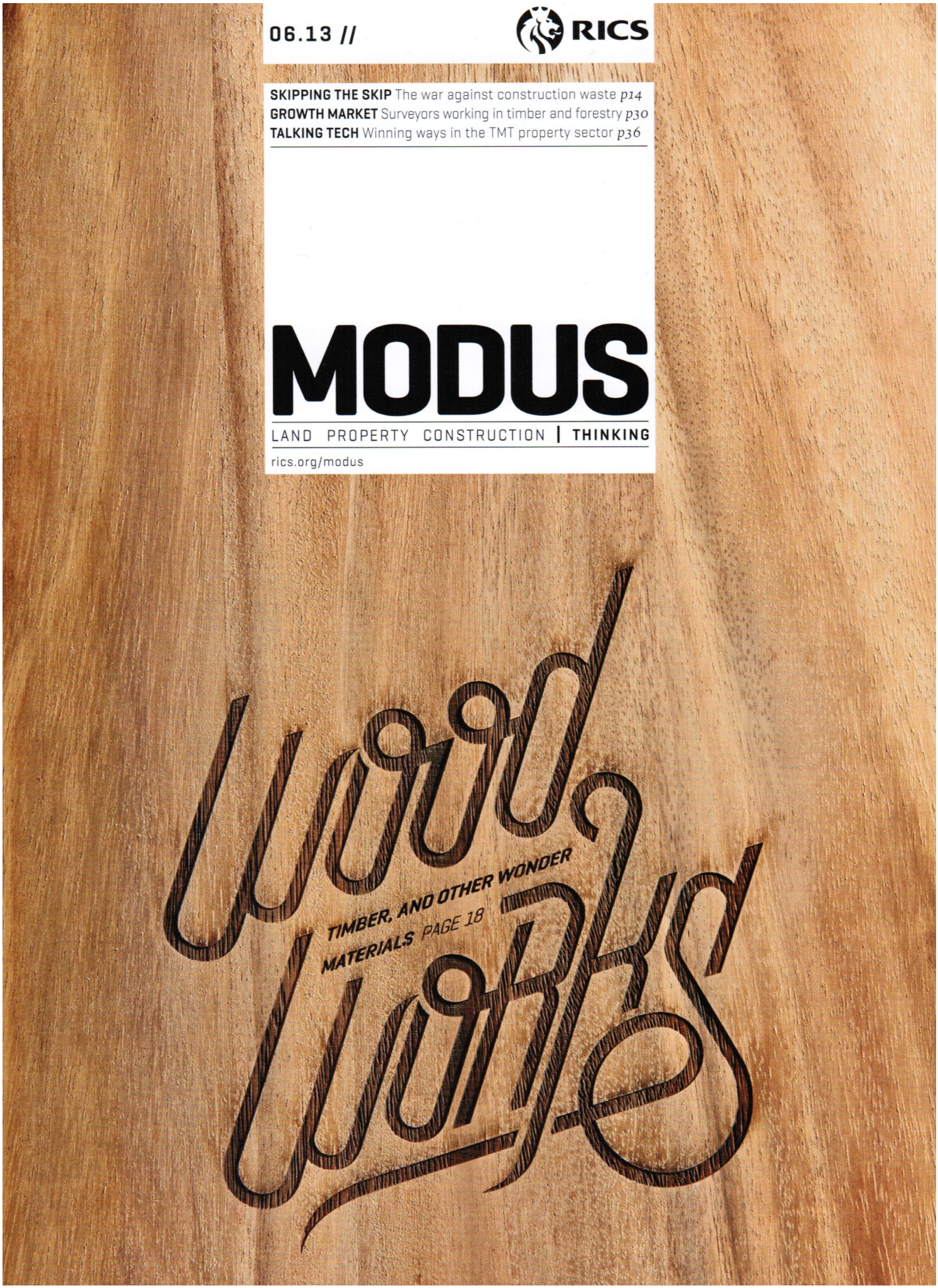


Modus

RICS

Modus is the membership magazine for the Royal Institution of Chartered Surveyors and is the UK's highest-circulation property-related B2B title, mailed 10 times a year to more than 95,000 chartered surveyors. There are also quarterly editions for Asia and the Americas. Modus focuses on the 'bigger picture', and employs a bold mix of photography, illustration and typography. At the 2012 CMA Awards, the judges gave Modus a Highly Commended Award for Best Membership Title.

Pg 5: AggreBind – Turning Dirt and Dust into Roads

TOMORROW'S MATERIALS

Compiled by **Roxane McMeeken**

CREATIVE MINDS AROUND THE GLOBE ARE REVOLUTIONISING THE CONSTRUCTION SECTOR WITH SMART MATERIALS THAT WILL HELP TO CUT COSTS, SAVE TIME AND MAKE OUR WORLD MORE SUSTAINABLE

Futuristic
LUNAR SOIL 1

The ability to 'print' a building is undeniably very exciting. A 3D-printing system is a large, mobile machine with multiple nozzles that spray a binding solution onto layers of sand (or a sand-like material). The machine is connected to a computer, so the designer draws a shape digitally, clicks print, and then the machine creates the shape by spraying layer upon layer. But what can it realistically be used for?

UK-headquartered 3D printing pioneer D-Shape lists multiple applications on its website, such as bus stops, swimming pool furnishings, kids' playground equipment and recreating missing parts of columns. However, one project D-Shape is involved in shows how the technique could really come into its own. Working with the European Space Agency, D-Shape is exploring the possibility of 3D printing a lunar base. JF Brandon, a representative from D-Shape Canada, says: '3D printing is ideal for the project because it would use lunar soil, which would drastically reduce the material and equipment needed to be transported to the moon from Earth.'

Applications: Ideal for construction in remote sites, such as deserts – and other planets.

Availability: At the moment, 3D printing at scale is still in the very early stages of development.

'Materials should perform in terms of aesthetics, too'

IAN HUNTER former materials researcher and co-founder of Materials Council

When we advise on materials selection, we usually take a performance-based approach, but materials should perform in terms of aesthetics, too. Often, the most important innovation is when changes are made to a material we already use – for instance, the current trend of enhancing traditional and natural materials. With natural materials, one problem has always been that they don't provide the level of aesthetic consistency the architects want. But now, there's a new wave of activity aimed at controlling nature: a supplier of traditional Italian marble, for example, has developed computer software that allows them to scan the marble and classify it in terms of its aesthetic qualities. The system sorts marble into eight categories, resulting is less wastage and a material that architects are more likely to use.

'With traditional products, there's a huge amount of innovation happening in concrete – from carbon-negative concrete to decorative products. One product I particularly like can produce a pattern or message when it gets wet. It's not widely used yet, but it could have a range of applications for aesthetic or safety purposes.

'In contrast, I think some new materials are being over-hyped. Graphene, for example, is a high-tech, lightweight super-conductor, but I don't see a need for it in construction. It's very expensive, and is much more appropriate for replacing silicon chips.'

Low-carbon
CARBON-NEGATIVE CEMENT 2

Probably as close to a miracle product for the construction industry as it gets, this new type of cement actually absorbs more carbon dioxide than it emits. With traditional cement considered to be the largest CO_2 emitter of all the mainstream construction materials, this new product could make the biggest dent in the industry's carbon footprint.

Making traditional cement entails a carbon-intensive process of heating limestone to 1,450°C. However, an alternative has been pioneered by UK firm Novacem that's based on magnesium oxide, which means more CO_2 is absorbed than emitted during its production. Further benefits are a lower heating temperature – 700°C is the maximum – and the fact that magnesium oxide, used to produce magnesium silicate, is a resource found in abundance worldwide.

Founded in 2007 as a spin-off from Imperial College London, Novacem unfortunately went into liquidation last year. Australian manufacturer Calix has bought the enterprise, allowing investment to continue in this important product.

Killer benefit: Absorbs carbon.

Availability: Still at prototype stage.

Sustainable
LEAD'S GREEN CREDENTIALS 3

Counter-intuitive as it may seem, lead is emerging as a 'new' sustainable material, and can now even be found in the Building Research Establishment's *Green Guide*. One of its main green features is its low melting point of 327°C, which is below that of any other metal used in construction, giving lead a smaller carbon footprint than other materials used to do the same jobs. Another benefit is that lead is completely recyclable, and can be used repeatedly without any loss of performance. It also has low replacement and maintenance requirements – as thousands of churches around the UK can prove. 'In terms of life-cycle quality, over 65 years, lead is almost 100% cheaper than conventional roofing materials,' explains Doug Weston from the Lead Sheet Association.

But what about the risk of theft? It's hoped the recently introduced ban on cash transactions for scrap metal in England and Wales will make lead a less attractive target. And as for its toxicity, Weston says it just needs to be handled safely and correctly, and that the impact from run-off is minimal.

Killer benefit: 100% recyclable.

Cost: Significantly cheaper than conventional alternatives.

CASE STUDY: 4

RAMMED EARTH CONSTRUCTION

If proof is required of the durability of rammed earth, its most successful application is in the Great Wall of China. But more recently, it was used to build the Sheppard Lecture Theatre at the Centre for Alternative Technology in Machynlleth, Wales, completed in 2010. Here, beautiful curved rammed earth walls reach up to 7.2m in height: 'The building is a great advert for rammed earth – it's big, bold and three storeys high,' says Rowland Keable, director of Rammed Earth Consulting, which worked on the theatre. Formed by packing 320 tonnes of loose subsoil into layers 150mm thick between shuttering, the walls are load-bearing, but here they don't provide the external façade – instead, they are surrounded by timber-framed glazing on one side, and hemp and lime on the other.

The material's comeback over the past couple of years is not only down to its durability and aesthetic quality. As the approach typically involves earth found on site, or very close by, rammed earth has the lowest carbon emissions of any mainstream masonry material, explains Keable. There's no need to transport it, or heat or chemically process it, and it doesn't involve sending waste to landfill. What's more, rammed earth buildings have an insulation value similar to that of conventional bricks or blocks, but as the walls are thicker than standard masonry, they store more heat or cold than a conventional building. As a result, rammed earth has been classified an A+ material under the BREAAM sustainability assessment methodology.

But, realistically, how widespread could rammed earth become? 'At the moment, people are building one- or two-storey buildings with cement – a material strong enough to build skyscrapers. This is clearly not the best approach,' says Keable. 'We need replacements, and rammed earth will undoubtedly be part of the picture.'

Killer benefit: The lowest embodied carbon of any building material.
Cost: Similar to a conventional approach.

Image: Timothy Soar B cat.org.uk

Pilkington's self-cleaning glass uses daylight and rain to break down and wash away organic dirt

Intelligent

SELF-CLEANING GLASS 5

Based on nanotechnology, self-cleaning glass is among a growing list of super-charged construction products. Andy Parkman, director for building engineering at AECOM, is currently working in this field: 'Nanotechnology is about modifying particles at the sub-atomic level, which changes the characteristics of the material,' he explains. In construction, this is mainly leading to coatings and additives for existing materials to enhance their performance.

So far, self-cleaning glass is probably the nanomaterial product used most widely. A version of the glass offered by the Japanese manufacturer Toto currently uses the photocatalyst titanium dioxide, which, when painted on a surface in nanoparticle form, reacts to daylight by releasing oxygen. This disintegrates organic substances on the surface. Also, when exposed to both sunlight and water, the titanium dioxide reacts to produce a hydrophilic layer that washes the surface clean in the rain.

Killer benefit: Eliminates major cleaning and maintenance needs.
Availability: Self-cleaning glass is already widely available from mainstream glass manufacturers such as Pilkington.

Low-carbon

MUSHROOM INSULATION 6

In the future, materials may be grown rather than manufactured. Ecovactive, a small company based in New York, has developed a form of insulation made of fungus. By inoculating agricultural waste products with mycelium (fungus), a 'mushroom' grows without any need for light, watering or petrochemicals. This results in a material that can be used for various types of insulation, and can even be grown in a mould to take the shape required. What's more, the process involves minimal carbon emissions, and the product is 100% biodegradeable.

Set up in 2007, Ecovactive has yet to put 'mushroom insulation' up for sale, but the process could well be the shape of things to come. 'As well as a viable alternative insulation, it may well have other uses as a construction material,' says Ian Hunter, from Materials Council. 'The challenge with some biodegradable products is that the binder isn't always biodegradable, too, so the products cannot degrade. But here, the mushroom itself is the binder.'

Killer benefit: A low-CO_2 insulation.
Availability: Still in development.

Futuristic

BREATHING GLASS 7

New York architectural practice The Living has created glass that 'breathes' like human skin. Reactive architecture is a growing trend, and mechanical louvres that open and close based on light and temperature sensors have been around for some years – but Living Glass is a whole new level of innovation. The glass is pierced with gill-like slits controlled by tiny embedded wires that contract in reaction to the electrical stimulus of various 'inputs' – such as CO_2 levels, warmth and human touch – opening the slits and allowing air to flow through. With no motors or mechanical parts, it reacts without making a sound, and can be used for windows or entire façades.

Availability: Currently only bespoke.
Cost: Very expensive for now.

'We need a more open-minded approach'

RICHARD QUARTERMAINE MRICS
project director, Sweett Group

As materials become increasingly scarce, buildings will become more expensive – so the standards we set now need to accommodate the development of new and innovative products. Designs and construction programmes shouldn't be restricted to specific materials, for example, and aesthetics may need to change. Generally, we need a more open-minded approach.

'At the moment, we're not seeing many products made from new materials, but we are seeing variants of existing materials used in a more resource-efficient way, which is helping to address raw material scarcity issues for now. A common theme is increasing recycled content. Clients are very interested in recycling, and many are now setting targets for recycled content in their projects. Using recycled materials is a great way to reduce embodied carbon, as less energy is needed to make them – for example, a good deal of the steel and plasterboard used in construction now contains a high percentage of recycled content.

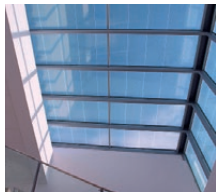
'In the future, products that can deliver buildings at lower costs and with reduced risk, as well as environmental benefits, are going to be the most in demand.'

Practical
TURNING DIRT AND DUST INTO ROADS 8

When added to most types of soil and sand, AggreBind transforms them into robust building materials. Developed in 2000, by the eponymous company based in both the UK and US, the soil-binding polymer allows roads and building blocks to be created in situ, using whatever material is available. This makes it a great solution for construction projects in places where trucking-in materials would be difficult.

'You just take the concentrated AggreBind to the site, dilute it and mix it with the material in place,' explains Robert Friedman, partner at AggreBind. 'You end up with a construction that is waterproof, solid and non-dusty.'
Applications: Roads and simple buildings, particularly in remote places and developing countries.
Cost: AggreBind says its product cuts costs by 50% through saving time, materials and equipment.

Using the soil-binding polymer AggreBind, roads can be constructed in situ, without using any cement



Aesthetic
INTEGRATED SOLAR PV 9

Traditionally, clients seeking to harness the sun's energy have had to suffer the indignity of attaching chunky photovoltaic (PV) panels to their buildings. Now, however, a growing number of manufacturers are developing PV systems that are far less incongruous. US-based Onyx Solar is among those offering a range of building-integrated PV materials for use on roofs and façades, including transparent PV products for use in skylights and windows.

'Building-integrated PV is now becoming widely available and, therefore, cheaper,' says Ian Hunter, from Materials Council. 'It's also becoming more flexible, and research is even being done into making it suitable for curved surfaces,' he adds. Unfortunately, some new products don't produce as much energy as the more robust panels, but the volume of research and development underway in this sector means that improved performance shouldn't be far off.
Killer benefit: Solar power without compromising on aesthetics.
Need to know: Generally delivers less energy than conventional PV panels – for now.

Futuristic
AEROGEL 10

Although invented in the 1930s, aerogel was little used until the 1990s, when NASA began insulating spaceships with it. Here on Earth, aerogels are now being used in a growing number of ultra-light, super-efficient insulation products, including Thermablok and Kalwall.

The most common type, aerogel silica, is created by removing liquid from a silica gel, which increases its density, and results in a product that is translucent, shatterproof and maintains a good level of thermal performance. Kalwall's product, for example, has the appearance of glass, and can be curved or flat, making it suitable for roofs, walls and conservatory-like atriums. It's highly insulating, with an impressive U-factor (rate of heat loss) performance.

As availability improves, aerogel products are becoming more reasonably priced and, therefore, more widely used in everyday projects, such as schools and other public buildings.
Killer benefit: Insulates, while also being ultra-light and transparent.
Applications: A neat solution for the light-starved colder climates of Northern Europe.

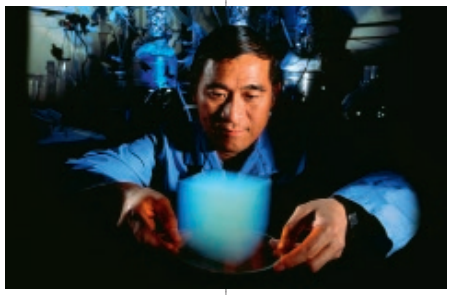


Image **NASA/JPL-Caltech**

'By asking the supply chain for help, you will unlock innovation'

DR PETER BONFIELD OBE chief executive, Building Research Establishment

During my secondment to the Olympic Delivery Authority from 2006 to 2012, we discovered something really important about materials. There, we had a whole bunch of challenges to meet, such as sustainability, the responsible sourcing of materials and delivering everything on time. But, rather than assuming we knew which materials would be best, we went out to the different sectors, showed them the challenges we had, and asked them what they would suggest.

'The materials producers came back with various solutions that met our criteria, and were often best in terms of cost, too. As a result, all our wood was responsibly sourced, and we used concrete that contained waste resources, and therefore had 30% lower embodied carbon.

'This enabled us to set unprecedented standards, and shows that if you stop kicking the supply chain, and ask it for help instead, you will unlock innovation. For cost consultants, simply talking to manufacturers can make them more able to deliver what clients want.

'Materials producers do need to learn more, though. When you ask them about how something is transported, or what plant it contains, they can answer precisely but they are often less knowledgeable about social impacts. That said, producers are getting better all the time.'

Intelligent
LIVING METAL 11

As well as glass engineered to 'breathe', metal mesh is currently being developed at the University of South California, in the US, to expand and contract to let in heat or air. The principle is actually ingeniously simple, says Ian Hunter, from Materials Council: 'If you have steel on one side of a strip, and copper on the other, one heats up, and therefore expands, faster than the other, causing the strip to curl.' These alloys, known as thermo-bimetals, could be used to make intelligent sunshades that close automatically in sunlight.
Killer benefit: Thermo-bimetals can be used to create products that self-regulate temperature.
Applications: Still in development at the moment, but eventually the products could be used in windows, walls and roofs.

Practical
SELF-HEALING CONCRETE 12

Cracks in concrete could become a problem of the past, thanks to a number of innovative projects to create the magical-sounding 'self-healing' concrete. Perhaps the most interesting initiative is Bio-concrete, which is currently being developed at Delft University in the Netherlands. The material contains spores of bacteria, which react with water when it enters through a crack, and grow to produce limestone, which then fills up the crack.

Dr Henk Jonkers, who is leading the project, says the product was tested on a concrete roof, where it stopped all leakage problems. Several years of further testing are planned, and Jonkers expects Bio-concrete to be available to buy in around four years' time: 'Our challenge now is to produce the healing agent at acceptable costs: we're aiming for about €30-€45 (£25.50-£38) per cubic metre of concrete mixture,' he says. Although this may still sound costly, Jonkers explains that the higher initial costs compensate for the costs that would otherwise be incurred for leakage repair and sealing cracks manually. In this way, the product should pay back the client within the first five years.

Meanwhile, the University of Michigan, in the US, is developing concrete that can actually bend. Known as Engineered Cement Composite (ECC), the product contains polyvinyl alcohol fibres and is based on the principle that, whereas one large fracture threatens a structure, multiple hairline cracks allow the concrete to move without breaking. It's also 40% lighter than normal concrete.
Killer benefit: Eliminates repair and maintenance needs.
Applications: Particularly useful for structures in earthquake zones.

Sustainable
BAMBOO FIBRES 13

A number of interesting and sustainable products based on bamboo are currently emerging. Leading bamboo manufacturer MOSO, based in the Netherlands, offers a comprehensive range – from indoor flooring tiles to outdoor decking panels – made by shredding down the hollow bamboo stems and gluing the fibres together under compression. Bamboo products are extremely strong and sustainable: MOSO says that bamboo stems can be harvested every five years in a mature plantation without decreasing the size of forest, and the harvesting process also encourages growth.
Applications: A sustainable and fast-growing alternative to MDF, which contains timber on a much longer growth cycle.
Need to know: The bamboo stems may need to travel a long way first, which significantly adds to the product's carbon footprint.

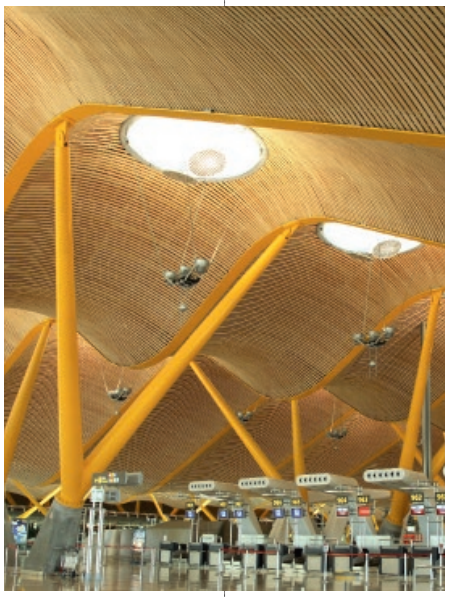


Image MOSO International

Sustainable
PRE-FAB PASSIVHAUS 14

Passivhaus sounds fantastic but it has a fatal flaw: to achieve the standard of insulation and air-tightness required for certification, each trade working on the building has to reach a level of precision so extreme that many projects miss the mark. However, former carpenter Ron Beattie has created a pre-fabricated building system that could revolutionise our ability to meet the standards. Launched in 2009, Beattie's system is simple, with no more than 16 parts for any type of building, which, he says, 'a 16-year-old trainee will have no problem assembling'. The buildings achieve air-tightness levels as low as $0.50m^3/hm^2$, which cuts heating costs by up to 90%. His company, Beattie Passive, has completed several houses, including four in Scotland that were indeed built by 16- to 18- year-olds.
Killer benefit: Makes Passivhaus standards more easily achievable.
Cost: Cheaper than a bespoke Passivhaus, because the labour costs are 50% lower and the components are mass-produced.

'Material development is being driven by the retrofit market'

ANDREW WYLIE associate director, Buro Happold

At the moment, there are three categories of innovation in materials: existing materials that are being used in new ways, existing materials that are currently unfamiliar to designers, and new, high-tech materials.

'Key existing materials being treated in innovative ways are concrete and steel. There's no big breakthrough here, but both are seeing more recycled content, which is greatly reducing costs and carbon emissions. Designs using these materials are also becoming more efficient, and more thought is being given to end-of-use processes, such as demolition and disposal.

'Existing materials that might be unfamiliar to some designers include plant and earth-based materials, which tend to have low embodied carbon, such as rammed earth or chalk, bamboo and hemp. We will see increasing use of cross-laminated timber, in particular. We used this for the flooring in the Royal Shakespeare Theatre in Stratford six years ago. Back then, no one had heard of the material, and we had to do a detailed study of the risks of importing it. But, over the past few years, there has been a quiet revolution in the use of timber.

'Another plant-based approach on the rise is straw-bale construction. Its advantages are that it stores carbon within the building, it has thermal insulation benefits and it's often produced locally. It was once the preserve of the hairy jumper brigade, but now companies are componentising straw bale, and it's moving into the conventional market.

'High-tech material development is being driven by the retrofit market. In particular, we are seeing growing use of phase-change materials, which act as a thermal sink and even out temperature fluctuations. Coatings that can be applied to existing elements of the building to improve performance will become increasingly important as we intensify efforts to improve the existing stock.

'The key challenge will be assessing which of these materials are most appropriate for a building. Before, you only thought about what would support the building's loads as effectively and cost-efficiently as possible. But now, we're also looking at how sustainable materials are, in terms of their embodied carbon and social implications.'

'We need to take a holistic approach to assessing materials'

NICK HAYES head of sustainability, EC Harris

Materials are becoming much more prominent in the industry – driven, primarily, by enlightened clients (particularly retailers) who are looking at them from a sustainability perspective. The most important thing is that materials must be viewed in "cradle-to-cradle" terms. This means we need to start by looking at the extraction, the transportation and installation; and then, how it's eventually uninstalled and what happens next – is it sent to landfill or recycled?

'Refurbishment is so much of the market at the moment, particularly in retail, where there tends to be a high turnaround of refreshments. With our retail clients, we've found that reducing the number of changes made to fixtures has a positive impact on embodied carbon, and also reduces costs. They can keep the existing frame and change only the fascias, which results in a refreshed look without removing so much material, while also reducing workload and increasing recycled content.

'Another smart approach is to target the elements that are the worst offenders in terms of embodied energy. This way, we can make a big difference by changing just one thing. And it's not just the materials themselves, but also how they're packaged. Ordering less automatically results in less packaging, but we can also choose materials with less packaging to start with. In general, we need to take a more holistic approach to assessing materials.'

Futuristic
BIO-COMPUTATION 15

'Using just light, water and a few nutrients, a tree can produce a pinecone – a complex 3D object. This suggests that, with synthetic biology, we might be able to manufacture new materials in an equally efficient way,' says David Benjamin, from architectural practice The Living. We could, he adds, potentially 'programme' biological systems to genetically engineer completely new materials with high-performance properties, controlled by designers via a computer. For example, imagine if you could engineer a panel that was firm in some areas and softer in others, or a beam that was light in some places and heavier in others.

Far-out as this might sound, it's already on the way. The Living is working with the universities of Cambridge and Bristol in the UK to develop a bio-computation-based process to harness natural systems of creation. A bacteria-based system is currently being developed, and the team has already created the software. However, the project is still at an early stage, and Benjamin says it could be a decade before the technique is used commercially.
Killer benefit: The potential to create completely new materials with bespoke properties.
Availability: Commercial use could be at least 10 years away.

Designed by Arquitectos Anónimos and manufactured by CARPAV, this family home in Esposende, Portugal, is clad almost entirely in cork bricks

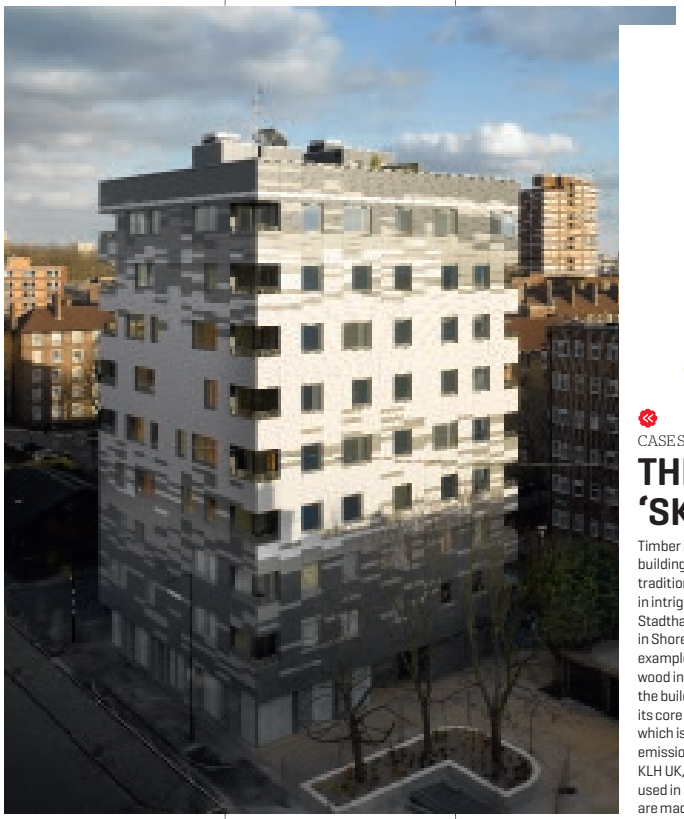
Sustainable
CORK OAK BARK 16

The beauty of cork is that it's bark – which means it can be shaved off the cork oak while the tree continues to grow. 'Cork bark is gaining attention because it has a fast regrowth cycle – around 10 years – so it's rapidly renewable, whereas most hardwoods take a long time to grow,' explains Ian Hunter, from Materials Council. Moreover, the cork oak actually stores carbon when it's generating bark, leading to greater levels of carbon sequestration.

The sustainability of cork means that it's becoming an increasingly mainstream material, and is often used for floor and wall tiles, as well as insulation. However, in order to be truly sustainable, the adhesive used to fix it must be equally eco-friendly.
Availability: It's widely available, but mainly produced in Portugal (just over 50% of the world's supply).
Surprising fact: Harvesting the cork bark triggers the tree to sequester more carbon.

Image **CARPAV (UNDA's workshop)**

Images **Will Pryce; waugh thistleton**



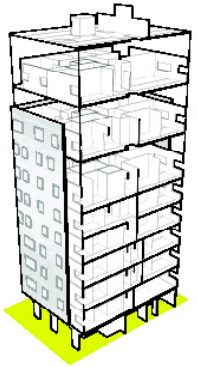
At nine storeys, Stadthaus in London is one of the world's tallest timber structures

Practical
HYGIENIC COATINGS 18

A growing range of anti-bacterial construction materials is making hospitals a safer place to be. In a major endorsement, hygienic coatings have been specified for the ongoing £1bn redevelopment of St Bartholomew's and the Royal London Hospitals, where Wallflex Hygienic Coating, manufactured by Construction Specialties UK, was specified for the operating theatres and anaesthetic rooms.

The hygienic coatings contain non-leaching anti-microbial agents that provide protection against dangerous fungi and bacteria, including MRSA and E. coli.
Applications: Healthcare, laboratories, swimming pools, schools, food and pharmaceutical process areas, and bathrooms.
Need to know: When applied and maintained correctly, Construction Specialties' products shouldn't need recoating for at least 10 years.

17



CASE STUDY:
THE TIMBER 'SKYSCRAPER'

Timber is hardly a novel ingredient for the building industry, but it's one of several traditional materials that are being used in intriguing new ways. Completed in 2009, Stadthaus, a nine-storey apartment building in Shoreditch, London, is a fascinating example of the load-bearing capabilities of wood in a cross-laminated form. Although the building sits on concrete foundations, its core and walls are made solely of timber, which is lower in both cost and carbon emissions than concrete. Created by KLH UK, the cross-laminated timber system used in Stadthaus comprises panels that are made of solid spruce strips stacked in perpendicular layers and glued under high pressure. This limits the effect of water on the wood, and makes the panels much stronger than unmodified timber.

Andrew Wylie, associate director and materials expert at engineer Buro Happold, says: 'Currently, clients are not keen on timber because they think it burns, rots and bends – but now engineered timber, such as cross-laminated panels and LVL (laminated veneer lumber), is increasingly addressing these concerns, and I think we're going to see wood being used a lot more in the future.'
Killer benefit: Wood beats concrete in terms of cost and sustainability.
Need to know: Flammability is currently being engineered out.

At London's Somerset House, phase-change materials increased the roof insulation while preserving the building's heritage

20

CASE STUDY:

PHASE-CHANGE MATERIALS

The £16.7m refurbishment of the east wing of Somerset House in London, completed last year, shows just how useful phase-change materials can be. Architect BDP's brief was to fully refurbish the Grade I-listed property, while simultaneously bringing it up to a sustainability standard of BREEAM Excellent. But, early on, BDP made an alarming discovery: the timber and slate roof of the building was a flimsy, lightweight structure, and not insulated at all, which was a major barrier to achieving a high level of sustainability. 'We needed to add mass to the roof to minimise temperature oscillations,' explains Ilic Testoni, an associate architect at BDP. 'Normally, we would add concrete, but with Somerset House being a true architectural treasure, both the outside roof and ceiling inside had to be protected, so concrete was not an option.'

The solution was to line the roof with phase-change material boards, by Eco Building Boards (ebb), which combine BASF's Micronal Phase Change Material with ebb's unfired clay building boards. The boards store and release heat, without taking up much space or adding too much weight. The 14mm-thick boards contain droplets of wax, so when the temperature rises above 23°C, the wax melts, absorbing heat. When the temperature falls, the wax solidifies and then heat is released. 'The boards act like concrete, but without increasing the thickness of the roof,' explains Testoni. 'It was a brilliant use of an ultra-modern material in a historic building.'

Killer benefit: Thermal mass without the bulk and weight (ebb PCM boards are 12kg per m², but a concrete slab with the same thermal mass is more than 120kg per m²).

Cost: Only slightly more expensive than equivalent conventional products.

Aesthetic

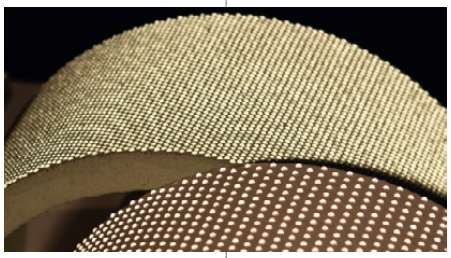
GLITTERING CONCRETE 19

It's a useful material, but only the most austere modernists tend to appreciate the stark aesthetics of concrete. However, several new types of concrete now incorporate light, which is transforming the grey stuff into something that can literally brighten up a property. Products made by Berlin-based BlingCrete, for example, contain tiny glass beads, making the material retroreflective – like cat's eyes on a road at night. What's more, the concretes also come in a range of colours and textures.

There is also a glow-in-the-dark concrete from Ambient Glow Technology, developed by Universal One Corporation in the US, and Hungary's Litracon offers a semi-translucent, patterned concrete.

Killer benefit: Makes boring concrete beautiful.

Applications: Mainly leisure interiors, but it could also be used for safety purposes, such as highlighting steps.



BlingCrete combines the strength of concrete with attractive, light-reflecting materials