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BRE Trust Quarterly Review October - December 2019

Prepared by the BRE Trust Secretariat

Summary of this report

This review summarises the progress of the BRE Trust's project, education and dissemination programmes during October-December 2019, and reports on the BRE Trust Conference held on 25 February 2020.

Annual Conference – speakers presented and discussed a range of wellbeing, sustainability and resilience issues, on the theme of improving people's lives through a better built environment.

Project reports

UK Housing conditions – A new BRE Trust report, *The Housing stock of the UK*, combines housing condition survey findings for England, Wales, Scotland and Northern Ireland in a single UK-wide report.

Connectivity for smart homes – Phase 1: validating modelling techniques for building entry loss. This research will support the planning and reliability of smart devices in homes and buildings.

Fire fatalities and serious injuries in Scotland – first phase of a comprehensive investigation into the conditions associated with fire deaths and serious fire injuries in homes in Scotland.

Impact of indoor air quality on children – The growing evidence that respiratory problems in children can be made worse by indoor air pollution, has highlighted a pressing need to improve indoor air quality.

Creating Positive Spaces by Measuring the Impact of your Design – practitioner's guide measuring the value of good design via pre-and post-occupancy evaluation, for which BRE has provided the technical content with BRE Trust support.

New project

Improving informal settlements in Myanmar – implementing QSAND as a monitoring and evaluation framework for a project to support displaced populations in northern Myanmar.

University and studentship reports

New BRE Trust lecturer – Gabriel Barros do Santos has been appointed BRE Trust Senior Lecturer in Civil and Structural Engineering at Herts University.

New PhD at Coventry University – Kwabena Boakye has been awarded a PhD studentship on calcined clays as a reactive alternative to fly ash as a binder in Portland cement concrete.

Enhancing community energy resilience – supporting Dr Long Seng To's Royal Academy of Engineering research fellowship at Loughborough University.

Edinburgh University report – updates from Professor Grunde Jomaas and Dr Angus Law.

PhD project updates:

- Alistair Wilson, Loughborough – study of distributed ledger technologies' potential to improve traceability assurance in the construction industry.
- Daniel Franks, Loughborough – building energy and environment: measurement, data, analysis and interpretation.
- Vasileios Koutsomarkos, Edinburgh – *a fire resilience assessment methodology for the built environment*.
- Arjan Dexters, Edinburgh– *Testing for knowledge: maximising information obtained from fire tests by using machine learning techniques*.

Completed PhD report – Benjamin Ralph, Edinburgh– modelling of fires in modern high-rise buildings.

Regular reports

Sales and downloads – updates from the BRE Bookshop CIS. Retail sales totalled 564 units. CIS downloads totalled 29,981.

Designing Building Wiki – updates on general performance, BRE articles and BREEAM Wiki. There were 455 BRE articles on Designing Buildings Wiki, the contents of which have been viewed 37,192 times.

The Flood Property Code of Practice – Part funded by the BRE Trust the CoP was published in December 2019.

Videos – Make Design Matter, first year highlights,

- Virtual VR health and safety training.
- Building blocks for affordable, sustainable homes**.**

Appendices – Project status and current studententships overview.

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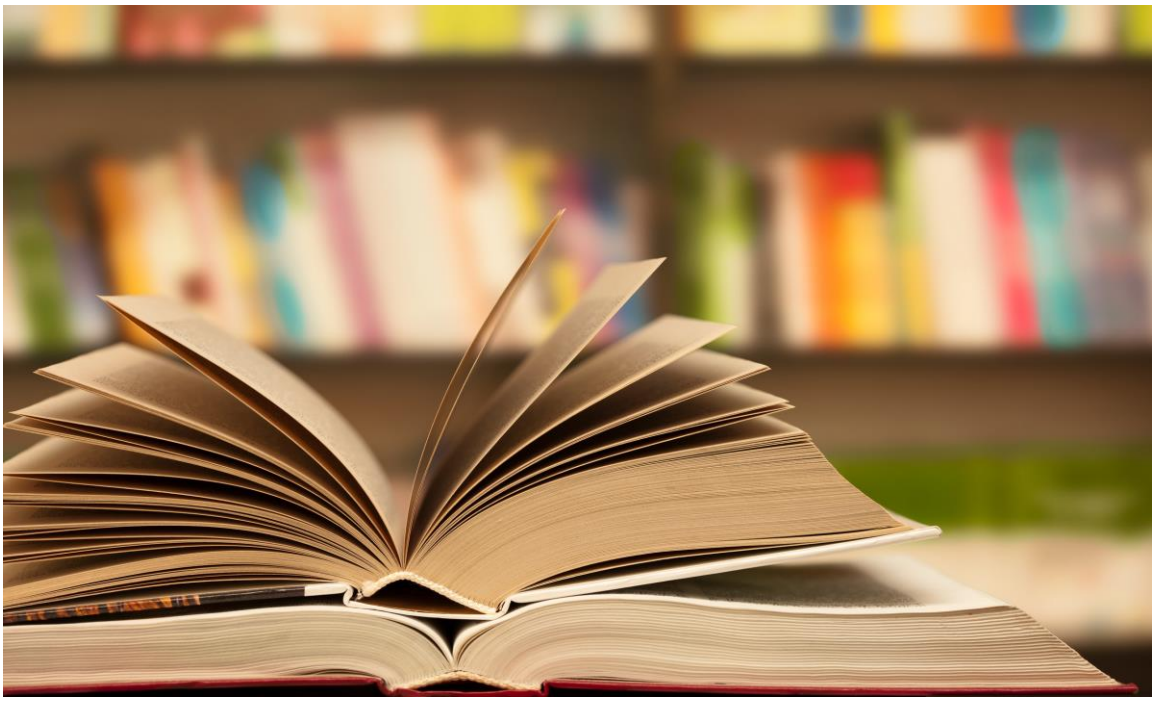


BRE Trust Conference 2020

Improving lives with a better built environment

BRE Trust Annual Conference
25 February 2020. British Library, London

A wide range of leading industry figures attended the 2020 BRE Trust Conference to hear prominent experts discussing their work to deliver positive and measurable impacts on wellbeing, sustainability and resilience in the built environment.

Delegates also had the opportunity to:

- explore an Innovation Zone showcasing our projects on global challenges such as increased urbanisation, the aging population and climate change,
- see behind the scenes of the partnerships delivering this work,
- discuss impact assessments made possible by new technologies and ways of working with data,
- shape the BRE Trust's future priorities and partnerships,
- help to build a delivery network of organisations with shared goals that support the work of your organisation and the BRE Trust's vision.

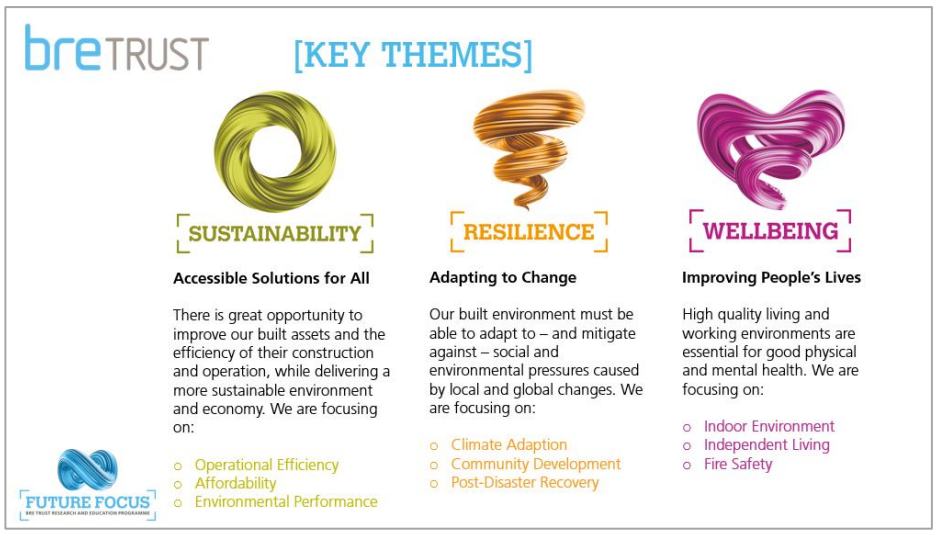
Welcome by Dr Deborah Pullen MBE – Executive Director, BRE Trust

Welcoming delegates to the conference, Deborah Pullen reflected on BRE's rich history of driving construction productivity, safety, environmental performance and advancements – and the BRE Trust's mission to both hold this national asset for the wider built environment, and support the construction research and teaching capability needed to meet the sector's changing needs.

Over the last 20 years the Trust has provided more than £25m of funding to support projects and scholarships, and attracted a further £50m in programme support from more than 30 core partners. It has recently been building on this success by establishing a number of delivery clusters with a range public, private and academic partners, including those in the teaching community and charity sector.

Impact

"It really is amazing what has been achieved by focusing on the right topics with the right people at the right time," said Deborah, "This has resulted in an increase in the pace and scale of application of new knowledge needed to address future global challenges at a time when we hear all the time that we need to meet future needs. We are also working together to find better ways to measure impact and share good practice and experience of this with others so that they can also maximise the value of their efforts."



Improving resilience to disasters

David Murray – Managing Director, Article 25

Article 25 is an international development organisation that builds homes, schools and healthcare facilities in communities where they are most needed, because of recent disasters such as earthquakes or conflicts, or as a result of poverty.

Established thirteen years ago to provide buildings that are as professionally designed and constructed as they would be if delivered by commercial companies, Article 25 has worked on more than 90 projects in 34 countries.

Local knowledge and consultation

It is all too easy for well-meaning responders to waste resources by providing assistance that does not give communities what they need for a sustainable post-disaster recovery, or to alleviate the problems of poverty.

Article 25 makes a point of consulting with as wide a range of local people as possible. For example, when expanding the Bethel School in Burkina Faso, which was popular but struggling to cope and turning children away, the teachers were consulted in detail about what the school needed. This included more classrooms of course, but also science, sports and vocational training facilities.

The wider community was consulted on secondary needs such as the provision of clean water, a safe space for women and girls, and areas for events and a market.

Bethel School in Burkina Faso.
Photo: Grant Smith

Local materials and techniques

In this country we know a lot about building with steel, concrete and glass, but it is often better to consider what is normal in the project areas – what has stood against earthquakes for centuries for example – and apply traditional techniques to modern settings.

Also, using locally sourced material keeps building and maintenance costs down, and means they are available at the local marketplace when reconstruction or additional construction is needed. When building a school in Niger (inspired by the success of that in Burkina Faso), an abundant local stone call laterite was used as the main building material – cheap, attractive and with low embodied energy. In addition, a number of local people learned masonry skills during the construction process.

As far as possible, passive techniques, such as maximising natural lighting, cooling and ventilation are used in building design. A new building at the Bethel School for example, has a double skin roof to encourage air to pass through the roof space and pull heat away from the classrooms, making the learning environment more comfortable (see photograph). These techniques reduce electricity requirements, costs and environmental impact.

Local workers

Article 25 investigates who is available in the local community to work on its projects, including architects, engineers, construction professionals and unskilled workers, and who is interested in learning carpentry, electrical and bricklaying, etc skills. The participation of women in the workforce is encouraged.

In a post-earthquake housing reconstruction project in Northern Pakistan, which provided 60 homes, the first was built using a team of local workers. The remaining 59 were built by the families that would live in them, using the skills learned from the first house construction and locally available materials, and individually designed to meet their particular needs.

Assessing the impact

Article 25 recently returned to Bethel School in Burkina Faso, with BRE Trust financial support, to carry out a post-occupancy evaluation of the school since it re-opened in September 2014. They are assessing, for example, how well the double skinned roof is working, whether the building has any maintenance and repair issues, and what have been the social and economic impacts of the project for those that worked on it – such as have they retained the skills they learned and used them on other projects.

The results are still being analysed, but anecdotal evidence suggest that the construction skills learned have been put to wider use, and the vocational courses now offered by the school have helped students to set up small local businesses.

For more information visit
https://www.bretrust.org.uk/knowledgehub/resilience/monitoring-indoor-environment-in-burkina-faso/

Affordable and sustainable energy for all

Dr Long Seng To, RAEng Research Fellow, Loughborough University

Dr To discussed the need to tackle energy resilience, the importance of building on local capacity – using examples in Nepal and Malawi – and her collaboration with the BRE Trust on QSAND.

She reflected on recent falls in photovoltaic and storage technology prices which (combined with innovative business models) are changing energy sector access. Decentralised options, such as renewables, storage, smart grids and the internet of things, are challenging the centralised energy model. Developing countries with lower investments in centralised grids have an opportunity to adopt alternative generation options.

The energy issue

There are 17 interconnected UN Sustainable Development Goals (SDGs) – with 169 targets to be achieved by 2030 – forming a plan of action for people, planet and prosperity. SDG 7 calls for affordable, reliable, sustainable and modern energy for all, with specific targets for energy access, renewable energy and energy efficiency.

A billion people have no access to electricity.
Three billion rely on traditional fuels for cooking, exposing women and children particularly to indoor air pollution and danger when collecting firewood. Developing countries also face other issues, including climate change, natural hazards and conflicts that cause disruption to infrastructure, including energy supply.

Community energy resilience

Communities are often surprisingly energy resilient. After the 2015 earthquakes in Nepal, people were reported to be salvaging their own renewable energy systems. Tasked with gathering data on this in Nepal, Dr To found that while the restoration of centralised energy services was quite slow in areas that were difficult to reach after the disaster, households and communities were very proactive in restoring some of their own energy services using informal networks.

Communities also cope with more everyday resilience challenges. Nepal is vulnerable to annual floods and landslides and climate change will impact on agriculture in the region. Communities are moving their settlements and energy systems, and sharing water sources between mini-hydro energy systems and agricultural irrigation.

In Malawi livelihoods are threatened by cycles of drought and flooding. Cyclone Idai highlighted the issue of energy resilience, and the view that a portfolio of renewable energy projects and mini grids may help to diversify power supplies away from large hydro-electric dams.

In fact, examples from around the world have demonstrated the contributions that communities can make to energy resilience. Over the next four years Dr To and her team are looking deeper at community level approaches in Malawi and Nepal, developing quantitative and qualitative measures of community energy resilience, and co-creating solutions with two communities in Nepal and two in Malawi.

QSAND

Dr To is working with the BRE Trust on the energy elements of QSAND, a very practical tool that can be used by agencies and communities to improve sustainability efforts. Also addressing much of the disaster cycle – from reduction to reconstruction – it is a decision making, design and benchmarking tool.

Models on energy planning have been developed in countries with well established centralised energy provision. Dr To is looking at countries where energy systems are now being built and are taking a more decentralised approach – addressing a knowledge gap by focussing on the community, not national level. She also wants to look at how energy interacts with other QSAND sectors such as water and shelter, and feed this back in tools to help communities plan their systems.

Improving settlements in Myanmar

Jamie Richardson, Shelter and settlements technical advisor, Catholic Relief Services (CRS)

CRS is an international humanitarian-aid organization that helps poor and vulnerable people living overseas, by responding to major emergencies, fighting disease and supporting agriculture. It works in around 100 countries, usually through a network of local partners.

Sustainability

In recent years CRS has increased the focus on sustainability issues in emergency humanitarian operations (as well as in subsequent development projects), recognising the impacts that very early decisions have on long-term outcomes. Looking for a tool to help deal with the difficulties of incorporating sustainability in complex emergency situations, CRS encountered the BRE Trust supported QSAND tool (see page 6).

QSAND was trialled in emergency operations following earthquakes in Nepal. It proved very useful but its impact was reduced because the operations there were already well underway. As part of a project in the Philippines (following a typhoon Haiyan) in which an at-risk community was given the opportunity to relocate, QSAND was used to take a snapshot of the programme to assess its success.

Community focus and participation

Moving forward, the benefits of focussing on strengthening communities and encouraging their participation is well recognised and is an important element in development projects. But this is time consuming and not easily managed in emergency situations, and the needs and resilience of every household are different. CRS therefore stripped down its development models with a view to providing a streamlined, rapid and adaptable means of supporting communities in emergencies.

Myanmar

This approach was put to the test when a million Rohingya people came across the border from Myanmar into Bangladesh, bringing very little with them. With its partners, CRS focused on 200 households and – with rapid planning and implementation driven by the community – redeveloped the site in three months. This model worked well, and a set of guidelines were developed and shared.

In contrast another, unassociated resettlement project within Myanmar had used a one-house-type-fits-all solution without community consultation, which had proved much less successful. As a result, CRS was asked to provide guidance and training for a Myanmar project based on the Bangladesh project model.

CRS also saw this as also a great opportunity to apply QSAND from the very beginning of a project to:

- gain an initial assessment, a before and after comparison and a performance score.
- provide a useful checklist for the project
- deliver an overall benchmark of project effectiveness to help promote this model.

There are 48 households involved in this pilot project and the first 11 have come together to move out of the camp they have been occupying for eight years. They are enthusiastically taking the opportunity to design and build their own homes, and are demonstrating to agencies in Myanmar that they have the drive and technical skills to do this successfully.

Improving fire safety

Raman Chagger, Principal Consultant, Fire Safety Group

Fire safety research projects at BRE typically involves a number of organisations working collaboratively with the aim of generating new knowledge that has practical, beneficial impacts.

The collaborative process

The process typically starts with a research idea that a group of stakeholders agrees could deliver valuable results. A number of partners then contribute to the work – usually including the BRE Trust which provides financial support, along with other collaborative partners who provide cash or in-kind support such as time, equipment or data.
BRE then performs the research work in collaboration with the partners, reporting the progress of the work at each stage. The new knowledge generated is used to:

- Publish guidance in the form of freely available briefing papers, videos and articles in the trade press.
- Help manufactures to develop and improve products.
- Help fire and rescue services to improve procedures.
- Develop new or revise existing standards, codes of practice and certification schemes.

Project examples

False fire alarms in buildings **–** a series of projects have identified strategies for reducing false fire alarms. These started with a small-scale study that found the best way of fully understanding the causes of false alarms would be to have a technical expert accompanying fire and rescue service staff while they attend false alarms.

A second project putting this into practice was conducted with an extensive group of stakeholders, resulting in 35 recommendations for reducing false fire alarms. This also identified the potential for multi-sensor detectors that use a number of different sensors (typically heat and smoke) to reduce false alarms.

With support from the BRE Trust, the Fire Industry Association (FIA) and a number of manufacturers, a further study found that multi-sensor detectors performed similarly to smoke detectors in warning of real fires, but were more resistant to false alarms. This has helped manufacturers to improve their products and is likely to lead to testing and certification service for false alarm resistance.

Visual alarm devices (VADs) **–** VADs give fire warning to hard of hearing people, and in noisy areas or where silent alarms are preferred.

A project privately funded by a manufacturer demonstrated that the latest LED technology, when using faster, shorter light pulse durations, can offer the same warning levels in VADs as high light intensity xenon devices. This led to changes in codes of practice, particularly in the USA, to specify shorter pulse durations for LED devices.

The research also raised a number of questions about how visual alarm devices can be more effectively used and how they should be sited. This has brought together around 15 organisations to undertake research into factors such as the impact of light and wall colour, illumination levels in the building, and the ability of people to see the warning lights when not facing the devices.

Causes of fire fatalities and serious injuries – there has been a steady decrease in fire fatalities in the UK homes over the last 35 years, but in recent years that decline has plateaued. This has prompted the BRE Trust, FIA, Scottish fire services and the Scottish Government to support a project investigating the conditions in which fire fatalities and serious injuries occur, and to use that data to propose ways in which these might be reduced.

This two-phase project is looking at the database gathered by Scottish fire and rescue services – the Incident Recording Database. The first phase has examined the records of nearly 20,000 incidents in a four-year period, and particularly those involving serious injuries and fatalities. The second phase will look in much more depth at the conditions in which the 126 fire fatalities occurred.

Full details of the first phase of this project – and of the projects described above – are available at www.bregroup.com/expertise/fire/fire-safety-research

Future project ideas

A number of project topics are being explored and partners sought for collaborative research on, for example:

- heat alarms in domestic kitchens and the impacts of dust build up and degradation with time,
- the best ways of dealing with the dangers of carbon monoxide in the home,
- the optimum spacing of CO and smoke detectors in commercial environments,
- identifying the electrical signatures of white goods and other electrical items that go on to catch fire.

Anyone interested in participating in these or other studies should contact Raman Chagger – email Raman.Chagger@bregroup.com

Quantifying the impacts of poor housing

Sue Adams, CEO, Care & Repair England

Care & Repair England is a charitable organisation set up in 1986 to improve the homes and living conditions of older people. A key element of this work is the provision of housing and cost benefit data that supports the case for action to improve housing.

The primary source of such data for England is the English House Conditions Survey conducted for government by BRE. Care & Repair England has worked with BRE to analyse this data with regard to ageing and housing conditions, and then publish reports that have been critical to making the case for action to address disrepair. The BRE Trust has provided funding and support for projects over the last five years, which have fed into this policy and practice improvement work.

There is a perception, including amongst many policy makers, that most older people live in – or *should* live in – age-specific housing such as sheltered or retirement schemes. In fact, there are 9.5milliom households (2 out of 5 homes in England) in which the head of house is over 55.

Currently, 96% of all older household, will carry on living in ordinary housing. Most people like their homes and want to stay connected with neighbours, friends and families, living independently for as long as possible. As each will experience different levels of health and fitness over their lifetime, what makes a good home will change and we need homes that can be adapted to our changing needs.

Improving existing homes

The housing stock is renewed very slowly. At current rates of replacement existing homes must last for more than 1,000 years, and 80% of the homes people will be living in by 2050 are already built. Consequently the biggest impact we can have on population health through housing improvement is by improving existing stock quality.

Care & Repair England is working with the Centre for Aging Better to set out the problem of non-decent homes and make the case for improving existing housing. The Centre has a 10-year target for reducing the number of people living in hazardous homes by a million. A joint report – which includes new analysis of EHS Data by BRE – has recently been published.

Low income home owners

The new report highlights the 10 million people living in 4.3 million non-decent homes across England, 2 million of which are occupied by someone over 55.

The biggest concentration of non-decent homes – 78% – is in the owner-occupier sector, not as many may think in the private rented and social rented housing sectors (both 11%).

The increased low-income home ownership is a relatively recent and growing issue – not solely due, as often assumed, to the 1980s right-to-buy policy – but primarily to the revolution in mortgage access amongst lower- and middle-income groups. This revolutionised housing tenure in the 1980s and 90s, changing from 50% home ownership to the peak of 76%. Unfortunately, there were no linked changes to welfare benefits or housing renewal programmes, e.g. how low-income households would afford longer term home maintenance, repair and renovation costs, particularly after retiring on low pensions.

The cost of poor housing

Recent work with the Centre for Ageing Better, using BRE data analysis, reveals a 31% growth in the number of over-75s living in non-decent homes. This is important to health and housing, as health analytics show the use of – and cost to – the NHS starts to increase after 75. Health conditions with the greatest impact on NHS costs are the incurable long-term conditions with increased incidence in later life. Most are caused or exacerbated by poor housing, e.g. respiratory and heart conditions, arthritis. To prevent NHS cost escalation, we must improve existing housing and build healthier homes for all ages.

The BRE EHS data analysis identifies the non-decent factors in homes that have the greatest impact on premature death, rates of illness and avoidable injury – and therefore the features that are most beneficial to put right. These are cold homes and fall hazards and making relatively modest housing improvements can result in significant savings for the NHS.

“BRE carries out the data analysis and provides key information, such as the fact that poor housing in England costs the NHS £1.4 billion a year in first-year treatment costs alone.” says Sue Adams, “We can then combine that information with other data sources, such as the fact that falls at home are the main cause of premature death and injury amongst older people. This solid data then underpins our work programmes, including targeted action to improve homes as well as profile raising, and campaigns for wider housing policy change.”

For more information http://careandrepair-england.org.uk/

The impact of indoor environment on health and wellbeing

Ed Suttie, Director, Strategic Advisory, BRE

"My thanks to Sue Adams (the previous speaker) for highlighting the inextricable link between the health and wellbeing of individuals and the buildings they occupy for the majority of their lives," said Ed Suttie when introducing his presentation.

What defines indoor environment quality?

Indoor environment quality (IEQ) is defined by a complex range of factors such as thermal comfort, ventilation, air quality, acoustics, natural and artificial lighting, colours and views from windows. But it is also about people – how we behave in and use the space, and the fact that we all have different versions of what makes high quality and comfortable indoor environments.

There is also the interaction between indoor and outdoor environment of a building – the impact indoors of, for example, outdoor air pollution, noise and lighting, other nearby buildings, traffic, views, construction work, and issues such as the building's orientation and location. And there are unintended consequences – for example, the drive for energy efficiency and reduced carbon emissions can lead to airtight buildings without sufficient ventilation, with impacts on air quality, thermal comfort, and conditions causing dampness and mould.

Other factors include the building materials used, the fit out, maintenance and cleaning, and the tricky balance between building management system (BMS) and occupant control. The BMS will run the building efficiently, but users with different personal comfort levels may want more control.

Solid evidence

As we typically spend 90% of our lives indoors – nearer 100% for many vulnerable people – it is not surprising that IEQ has a critical impact on health and wellbeing – and productivity in the workplace, the ability to teach and learn in educational buildings, heal in health buildings, and so on.

There is now very solid scientific evidence for a wide spectrum – from irritation to morbidity – of impacts of IEQ on health and wellbeing. This has recently been added to by a new report from the Royal College of Paediatrics and Child Health and the Royal College of Physicians on, *The inside story. The impact of air pollution on children and young people*.

It is based on an extensive review of indoor pollution research, evidence from a wide range of practitioners and experts (including BRE with BRE Trust support), and conversations with children, young people and families – further details are on page 21.

Measurement and validation

BRE is engaged in range of IAQ measurement and validation activities in extensive facilities, including:

Product and system testing – a recent example has been the testing of an increasingly wide range IAQ sensors and monitors now commercially available.

30m^3 indoor air quality chamber – included in the photograph below being used to test the impact of interior green walls.

40m^3 indoor environment quality chamber – can be set up as a space within a building and occupied for full-scale indoor environment quality analysis.

Full-scale mock-ups of actual buildings or parts of buildings for measurement and validation.

Understanding occupants

It is too often forgotten that buildings should constructed or refurbished for the benefit of the people occupying them and the tasks they must carry out. Obtaining full information about the occupants and their experiences is key to getting this right. A valuable tool is pre- and post-occupancy evaluation (POE), which measures the performance around a building's life cycle – from preparation of the brief and design to handover and in-use.

A new publication on *Creating positive workspaces* has been produced, with BRE Trust support, by a partnership of BRE, Interface and Oliver Heath Design. It gives guidance on POE, and on designing workspaces that have positive impacts on health and wellbeing. It is freely available from https://info.interface.com/whitepapers-en_GB#impact_design?utm_source=bre-group&utm_medium=referral&utm_campaign=design-guides-en_gb-organic&utm_content=poe

Research

Research and the generation of new knowledge is at the core of BRE's activities. One current example concerning health and wellbeing in buildings is the Biophilic Office Project.

Biophilic design is a human-centred approach that acknowledges our biological connection with nature. It brings the positive aspects of the outdoors – both living (such as plants) and non-living (such as light, water and diversity) – into the built environment.

The Biophilic Office Project at BRE's Watford campus is measuring the effects of a full biophilic refurbishment on the occupants of a 1980s office building. This working office and its occupants (and a control building) have been monitored for more than 12 months (first phase) and, following planned refurbishment using varying levels of biophilic design, will be monitored again for a further 12 months.

In addition, one of the buildings at the BRE Innovation Park in Watford is currently being converted into a demonstration biophilic space. A report on the first phase monitoring will be freely available once launched in April.

Use of data in the built environment

Professor Katherine Royse, Chief Digital Officer, British Geological Survey

The British Geological Survey (BGS) is the custodian a huge amount of data, the presentation of which has been revolutionised since Professor Royse first joined the organisation. "We've gone from colouring maps with pencils," she said, "through the digital revolution to now producing mathematical and conceptual models in 4D – bringing in time elements to understand how ground is changing with climate change."

Another major development has been in the accessibility of information to wide ranging users. "We used to produce geological maps to indicate, for example, areas at risk of subsidence. These were really useful – but only to geologists."

BGS data outputs now aim to inform all of those who need to know, typically with the help of additional data from a variety of other sources, and to meet the real needs of users. "As scientists we tended to be very good at providing solutions to problems that no-one knew they had," said Professor Royse. "We have to understand the concerns that people actually have and try to address *them*."

Data mashing to solve real problems

An example of addressing real concerns by combining BGS and other data – data mashing – is the work on debris flow, which is common in Scotland. In partnership with the Met Office, south facing slopes experiencing the worst weather which also had potential for debris flows were identified. This enabled BGS to make forecasts of debris flow risks and help transport authorities in Scotland to understand those risks.

Other examples include adding climate change data to BGS's swell/shrink data, to work out where in the country swell/shrink potential is going to get worse, and where it will get better (mostly worse). This is useful for the construction industry as it informs the types and depths of building foundations needed.

BGS has worked closely with many organisations. Two recent examples are Historic England and the Environment Agency, who BGS has worked with to understand the problems they need to address, and produce a set of products and services for them. Some of these services are free and some are premium services, but the point is they were designed with the user in mind.

Flooding

The topical issues on which BGS is working include flooding. Flood risk is not only the result of heavy rainfall, but also partly affected by groundwater conditions. In high rainfall the groundwater levels rise and once they reach the surface can remain at that level for a long time – because groundwater does not run away as rainwater does – and particularly damaging flooding can result.

BGS has been working with a company call Ambiental Risk Analytics to help it piece together the risks of groundwater and surface water flooding. The idea is to combine these to develop a whole-system approach that will provide a fuller understanding of flood risks. While organisations such as the Environment Agency may caution against building on flood plains, they recognise that there is sometimes no alternative – so it is very important to understand and mitigate the risk.

FAIR data

In these and many other projects, BGS is working to follow the principles of FAIR data – data that is findable, accessible, interoperable and reusable. Making data findable and accessible is relatively straightforward, but making it interoperable and reusable is more difficult because it is not always possible to know how people will use the data, or in what format it is needed. This is where working in partnership with those needing to use the data is so vital.

To encourage more building on brownfield sites for example, BGS has co-designed with the Greater Manchester Authority, a tool to help understand not only the ground risks but also the cost of ground remediation. It is a way of looking at the ground as a geologist, but then channelling this into Manchester's issue of large quantities of unused brownfield land, combined with its housing shortage.

Another issue that BGS has been working on is that of how sub-surface data can be applied in BIM. This has again involved working with a range of other organisations to understand their problems, enable them to use BGS data in the form that they want it, and within the systems that they want to use.

Visit the BGS website - www.bgs.ac.uk – for more information.

Understanding ground conditions is critical to flood resilience. Here extensive and vital infrastructure has been put out of action by flooding

Digital modelling to support waste management

Dr Ricardo Codinhoto, Senior lecturer, Centre for Advanced Architectural Studies, University of Bath

While the use of building information modelling (BIM) in building design and construction phases is well established, the use of BIM in the operation and management of buildings is still at a very early stage. Design and construction teams produce large amounts of data, but at building handover only a small amount of that information goes through the system for use in facilities management.

Managing operational waste

In view of the huge volumes of waste being generated in the UK and the increasingly scarce landfill availability, this research focused on waste and waste management, investigating the use of a BIM-based model in managing operational waste. The aim was also to help facilities managers with the difficult task of maintaining public assets in a time of tight budgets.

The University of Bath has 118 buildings, 20,000 occupants and annual waste generation (general and recyclable) of 280 tonnes. It was used by the project team to represent a mini-city, in which the flows of people, waste and waste services, and the geometry of the buildings, could be modelled and their interconnections examined. The University has a good track record of not sending waste to landfill, but still needs to reduce the waste generated.

The aims of the work included finding ways of improving the efficiency of waste collection, and of identifying waste generation 'hotspots' where interventions could most effectively be made to reduce waste.

The project focussed on the library building which has high occupancy and large volumes of waste generated. It examined waste generation figures and peaks, the numbers of people using the library and where they go within the building. The building has recycled waste collection twice a day, but not all of the bins would be full, so this was not the most efficient use of time.

The building was modelled, not only for the physical locations of items, but also to understand the relationship between volumes of waste generated and the location of the bins, and the different types of bins in different rooms.

A shortest-path algorithm was used to understand the best solution for waste collection and to identify improvements.

An infrared sensor was developed for the bins to provide information on how much they contained, which was made available on-line and readily accessible so that the porters would be able to target only the bins that needed emptying, thereby saving time.

Conclusions

Among the project's conclusions were that a digital system could support the reduction of waste generation, and the Internet of Things could be used to increase the accuracy of waste management systems and save a significant amount of time in waste collection.

However, the current waste information available is not generally sufficient to produce effective operational waste management models. If waste information collection was expanded, meaningful interventions are possible that could improve collection efficiency and reduce waste generation.

Next steps

The team is now modelling the whole Bath University campus in order to understand it as a system and to create generic models and systems that can be used elsewhere. Going forward, one of the ideas they are exploring is the use of robot bins that "collect themselves" and perhaps give educational messages to those throwing waste materials away.

Taking the further idea of mapping flows of people and materials through buildings, the team – with a number of international partners – is looking into ways of reducing reactive maintenance, using ideas for monitoring people to investigate loneliness, and examining fire evacuation procedures, particularly for vulnerable people.

This project was part funded by the BRE Trust supported Worshipful Company of Constructors Research Award 2018. A video in which Dr Codinhoto explains the project in more detail can be seen at www.bretrust.org.uk/knowledgehub/sustainability/worshipful-company-of-constructors-research-award-2018

The importance of social value and how to measure it

Alan Somerville, Executive Director, Building Performance Group, BRE, and Nathan Goode, Director, Social Value Portal

Social value means different thing to different people, but for many it is about using capital for good, and for creating a better society.

Environmental and social governance (ESG) is now a key performance metric for many of the world's biggest investors. The world's largest investor Blackrock, for example, has put sustainability right at the heart of its investment strategy, reinforcing the view that driving ESG performance is good investment management. It has been reported that the UK alone has about £125 million of capital a week capital going into ESF designated funds, so it is a rapidly growing sector.

Measuring 'S' – the Social Value Portal

When it comes to measuring ESG, it is the measurement of the social value, 'S', element that is the most challenging. This issue is addressed by the Social Value Portal, an on-line platform formed in 2014, which allows organisations to measure and manage the social value they generate. It enables organisations to report both non-financial and financial data, and rewards them for doing "more good" in the community.

The Social Value Portal is applying a number of the data principles discussed earlier, such as accessibility, transparency and comparability. Reporting on social value and community benefits has a good history, but has tended to function in isolation, lacking scale and comparability.

The Portal has two component parts, the first being the platform itself. This is the data collection mechanism, designed to be as accessible and user friendly as possible. It is geospatial in functionality so that users can map where social value is being delivered.

The TOMs

The second component is the methodology for calculating social value called the TOMs – Themes, Outcomes and Measures:

Themes – the overarching strategic themes that an organisation is looking to pursue.

Outcomes – the objectives or goals that an organisation is looking to achieve that will contribute to the Theme.

Measures – the measures that can be used to assess whether these Outcomes have been achieved.

The idea is to create a framework for social value measurement which sits behind the portal and is porous and flexible enough to allow data to feed in, to build it and influence its development. The intension is to make a level playing field that will allow benchmarking of social value in the same way as is done for environmental data.

Key features of the TOMs include transparency, consultation and engagement. The Portal's development included an 18-month consultation process with a large number of public and private sector organisations, which culminated in the launch of the first set of TOMs in 2018. A national social value task force supervised the launch of the 2020 TOMs and has a conference every year to debate social value and its issues. The TOMs framework and guidance can be freely downloaded from the Social Value Portal.

SDGs

The framework has been mapped against the Sustainable Development Goals (SDGs), which make up an umbrella concept that both public and private sector organisation across the globe are now driving towards. The aim is to find out to what extent a measure against the TOMs framework delivers against a particular SDG. The Social Value Portal aims to launch this online as a plug-in application shortly.

The Social Value Portal is at socialvalueportal.com/

"Public opinion, capital markets, occupier expectations and consumers are driving an exponential change in our perceptions of value," said Alan Somerville in conclusion, "and this is driving greater demand for disclosure and transparency of performance. Data is the golden thread that runs through all of this, and robust standards, assurance and tools are the methodologies we can use to prove performance and measure impacts."

Sir James Wates – Chair, BRE Trust

Our Future Focus

Sir James Wates began by congratulating BRE Trust partners on their achievements – many exemplified in the day's presentations – at a time when funding and resources are at a premium.

The Trust continues to focus on challenges facing society, including home and business destruction in extreme weather events, fire or civil unrest. Sir James highlighted the critical need to develop and make available to industry, improved products, processes and tools that reduce the economic and environmental impacts of such events.

Collaborating with partners

He particularly emphasised the importance of collaboration, for example in capitalising on the opportunities offered by innovations, particularly digital, to give supply chains the skills to control and monitor asset performance. These assets have to perform better said Sir James. "We really do need radical change in how we conceive, construct, and maintain the buildings of the future if we as a society are going to meet zero-carbon goals."

A number of the day's presentations highlighted how new data analysis techniques can deliver more knowledge. The Trust is keen to support projects where data can be created, shared and used.

"Collaboration is at the heart of this," said Sir James, "whether this be about assessing specific impacts of an increasing ageing society, tracking geographical changes, or using BIM to manage resources more effectively. We want the BRE Trust to be a catalyst for the collaborative sharing and analysis of data."

Sir James pointed to the collaboration between academic, industry, public and charity sectors, demonstrated in the conference's showcase of Trust supported projects – which also illustrated the drive for increased impact with limited funding. "Everybody agrees that generating social value in construction projects is essential," said Sir James, "but not everybody agrees how it should be measured." The conference presentation on measuring social value showed how funders and deliverers can validate impacts.

"We are keen to hear from you"

The Trust wants to find new partners to work with – particularly in its sustainability, resilience and wellbeing focus areas – and combine knowledge and resources. "We are keen to hear from you," said Sir James. "Whether it be about bringing existing projects to the table, aligning some of your funding commitments to corporate social responsibility, or some other means to collaborate."

Great response to the Conference

The BRE Trust Conference was widely praised for the quality of its presentations and displays, and for the opportunities it presented for making new contacts and sharing ideas. A small selection of comments includes:

David Murray, Managing Director, Article 25

"It was a real pleasure being a part of yesterday's conference! Great networking opportunities, lots of business cards exchanged, real diversity in the presentation topics, and lots of useful insight."

Allan Mayo, Smart Cities Adviser, Digital Greenwich

"Many congratulations on what I thought was a really successful day. The presentations were just the right length and on interesting topics, the stands added colour, and I think you are blessed with keen and motivated staff, who also have the important characteristic of being pleasant and helpful!!"

Siobhan Shaw, Senior Trusts and Foundations Manager, Autistica

"Congratulations on a fantastic event yesterday – I really enjoyed hearing about all the different projects and partnerships the BRE Trust is involved in, and we've definitely got some further food for thought for our own initiative. It was also fantastic to hear how keen the Trust is to catalyse partnerships and drive forward projects focused on collecting and using data."

Project Reports

The Housing Stock in the UK

A snapshot of housing conditions throughout the UK
BRE Trust support: £8k. MHCLG: £8k

A new BRE Trust report, *The Housing Stock of The United Kingdom*, combines the findings of housing condition surveys in England, Wales, Scotland and Northern Ireland in a single UK-wide report.

With a legacy of massive house building during the industrial revolution, the UK's housing stock is the oldest in Europe – probably the world – and is only very slowly being replaced. Older homes often present challenges when making them healthy, safe and suitable for the future. Housing condition surveys offer the detailed information needed to inform the targeted and costed housing policies required to deliver better homes.

Surveys in the four UK nations are conducted separately over different timescales, with different sampling criteria and survey instruments. However, the key information they use to describe housing in the four nations is comparable, and in 2017 the four surveys were – for the first time in nine years – all being conducted during the same year.

This presented the opportunity to gather the published findings from the four surveys and combine them into a single recently published report, *The Housing Stock of The UK*, to provide UK-wide information on:

- dwelling age and type, size, construction, materials,
- tenure,
- indicators of housing quality and condition,
- heating, fuel type, insulation and energy efficiency,
- the cost of poor housing.

This publication follows the earlier Housing in the UK, which used data from the national surveys when they last aligned in 2008. It became the recognised source for UK housing statistics but has become out of date.

The new report comments that:

"UK housing stock is changing very slowly over time and it is clear that substantial replacement by newbuild is not an option. Improving our existing dwellings does not, however, need to be overly expensive and has multiple benefits to society as a whole, both economic and social. It is also more sustainable."

It also gives insights into the differences between the four nations' housing stocks, and will help to answer with the regular calls for statistics on UK housing for comparisons with other countries – a task that is not straightforward when using four separate surveys.

The report is freely available at:
www.bretrust.org.uk/knowledgehub/health/indoor-environments

Connectivity for smart homes

Phase 1: validating modelling techniques for building entry loss
BRE Trust support: £53k. Industry: £63k

This research on computer modelling techniques will support the planning and reliability of smart devices in homes and buildings.

The issue

Smart home and building services – such as mobile communications, smart metering, machine-to-machine services and emerging technologies for energy, wellbeing and productivity – depend on reliable wireless connectivity, i.e. the ability to connect to the internet and access services.

This in turn depends on the strength of wireless signals entering buildings, which can be attenuated by the building fabric – this is known as building entry loss. Developing and planning wireless networks therefore requires accurate information on signal losses into buildings.

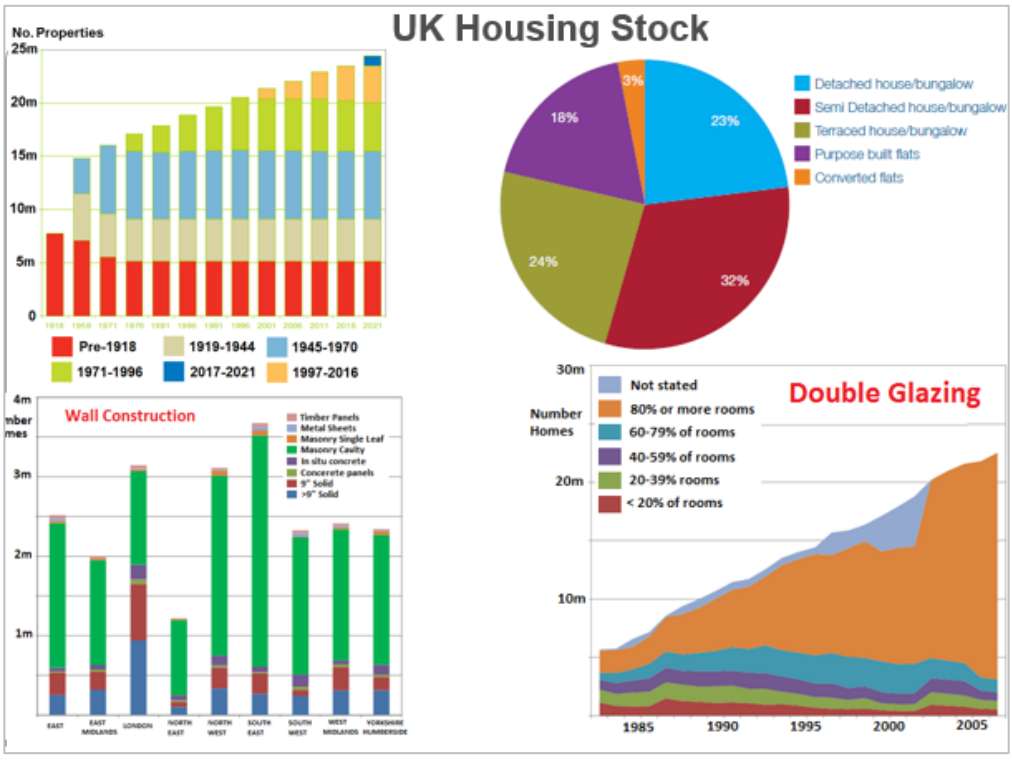
The current use of simplified models to estimate signal loss can result in the reduced reliability of services, or the need to plan for excessive margins of error – this can lead to over engineering and increased costs, or decisions not to proceed with novel applications. There have, for example, been widely publicised problems with the smart meter roll-out programme.

Resolving this issue is made all the more difficult by the wide variation in construction types and materials used in house building. There has also been an increase in the volume of metallic products being used to insulate houses for good thermal performance. These tend to attenuate the signal levels more than traditional building materials, and are widely used in offsite construction.

Research aims

This research project aimed to demonstrate the feasibility of using computer modelling techniques to predict the building entry loss of wireless signals into and out of buildings. It has compared the results of measuring and modelling building entry loss in distinctly different buildings at BRE's Watford site. The project aims also included:

- producing a report comparing the accuracy of modelling and taking measurements for radio frequencies representing a range of existing and emerging applications,
- developing knowledge around optimum measurement and modelling techniques,
- setting the foundations for a potentially large programme of industry supported research, extending this work to the considerable variations in housing construction and materials across a housing stock of 26 million homes.



Wide range of construction methods, products and materials used in housing.

The project and its findings

Both measuring and modelling building entry loss have challenges when developing the correct methodologies, including the complexities involved with the range of construction methods, products and materials, and the very wide range of radio frequencies covered.

By comparing the new test results with previous measurement campaigns, the project identified significant improvements in the underlying radio propagation mechanisms, and in the resulting models for different house types. An improved classification of housing types was also proposed:

- traditional brick houses without foil-backed plasterboard or modern low-E glazing,
- traditional brick houses (or modern versions of this) with foil-backed insulation and with modern low-E glazing,
- modern offsite construction houses (modular and panel based) with more lightweight wall structures that include foil insulation (often multiple layers of foil) and with low-E glazing.

A range of computer modelling methods were reviewed for their applicability in simulating radio signal propagation in houses, and two were selected:

- a detailed Method of Moments (MoM) that could handle variations and complexities in material types and shapes, but which was computationally intensive,
- a ray-tracing method that required further approximation of the model whilst allowing large structures to be computed more efficiently at high frequencies.

The practicality, limitations and optimum methods of creating simulation models from BIM models was explored, including consideration of the types of approximation that needed to be made and their impacts.

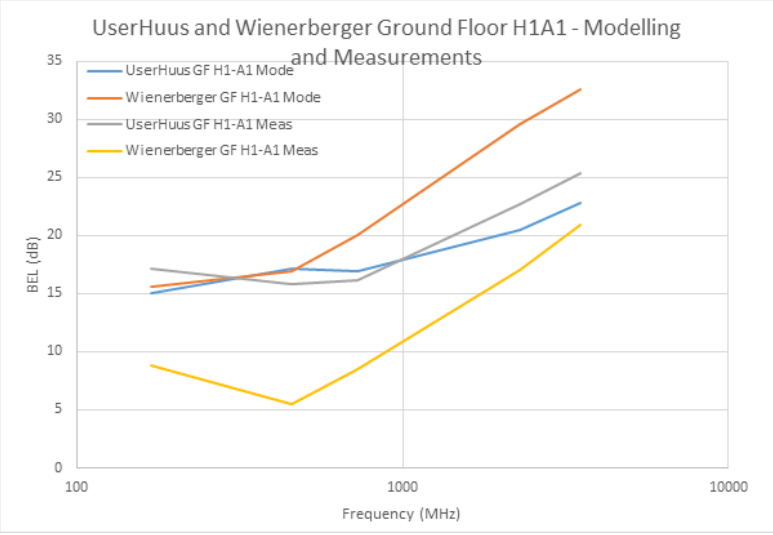
Modelling of the signal loss from internal walls and metallised windows had a big impact on the results, and this is an area that could be explored further in any follow-on work. The modelling results were also very good at looking at various trends, and for sensitivity analysis of – for example – different angles, depths, materials and layouts of houses.

The advantages of using the computer modelling methods were clear. Wide ranging scenarios can be performed relatively quickly, allowing numerous parameters to be adjusted and their impacts investigated. This work gave confidence that, with further work, the use of computer modelling techniques could considerably improve the building entry loss models used by industry.

An example of the comparison between the measurements and modelling is shown below for the UserHuus and Wienerberger houses on the BRE Innovation Park. This shows the variation in building entry loss with frequency. There is a very close agreement between measurement and modelling for the Userhuus. For the Wienerberger house the trend is predicted well but there is an offset in the level. It is thought that this might be due to the way the windows or internal walls are modelled.

Project impacts

This work will contribute to better underpinning of wireless propagation models that support the planning and reliability of smart devices in homes and buildings. It will enable consideration in greater detail of house type, age and upgrades –particularly improvements to thermal performance which can impact wireless signal propagation by using of aluminium layers. This will in turn support better performance and user-experience of smart technologies in a range of areas, including energy, wellbeing, security and productivity.



This work resulted in a paper that has been submitted to the International Telecommunications Union (ITU) working group on building entry loss, which will help further refine wireless propagation models for homes.
The longer term impact of this project is likely to be reflected in future industry measurement campaigns, including those by Ofcom, which will identify at scale the accuracy of improved models.

Extending BRE's capabilities

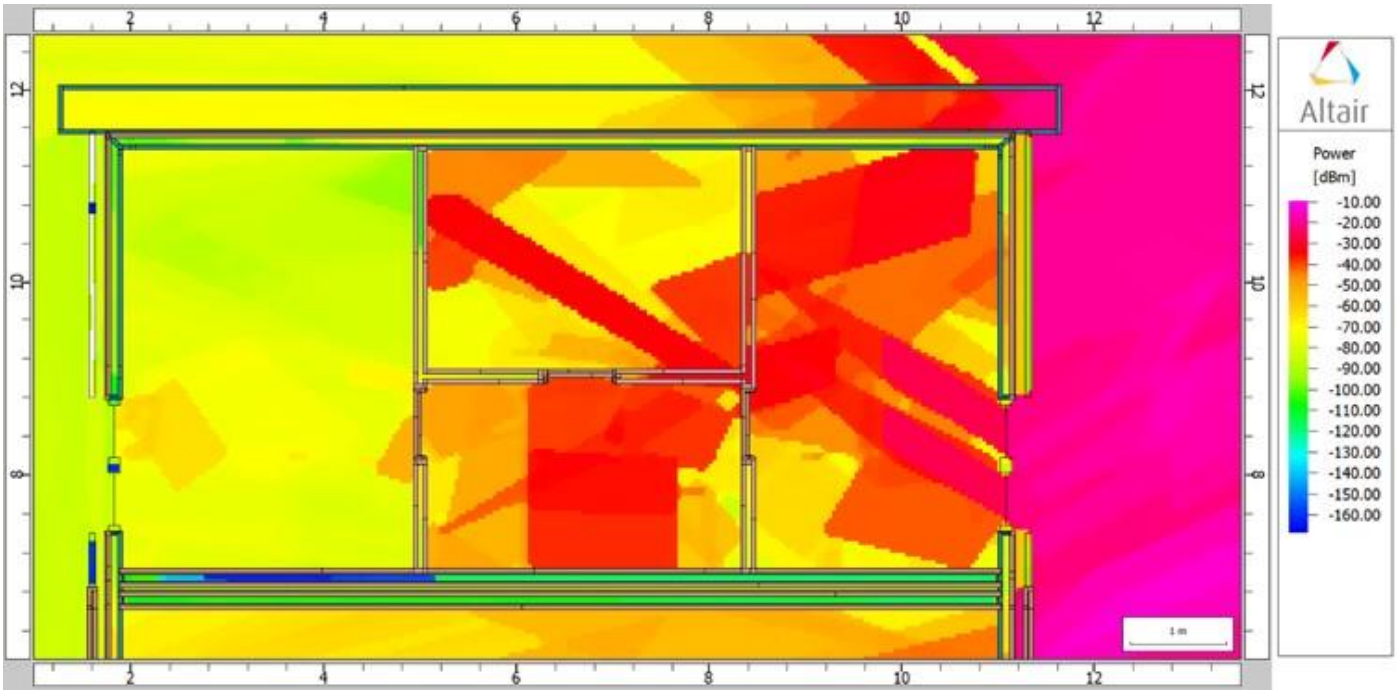
This project has built on previous work undertaken by BRE, including a significant report for Ofcom in 2014, "Building Materials and Propagation", (www.ofcom.org.uk/__data/assets/pdf_file/0016/84022/building_materials_and_propagation.pdf), and performing radiocommunications measurements on the BRE Innovation Park for Ofcom, Telefonica, BT, EE, BBC, Qualcomm and Arqiva. This project performed the work in greater depth and introduced modelling techniques which has expanded BRE's capabilities and supports our exposure in smart homes and buildings.

Next steps

The project made recommendations for further work, for which the team will aim to develop research proposals and seek industry funding, including:

- In-situ measuring of the double-glazing in different housing types.
- Sampling rooms more densely at millimetre-wave frequencies.
- Measuring losses through double-glazing in the BRE anechoic chamber, while discussing existing measurement data with Surrey University and others.
- Modelling building types using ray tracing.
- Investigating options for additional measurements at 60 GHz.
- Investigating the impact of roof structures.
- Investigating a wider range of model parameters and sensitivity of results to these parameters.

The project team are exploring ways in which this work could support the work of the Construction Innovation Hub, and how the exposure from the Hub might present other opportunities.



Wireless propagation modelling using Ray Tracing

The causes of fire fatalities and serious fire injuries in Scotland and potential solutions to reduce them

BRE Trust support: £28.5k Trust, Partner support: £37.5k cash contribution, £55k in-kind

Phase 1: IRS review

The first phase of a comprehensive investigation into the underlying conditions associated with fire deaths and serious fire injuries in domestic dwellings in Scotland, for the period from April 2013 to March 2017, has been completed.

By reviewing 38 issues detailed in the Incident Recording System (which is used by fire and rescue services to record incidents attended), key factors and common conditions were identified under which fatalities and serious injuries occur. This enabled a profile of a person involved in a typical fire fatality or serious injury to be formed, and the associated demographic profile and common background conditions to be identified.

Factors such as living alone, being vulnerable or elderly, falling asleep or being asleep, having medical conditions, illnesses or temporary lack of physical mobility, or not hearing the alarm all contribute.

Scottish Fire and Rescue Service engaging with the community to identify fires safety risks and measure to reduce them. (Photo courtesy of Scottish Fire and Rescue Service.)

Recommendations

Fourteen recommendations have been made to address the highlighted fire safety issues, and concerns that current technologies and approaches may not provide sufficient protection for vulnerable people. The recommendations are targeted at further developing existing technologies to safeguard vulnerable people, and generally reducing fire-related fatalities and serious injuries in the future. They include:

- providing additional warnings from smoke alarms,
- increasing the use of combined detection and suppression water mist systems'
- developing video analytic techniques,
- reviewing fires from electrical items and proposing ways to reduce their occurrence,
- making the greater use of the most appropriate means of fire in domestic dwellings.

Next phase

The next phase of this research work will focus further on specific details from fire investigation reports for each of the 126 domestic fire fatalities occurring in the review period. In order to assess the proposed recommendations, the potential effectiveness of each of them will be considered during the review of the fire investigation reports.

A report on the first phase gives details on the first of a comprehensive investigation into the underlying conditions associated with fire deaths and serious fire injuries in domestic dwellings in Scotland, for the period from April 2013 to March 2017.

The report is available at:
www.bregroup.com/expertise/fire/fire-safety-research

Health effects of indoor air quality on children and young people

BRE Trust support £8k, Partner cash and in-kind contribution £11k

The growing evidence that respiratory problems in children can be made worse by indoor air pollution in homes, schools and nurseries, has highlighted a pressing need to improve indoor air quality (IAQ).

This is according to a report from the Royal College of Paediatrics and Child Health and the Royal College of Physicians, based on an extensive review of indoor pollution research, evidence from a wide range of practitioners and experts, and conversations with children, young people and families. It presents evidence linking indoor air pollution to childhood health problems such as asthma, wheezing, conjunctivitis, dermatitis and eczema.

Wide-ranging contributory factors detailed in the report include the materials used to construct and decorate buildings, which can be long term sources of VOCs and formaldehyde, and the design and refurbishment of buildings to be more airtight. Airtight construction can improve energy efficiency but should incorporate sufficient ventilation to prevent the build-up of pollutants.

Respiratory problems in children can be made worse by indoor air pollution in homes, schools and nurseries.

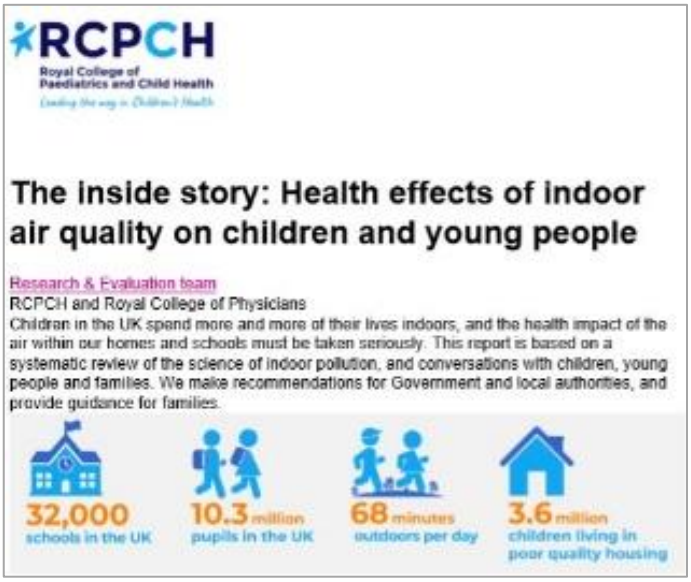
A group of experts reviewed the evidence and formulated recommendations for action by government and local authorities, and guidance for families.

"I was very happy for the BRE IAQ team to participate (with support from the BRE Trust) in this crucial and timely report, which benefitted from the contributions of a wide range of stakeholders," says Dr Andy Dengel, Director, BRE Environment.

"The importance of good indoor air quality for health and wellbeing is now increasingly being recognised, and in children and young people the effects of poor IAQ can be more marked due to respiratory and other bodily systems still being in development. Now, as called for in the report, it is time for urgent action by many parties."

Those parties include people designing, constructing, maintaining and repairing buildings, who the report says (among many recommendations) should be helped to avoid the use of harmful chemicals and pollutants with the support of clear labelling and a national system for control. Professional bodies for design and construction should provide or accredit training about indoor air quality, providing high standards for ventilation, energy efficiency, and reduction in exposure to allergens and pollutants.

The full report is freely available from the RCPCH website: www.rcpch.ac.uk/resources/inside-story-health-effects-indoor-air-quality-children-young-people#downloadBox



Creating Positive Spaces by Measuring the Impact of your Design

The issue

With staff costs in office-based businesses typically accounting for 90% of a company's costs, any improvements in employee health or productivity can have important financial implications. There is now strong evidence for the built environment's impact on staff health, wellbeing and work performance, and a growing focus on health and wellbeing in business and construction.

However, most organisations do not carry out workplace performance reviews, and many designers and developers don't gather feedback on their buildings – so they are unaware of the building-related issues impacting their staff and their business, or how to address them through office design.

Pre-and post-occupancy evaluation

Pre-and post-occupancy evaluation (POE) is a tried and tested means of demonstrating how well buildings, or completed new build and refurbishment projects, are performing in use. POE also highlights any gaps in communication and understanding amongst building managers and occupants that my hinder a building's operational performance.

The project

Two of BRE's partners in the Biophilic Office project, Interface and Oliver Heath Design are working on a series of guides on human-centred design, aimed at designers, decision makers, end users and influencers in the built environment.

One of these has been the focus of a BRE Trust supported project to develop a guide on ***Creating Positive Spaces by Measuring the Impact of your Design,*** for which BRE has provided the technical content.

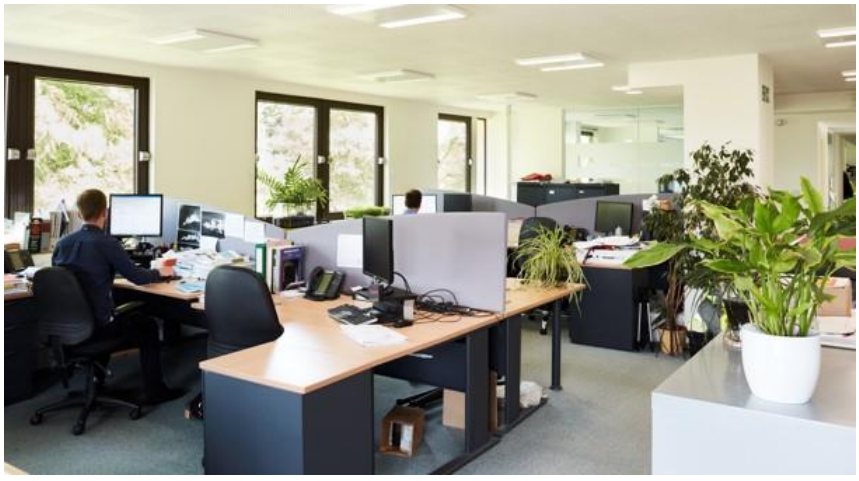
A practitioner's guide

The new publication is a practitioner's guide on how to measure the value of good design via pre-and post-occupancy evaluation – inspiring architects, designers and end-users to design spaces with people in mind. It covers issues such as:

- what a pre- and post-occupancy evaluation is,
- how POE can benefit project teams, clients and building occupants,
- what a POE process looks like,
- how to get started or go all in with POE.

The guide also includes a number of case studies to illustrate how wide-ranging POE approaches and processes can be, including one of BRE's own workplaces.

Creating Positive Spaces by Measuring the Impact of Your Design is available as a free download via www.bregroup.com/services/advisory/builldings-in-use/post-occupancy-evaluation



There is now strong evidence for the built environment's impact on staff health, wellbeing and work performance.

New Project

Improving informal settlements in Myanmar

Communities across northern Myanmar have been devastated by a decades-long conflict between the Kachin Independence Army (KIA) and the government of Myanmar.

Since the country gained its independence from the British in 1948, the Kachin people – an umbrella term used for the confederation of six ethnic groups who live in the Kachin state—have sought equality and autonomy in the Kachin state. Following the most recent large-scale outbreak of violence in 2011, around 100,000 people were internally displaced and residing in poorly-equipped camps. At the end of 2018, and at the behest of many of the internally displaced persons, the Myanmar Government announced that it would be closing the camps and relocating displaced populations in predetermined locations across Kachin and Northern Shan.

Karuna Mission Social Solidarity (KMSS), a faith-based social network that has been a major humanitarian responder to the conflict, will lead the process of supporting the displaced populations as they move into new neighbourhoods and build their own homes.

Catholic Relief Services (CRS), the US-arm of the CARITAS movement and one of the world's leading international humanitarian organisations, is looking to support KMSS by building their technical capacity to respond to the needs of the uprooted families and communities in Kachin and Northern Shan.

The BRE Trust is supporting this capacity-building programme through the implementation of QSAND as a monitoring and evaluation framework for the project. QSAND will support the assessment of the sustainability and social inclusivity of the intervention.

Jamie Richardson, Shelter and Settlements Technical Advisor for Catholic Relief Services, spoke about this project at the BRE Annual Conference – see page 7 – and further information is at:
www.bretrust.org.uk/knowledgehub/resilience/qsand-application-in-myanmar

Photo Credit: CRS

University Partners

Coventry University

New PhD – Clay in low-carbon cements

Kwabena Boakye has been awarded a PhD studentship – supported by the BRE Trust in partnership with Coventry University – on calcined clays as a reactive alternative to fly ash as a binder in Portland cement concrete.

Kwabena is a Principal Technical Officer in the Materials Division of the *Building and Road Research Institute*, part of the Council for Scientific and Industrial Research of *Ghana.*

The project will examine the availability, mineralogy and chemistry of UK clays, their properties and potential use in cement to produce mortars and concretes. It will consider the sustainability, role in carbon footprint reduction and performance in service environments of such materials.

Kwabena Boakye has been awarded a BRE Trust supported PhD at Coventry University.

University of Hertfordshire

New BRE Trust lecturer

Gabriel Barros do Santos has been appointed to the role of BRE Trust Senior Lecturer in Civil and Structural Engineering at the University of Hertfordshire.

The Trust is supporting the University in its delivery of new BSc and MSc civil engineering courses for a three-year period.

The BRE Trust Lecturer will extend the University's capacity in teaching and student research in civil engineering, to ensure that graduating BSc and MSc civil engineering students have the current and relevant knowledge and skills needed to meet industry's needs.

The Trust is providing funding of £30,000 a year for three years.

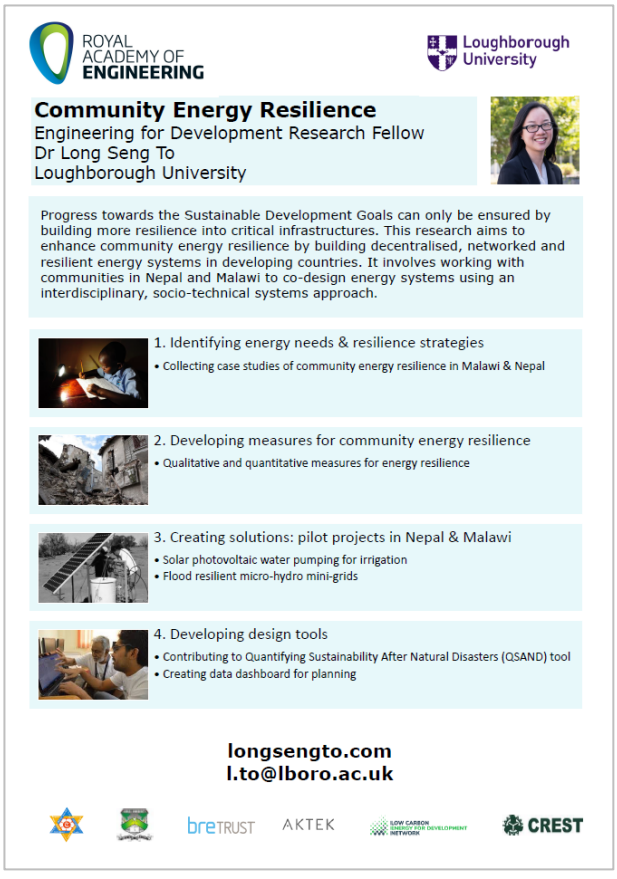
University of Loughborough

Loughborough RAEng Fellowship - Enhancing community energy resilience

The BRE Trust is supporting Dr Long Seng To's Royal Academy of Engineering research fellowship at Loughborough University. Dr To's project, titled 'Enhancing community energy resilience using renewable energy in developing countries', is focused on finding ways of providing affordable, reliable, and sustainable energy for rural communities. The proposal for this project was backed by BRE and, since BRE Trust support was awarded to Dr To, the Trust has aided the fellowship by participating in development workshops and connecting Dr To with other partners to help grow her network.

Linked to QSAND goals

The aim of this research is closely linked to the goals of the QSAND framework, which also has a focus on using local resources and expertise to develop resilience and sustainability in at-risk communities. This research will hopefully provide valuable insight into ways of further developing the energy component of QSAND, in order to support local innovation in creating sustainable energy solutions.



Meanwhile, QSAND will help to frame the fellowship research in a more holistic manner by assessing energy issues within the wider shelter and settlement context.

QSAND will therefore be applied by project partners in Nepal and Malawi to support the assessment of community energy resilience in the areas identified for research. This research will be led by in-country partners, namely Mzuzu University in Malawi and Tribhuvan University in Nepal. The BRE Trust and Dr To will support this activity and include other stakeholders from the humanitarian and academic spheres, to produce detailed case studies that can inform the development of community energy resilience globally.

You can hear more about the project through Dr To's Fellowship Inaugural Lecture, available to view at: https://lboro.cloud.panopto.eu/Panopto/Pages/Viewer.aspx?id=0cd72caa-c789-46b3-92d2-aaef0076a1a4.

QSAND

Alistair Wilson – Blockchain Technology

In response to the growing interest in being able to reliably track and trace construction products through complex supply chains, Alistair Wilson is Investigating the potential of distributed ledger technologies (DLT) – which include blockchain technology – to improve traceability assurance.

The project is exploring the theory of traceability, examining current practice and assessing the potential of DLT for product traceability. It will identify requirements, challenges and enablers for using DLT to improve traceability in construction, and develop and validate an assurance framework.

In his report on this quarter's progress Alistair says, "The first study (on the theory and current practice of traceability) is now planned – this is to enrich and validate an information lifecycle model for a generic construction product, which forms the basis of the exploration of traceability incentives and applications in construction supply chains".

Alistair visited BRE in November 2019 to give a presentation – attended by 70 BRE staff – on the issue of product traceability and his work in this area, entitled *Traceability in Trouble. Can blockchain give us breakthrough*? An abstract to present paper at ARCOM conference in March (Northumbria) has been accepted.

Daniel Franks – Energy Demand

Daniel Franks' project, *Building energy and environment: measurement, data, analysis and interpretation*, is using occupant and building data to categorise energy use at home.

In England and many other Western countries a quarter of energy is used in homes, primarily for maintaining comfortable indoor conditions. The last 30 years' research and policy efforts have mainly focused on more energy-efficient buildings and technologies, but energy consumption for space heating is determined, not only by this, but also by the way inhabitants use energy.

This project is investigating how different social and dwelling groups regulate indoor climate on a national scale, primarily by examining data on the internal temperatures of 1500 English homes.

The research in this quarter has mainly focused on exploring underheating in homes in an way analogous to that used to study summertime overheating. Daniel discussed his project at the BRE Trust Conference on 25 February.

Alistair Wilson at BRE, presenting on the potential for DLT in the traceability of construction products.

Loughborough University

University of Edinburgh

BRE Centre for Fire Safety Engineering

Professor Grunde Jomaas, BRE Chair of Fire Safety Engineering reports that, "The ongoing projects are running well, and some new funding applications are being worked on. Many members are involved in international projects and we therefore have many visitors to the centre. Various members remain active in committee and standardisation work related to Grenfell Tower, cladding materials, British Standards updates (e.g. BS 8414 and BS 9414) and MHCLG".

Ricky Carvel (see photo) and Farian Wu received the 'Best Poster' (Fire Magazine Research Excellence) Award at the RE19 Conference in Birmingham on 13 November. In the next quarter Professor Jomas will give an invited talk in Kanpur, India.

Ricky Carvel receiving the Best Poster Award at the RE19 Conference.

Dr Angus Law, BRE Lecturer in Fire Safety Engineering, chaired a workshop on the implications of the building safety programme for planning. He delivered a three-day CPD programme on structural fire safety to Trenton Fire, and also the Structural Design for Fire Class as part of the Edinburgh Undergraduate and MSc offerings.
Angus secured funding from the Institution of Infrastructure and the Environment (UoE) for a joint project on the non-destructive monitoring of structural behaviour during fire using vibration analysis.

He supervises the BRE Trust supported PhD student, Vasilis Koutsomarkos, with whom he visited BRE to present the PhD project's progress.

Angus' planned activities include completing the first journal paper to result from the BRE indexing project, which will be submitted to the Fire Safety Journal. He will deliver a talk on testing at the LABC conference in Northern Ireland, and an evening seminar on CLT at the IStructE Scotland branch in Glasgow.

PhD project Updates

Vasileios Koutsomarkos – Fire robustness index

This project is developing a fire robustness index for assessing a building's ability to withstand a fire event. It will provide a science-focused and data-reinforced approach that effectively contributes to risk-informed decision making and cost-efficient design solutions. In this quarter Vasilis concluded his literature review and is now in the final stages of writing a journal paper on indexing methods.
In the next quarter he will outline the methodology's structure, meet and interview professionals and academics who were part of development teams for the most notable assessment methodologies, and submit a poster abstract for IAFSS 2020.

Arjan Dexters – Maximising information from fire tests with machine learning techniques

Current fire testing procedures to demonstrate the compliance of construction materials with regulations are benchmarked against a specific hazard scenario – so any actual fire exposure will inevitably differ from the test situation (duration, maximum temperature, etc.). This project (supervised by Professor Jomass) is developing a machine learning algorithm to predict large-scale test results based on parameters obtained from bench-scale tests.
This quarter Ajan has worked on the machine learning algorithm to predict the Euroclass of a material, and with the MatLab code of ConeTools. Plans for the next quarter include, submitting a paper on ConeTools and machine learning for special issue in Fire Technology: "Smart Systems in Fire Engineering". Arjan presented a poster at the BRE Trust research conference on 25 February.

THE UNIVERSITY of EDINBURGH

Completed PhD project report

Improving fire safety design with coupled hybrid modelling

A new computer model can provide added insights into fire risks in complex buildings, and help engineers to develop robust fire safety designs. This coupled hybrid modelling has been investigated by Benjamin Ralph as part of a BRE Trust supported PhD studentship at the University of Edinburgh.

Fire engineers commonly use computational fluid dynamics (CFD)-based fire modelling to develop and test the designs of complex buildings. However, as these models are very complicated and this type of simulation takes an impractically long time to run, engineers typically reduce the size of the model to shorten the time needed.

The problem is that a simplified model may not be able to account for the entire building. That means that the ways in which fire and smoke might spread throughout the whole building cannot be fully determined, nor can the effect on the growth and spread of fire and smoke of parts of the building far from the fire. This can put limits on the ability of engineers to develop robust fire safety solutions.

One way of addressing this limitation is the use of 'coupled hybrid modelling'. This combines the originally used model (which takes a long time to run) and another model (which takes a much shorter time) together. Fire engineers can thereby increase the model size to include more or all of a building, but still carry out a simulation in a reasonable length of time.

New model and experimental test rig

A literature review of existing coupled hybrid models identified a lack of collaborative working and the use of proprietary software. Therefore, a coupled hybrid model has been developed, based on the open-source and widely used fire model, Fire Dynamics Simulator (FDS).

A new computer model must be compared with real experiments to confirm that it can represent the real world within reasonable limits. Applicable experimental data were not found during an extensive literature search and discussions with applicable bodies. Therefore, to provide these data, a new experimental rig was specifically designed and built.

Ventilation issue revealed

Data from the new rig were first used to examine potential holes in the current typical fire safety design model for complex buildings. This analysis showed that there are phenomena related to the two-way coupling of a fire and a shared ventilation system, which may not be captured by commonly used simple engineering methods – or addressed in current design guidance documents.

The new experimental data was then compared with the predictions of the coupled hybrid computer model, and the qualitative and quantitative differences highlighted. The computer model was found to predict fire hazards within the experimental set-up effectively, providing key information needed by future model users to ensure that their analysis is robust.

The original insights into how a total building system and a fire interacts, and the newly developed coupled hybrid model, can be used together by fire engineers. This will help them to deliver design solutions with more deeply understood fire life safety risks for complex buildings that incorporate mechanical ventilation systems.

"The overall experience and opportunity has been priceless and I have learnt so much. I now aim to continue expanding my knowledge and learning new skills to help society become safer and more sustainable."

Ben Ralph

Programme Dissemination

Sales and Downloads

BRE Bookshop

Retail sales, including those through Amazon and Taylor and Francis International, totalled 564 units for the quarter October to December 2019.

Bestsellers in this quarter include: DG365 Soakaway design with 31 sales, BR187 External fire spread: building separation and boundary distances (BR 187 2nd edition) 18 sales, Radon featured publication, 21 sales and BR209 Site layout planning for daylight and sunlight: a guide to good practice, 23 sales.

Construction Information Service (CIS)

Analysis of the Top 20 CIS downloads reveal that CIS users value:

- BRE guidance on ground engineering and related subjects with 6 titles in the Top 20 downloads
- the Expert Collections for their convenient format with 5 collections in the Top 20
- guidance on damp-related subjects with 2 titles in the Top 20.

CIS downloads during October-December 2019 totalled 29,981.

Designing Buildings Wiki

By the end of this quarter there were 9000 articles on Designing Buildings Wiki, and the site was visited by 2,097,032 unique users.

Designing Buildings Wiki received 5,419,152 page views, a 2% increase compared to the same quarter in the previous year. The BRE Trust logo appears on every page of the site and so was viewed 5,419,152 times.

BRE articles

By the end of the quarter, there were 455 BRE articles on Designing Buildings Wiki. These can be seen at:
www.designingbuildings.co.uk/wiki/BRE_articles_on_Designing_Buildings_Wiki

www.designingbuildings.co.uk/wiki/BRE_Buzz_articles_on_Designing_Buildings_Wiki

This content was viewed 37,192 times during the quarter.
The top 5 BRE articles were:

- BREEAM (3,089 page views)
- BRE Digest 365 Soakaway design (1,423 page views)
- Electricity supply (1,212 page views)
- The daylight factor (1,144 page views)
- Fire performance of external thermal insulation for walls of multistorey buildings, third edition (BR 135) (1,094 page views)

BREEAM Wiki

There are now 301 articles on BREEAM Wiki.
These can be seen at:
https://www.designingbuildings.co.uk/wiki/Category:BREEAM.
This content was viewed 28,428 times during the quarter (there may be some overlap between these and page views of BRE articles).

New BRE Trust articles

New articles prepared by the BRE Trust Secretariat and accepted on Designing Buildings Wiki include:

Circadian Lighting – project designed to turn theories on the benefits of circadian lighting into practical guidance for building designers, managers and owners.

Energy efficiency retrofit – series of training videos on effectively retrofitting energy efficiency measures to buildings.

Assessing dementia adaptation measures – project to develop a method of assessing the impact of measures taken to adapt homes for those experiencing dementia.

Improving fire safety design with coupled hybrid modelling – a PhD project to develop a computer model that can provide added insights into fire risks in complex buildings, and help engineers to develop robust fire safety designs (see page 28).

Health effects of indoor air quality on children and young people – report from the Royal College of Paediatrics and Child Health and the Royal College of Physicians (see page 21).

Flood Resilience Repair Demonstration House.

Property flood resilience Code of Practice

A Roundtable of private and public sector members was set up by government following the flood damage caused by storms in 2015/16, to deliver the Property Flood Resilience Action Plan of recommendations and action to make the UK more flood resilient. This included the need to demonstrate what good flood resilience practice actually looks like.

With the support of the BRE Trust and several partner organisations, the Flood Resilient Repair Demonstration House was successfully created on BRE's Watford site. The experience gained during the design and implementation of the house helped BRE to become an important source of good practice expertise in the field of property flood resilience. This has fed into other projects including the development of the CIRIA Code of Practice (CoP) for Property Flood Resilience, for which BRE was appointed as authoring team lead.

Published in December 2019, the CoP is concerned with property flood resilience measures that can be introduced to buildings at risk from flooding. They can be installed as part of the repair of buildings after they have been flooded, and can also be fitted in anticipation of a flood by property owners wishing to be proactive. The CoP, which includes six standards that specify what should be achieved, is available at:
www.ciria.org/ItemDetail?iProductCode=C790F&Category=FREEPUBS

Make Design Matter – first year report

The BRE Trust provided £10k to this £50k project.

David Murray, the Managing Director of humanitarian architecture charity Article 25, has reported on the first year of the Make Design Matter series of monthly talks, which have brought together outstanding design professionals who work to support the most vulnerable in society across the developing world.

"We have now hosted twelve talks," said David in a letter to Deborah Pullen. "As we intended to raise the profile of humanitarian design, we proactively sought the support of architects, engineers and others, to host each talk. That way, we were in a position to showcase the work of that host – as well as build relationships amongst designers, engineers and the general public – whilst sharing valuable insight on each completed design & build project.

"Building a network of humanitarian design and construction professionals, we hosted talks at HKS AKT II, SecondHome, Hoare Lea, The Building Centre, Allies & Morrison, Jestico & Whiles, Weston Williamson, AHMM, and John McAslan + Partners.

Our speakers have been:

Dan Flower, Design Director at HKS, on *Creating a passive designed maternity unit in Uganda*,

Jateen Lad on the *Centre for Rural Development in India*,

Laura Katharina Straehle & Ellen Rouwendaal on *Pavilions for Okana, Kenya*,

Kelly Doran at MASS Design Group on Healthcare projects in Africa,

Matthew Cox and Max Kettenacker from Allies + Morrison on *A Microloan Training Centre in Africa*,

James Mitchell from Orkid Studios on *Social housing, healthcare and women in construction, Kenya*,

Andrea Panizzo of EVA on *Public spaces in Haiti*,

Bea Sennewald of Article 25 on *The Bethel School in Gourcy, Burkina Faso*.

Building a large, diverse audience

"With bookings open for 'general sale' via Eventbrite, we know that our audiences are an eclectic mix of architects, engineers, students, built environment professionals and the general public. Each talk has been attended by between 100 and 200 guests, and the total audience size reached face-to-face has been over 800 to date.

"75% of our Facebook audience is aged 25-44, and 55% of the total audience are women. Our Top Tweet on #MakeDesignMatter earned 6,744 impressions. We also created video content of each talk and posted this online to maximise digital dissemination.

"Thank you so much to all at the BRE Trust for your continued support to our charity and this important profile-raising, dissemination and promotion effort in the UK. It is really helping to showcase the important work and impact that human-centred design and construction is having on communities across the world. Thank you also for your commitment of £15,000 of future funding for a second year of talks."

Highlights from the 2019 talks can be viewed at www.article-25.org/videos

VR health and safety training – new video

Work to develop a virtual-reality tool that will deliver training designed to improve health and safety in the construction industry has been presented in a video.

This project has been conducted by Dr Zulfikar Adamu of Southbank University, with funding from the Royal Charter International Research Award 2018, of which Dr Adamu was a co-winner. The Awards is supported by the BRE Trust and the Worshipful Company of Constructors.

The research at Southbank University is developing a virtual-reality tool to deliver training that is designed to improve health and safety in the construction industry. It includes a psychometric test to assess key personality traits for each trainee, the outcomes of which are used to customise the virtual-reality experience so that the training benefits are enhanced.

The trainee then becomes a 'player' in a virtual-reality, health and safety training 'game', which is set in a construction workplace with a range of hazards (such as, falling equipment, fire and working at heights), adapted to the player's particular personality and needs.

Other variables include the weather, such as rain, wind, snow and lightning, set to varying strengths, and inventory such as equipment and tools – so the player's ability to, for example, work safely on scaffolding on a windy day can be tested and lessons learned. The impacts of health issues such as dust and vibration, and the player's ability to appropriately deal with these, can also be included.

The next steps are to finalise the desk top application for use on laptops, etc, and then to enable it to be played at home on smart TVs – bringing construction into the home in a way that could potentially help to attract new talent to the industry. The final step will be to make a web accessible version of the game so it can be streamed live.

The video is available to view at: www.bretrust.org.uk/knowledgehub/wellbeing/wcc-research-award-2018

Building blocks for more affordable and sustainable homes – vlog update

Alastair Marsh of the University of Leeds – the winner of the BRE Trust sponsored 2018 Royal Charter International Research Award for Young Constructors – has completed his first vlog on the project's progress.

Alastair is collaborating with an NGO, HYT Uganda on a project to using waste material produced after harvesting rice – rice husk ash – as a supplementary cementitious material. The aim is to reduce the financial and environmental costs of manufacturing building blocks for constructing homes.

He has initially been focussed on the administrative, logistic and financial aspects of the project, including the preparations for a field visit to Uganda this April. Arrangements have been made for a research assistant in Uganda and a summer student in Leeds. Alastair has been discussing the appropriate 'recipe' for the building blocks with HYT Uganda, and conducting laboratory tests on rice husk ash to investigate its physical, chemical and reactive properties.

The vlog can be viewed on the BRE Trust Knowledge Hub at: www.bretrust.org.uk/knowledgehub/2020/01/23/dr-alastair-marshs-blog/

Further monthly video updates (and fortnightly during work in Uganda) will follow.

Appendix A: Project Status

Wellbeing

- 100 Years of Council Housing. **Trust Contribution** - £8.9k. **Other Contribution** - £8.25k. **Status** – In Progress
- Contribution to the “Guide to creating Positive spaces using pre and Post Occupancy Evaluation”. **Trust Contribution** - £7.7k. **Other Contribution** - £15k. **Status** – Complete
- Optimum replacement of detectors. **Trust Contribution** - £30k**. Other Contribution** - £37.5k. **Status** – In Progress
- UK Housing in 2017. **Trust Contribution** - £8k. **Other Contribution** - £11k. **Status** – Complete
- The use of innovative solutions and digital technologies to increase safety and wellbeing of people and protect them from the dangers of fire. **Trust Contribution** - £12.5k. **Other Contribution** - £72.5k. **Status** – In Progress
- The degradation in performance of heat alarms located in domestic kitchens**. Trust Contribution** - £30k. **Other Contribution** - £40k. **Status** – Approved

Sustainability

- Redevco real estate asset performance. **Trust Contribution** – 80k. **Status –** In Progress

Resilience

- Redevco QSAND bringing sustainability to post disaster relief. **Trust Contribution –** 100k. **Status –** In Progress
- 3 Resilience - Tackling overheating in urban dwellings. **Trust Contribution** - £40k. **Status** – Cancelled
- Centre for Smart Homes. **Trust Contribution** - £53.6k. **Other Contribution** - £81k. **Status** – Complete

Appendix B: Current Studentships

Low cost approach for characterization of Residential Building stock for energy labelling, *Ioanna Vrachimi, University of Strathclyde*
Blockchains for traceability assurance, *A*listair Wilson, Loughborough University
Next generation natural fibre reinforced geopolymers, *James Bradford, University of Bath*
Optimising phase change material use for energy- efficient buildings, *Ahmad Wadee, University of Bath*
Developing a Fire Resilience Assessment Methodology for the Built Environment, *Vasileios Koutsomarkos, University of Edinburgh*
Testing for knowledge: maximizing information obtained from fire test, using machine learning techniques, *Arjan Dexters, University of Edinburgh*
Self-healing concrete, *Lorena Skevi, University of Bath*
Building energy and environment: measurement, data, analysis and interpretation, *Daniel Franks, Loughborough University*

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