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Developments in residential flooring

Understanding the implications

Technical case study

By Sean Downey (B.A, B.A.I.)

PRODUCT CERTIFICATION AUDIT & INSPECTION TEST SERVICES

Product Approval and Certification

Quality and safety first are the ground rules

As the population expands with a significant impact on developments within the construction industry, flooring manufacturers are also looking at ways to expand and develop more products and technologies that meet the increasing demands being made of the marketplace for greater efficiency and adherence to environmental guidelines.
In particular, increasingly more stringent guidelines which have come into effect with regard to thermal efficiency is making the flooring system selection process more complex.
As a result, making the right decisions when selecting building products for all kinds of construction projects is even more essential. However, as with all developing technology an unfortunate caveat still exists; the influx of new products and differing systems which can make it difficult to specify the right products for each individual site. This complexity presents enormous challenges, not only to the majority who want to choose the best possible recommended solutions but also to those who need to oversee the procurement processes to ensure compliance and safety.

> "The influx of new products and differing systems which can create a smokescreen for people who want to cut corners or finish a job quickly without due diligence."

From traditional flooring to thermally efficient flooring

The choice of floor construction depends on the type of foundations and superstructure, ground conditions and, increasingly, the requirements for thermal efficiency.
Soil type, quality and the contractor's preferences on construction programming will often dictate the primary decision over a ground-bearing floor slab or suspended construction, however each party to the floor construction will have their own priorities. These other priorities include cost, speed of installation, thermal resistance, quality, availability of materials and labour, all of which will dictate the choice of construction method.

Traditionally floor constructions consisted of either a ground-bearing or suspended concrete slab, or a suspended timber floor bearing on masonry, which offered easy construction techniques and adaptability - especially on difficult ground.

Floor installation in progress

However, increased Part L requirements for energy efficiency and the prevalence of off-site construction has swung the market towards precast concrete products – either beam and block or precast floor elements. Both have distinct advantages: beams and blocks are readily available as stock items from suppliers and can be installed with minimal plant requirements, whilst precast elements can be rapidly installed and provide an immediate working platform for follow-on trades.

A case for thermal performance developments in the flooring industry

Until fairly recently, the division of duties was split clearly between structural and insulator components. The primary structural performance of the floor was provided by precast or cast-in situ concrete or suspended timber and the insulation added to meet the requirements for U-values identified in the Building Regulations. Increasing thermal performance requirements and a drive for construction efficiency created an opportunity to redesign the floor systems to meet more exacting standards and, with a push for reduced environmental profiles, recruit the insulation into a dual-purpose role. This meant pushing insulation into scenarios where it had not previously been used and broadening the envelope of performance criteria for insulation materials.

No longer must they simply offer low thermal conductivity, they are now required to retain that thermal performance whilst being sufficiently robust and stiff enough to contribute to the performance of the structure; resist concentrated loads, uneven

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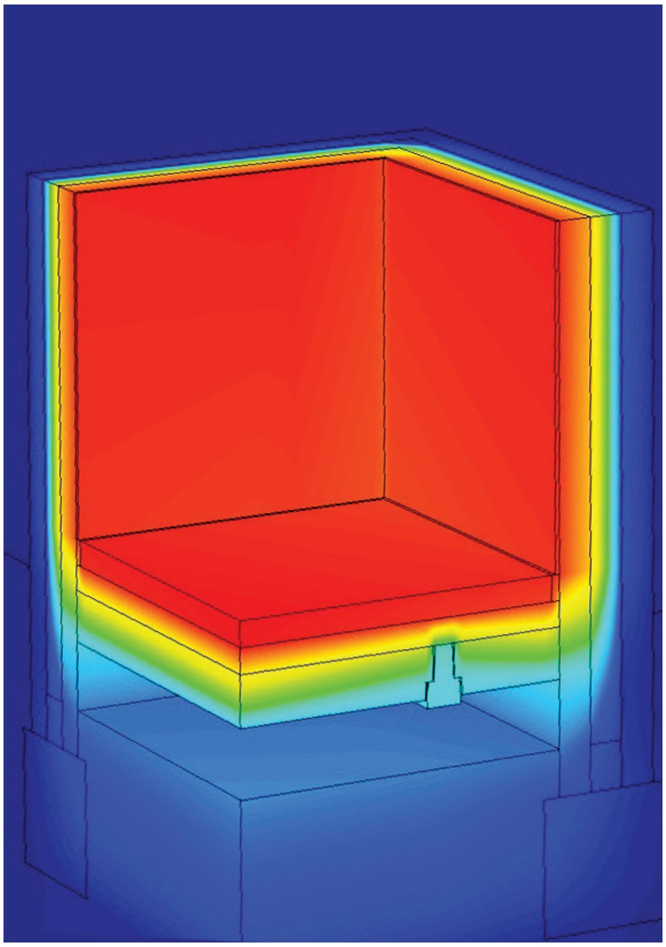


Wall/floor junction

stress distributions, creep, short and long-term deflections - and do so at a price point that is attractive to specifiers.

Beam and poly systems

The most common form of structural insulated floor is now the “beam and poly block”, consisting of pre-stressed concrete beams, expanded or extruded polystyrene (EPS or XPS) infill system and a concrete topping. In many cases, the EPS or XPS will be load-bearing, transferring imposed loads from the concrete topping to the supporting beams.

The mechanism through which the loads are transferred vary from system to system but, in most cases, the stiffness of the concrete beams and toppings relative to that of the insulation mean that recruitment of the flexural and shear strength of insulation is not readily achieved and the insulation acts in direct compression in the region of the beam header. This gives rise to significant concentrated stresses to be resisted.

As both EPS and XPS exhibit visco-elastic behaviour under constant stress, the deflections due to creep must be accounted for and the serviceability of the floor is further complicated by the need to preserve both the micro properties and thickness of the insulation needed to fulfil its thermal function. This is where the engineering trade-off is made between low-density, lower-cost and low-thermal conductivity materials and stiffer, less efficient dense grades of insulation, with a floor system often being optimised with a range of materials which puts the stiffer materials in the highly-stressed areas but minimises the thermal bridging effect. Insulation materials applied in this manner require rigorous testing and analysis before the required serviceability and durability can be ascertained.

For beam and block floors, the most obvious example of this conflict between thermal and structural performance can be found at the floor edges. To achieve the lowest linear thermal transmittance (Ψ) value at the wall-floor junction, it is preferable to place the first floor beam as far as possible away from the wall. However, doing this creates a cantilevered section of insulation and concrete topping.

The concrete typically has a limited depth of no more than 75mm and minimal or no reinforcement to resist the imposed stresses. Such a thin concrete element is also less tolerant to poor construction practice and needs careful pre and post-pour attention to avoid problems with shrinkage, bleeding and thermal stresses, especially on exposed sites or during warm or windy weather. Nonetheless, when designed and executed correctly, this can provide a satisfactory floor solution with excellent thermal performance.

With the increasing complexity of proprietary thermal-structural floor systems and ever-leaner construction techniques comes an increase in the value of certification, as builders, home-owners and warranty providers need well-founded confidence that all of the system components work together and can be designed into a satisfactory floor.

The case for fibre reinforced concrete

One aspect which has been of significant concern in the industry in recent years is the replacement of traditional steel reinforcing mesh in the concrete toppings with steel or polymer fibres, which can offer time and material saving to the builder. Design of fibre reinforced concrete is not covered by current Eurocode standards, so achieving acceptance of such systems by warranty providers and building control professionals has been a difficult task for floor system providers.

These suppliers, in conjunction with the British Board of Agrément (BBA), fibre suppliers and insurance companies have conducted, over several years, a multitude of full and small-scale load tests to develop, prove and refine their offerings. Certification is granted only to those systems which have been adjudged to comprise components which together satisfactorily perform as a system and are manufactured under the strictest quality controls to ensure constancy of performance.

The absence of definitive design standards for structural insulation materials in floors and the complex interaction between the insulation and concrete components increases the risk of failure due to product substitution, i.e. the use of materials other than those approved as part of a certified system. As noted in the Hackitt report*, such practice should be avoided at all costs.

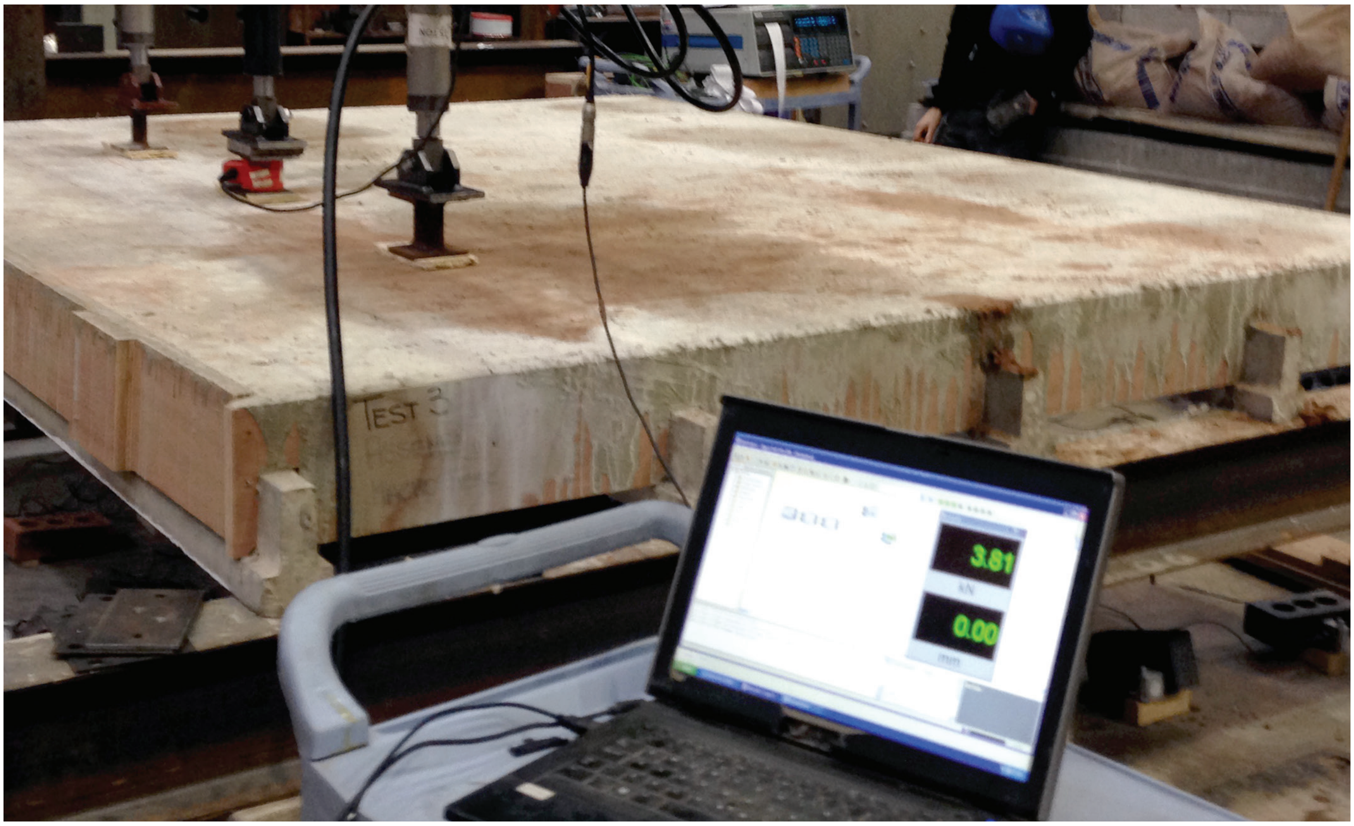
The importance of correct installation procedures

Of course, independent certification of a floor system means little if there is no adequate ownership of the quality of the installation and quality assurance procedures adopted on-site. As floors can be quickly and easily constructed by several different sub-contractors, hidden within the building, consisting of materials with time-dependent performance characteristics which are often quickly concealed by finishes and the rest of the structure, a floor could be a hiding place for future problems. The requirement to adhere rigidly to the approved construction details for proprietary systems, with adequate inspection and sign-off by competent persons, cannot be stressed enough.

Bem and block floors tested to destruction

> “One of the key challenges facing the construction industry, as highlighted in the Hackitt review, is the establishment of ownership over the design and procurement chain.”

* Hackitt report: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/707785/Building_a_Safer_Future_-_web.pdf



Full scale floor testing

As the pace of change in the flooring sector moves swiftly on, the potential for future problems has led to warranty providers being very selective about which systems they will accept. This is best seen by the recent NHBC prohibition of micro-fibre toppings which are normally still certified by certification bodies such as the BBA and accepted by the construction industry at large.**

The Hackitt review implications

One of the key challenges facing the construction industry, as highlighted in the Hackitt review, is the establishment of ownership over the design and procurement chain. Even for relatively simple elements such as domestic house floors, this chain can be complex, with a multitude of component suppliers, main contractors, sub-contractors and designers getting involved along the way. While individual components will often be covered by their own British or European standards, compliance with product standards is not a guarantee that the system assembled of such components will function satisfactorily as a whole and therefore does not cover aspects relating to design and installation. This is because standard components can also often be put to use in configurations not covered by current standards and, in addition, product suppliers often lack knowledge of how their products can be integrated into systems and the significance of the interactions between different parts of floor systems.

Fit and safe - the bottom line

While there have been and continue to be new developments in the evolution of floors, it is important that when innovative products are introduced into the construction process, the product procurement processes are properly and clearly defined so that all flooring systems have the right safety standards intact.

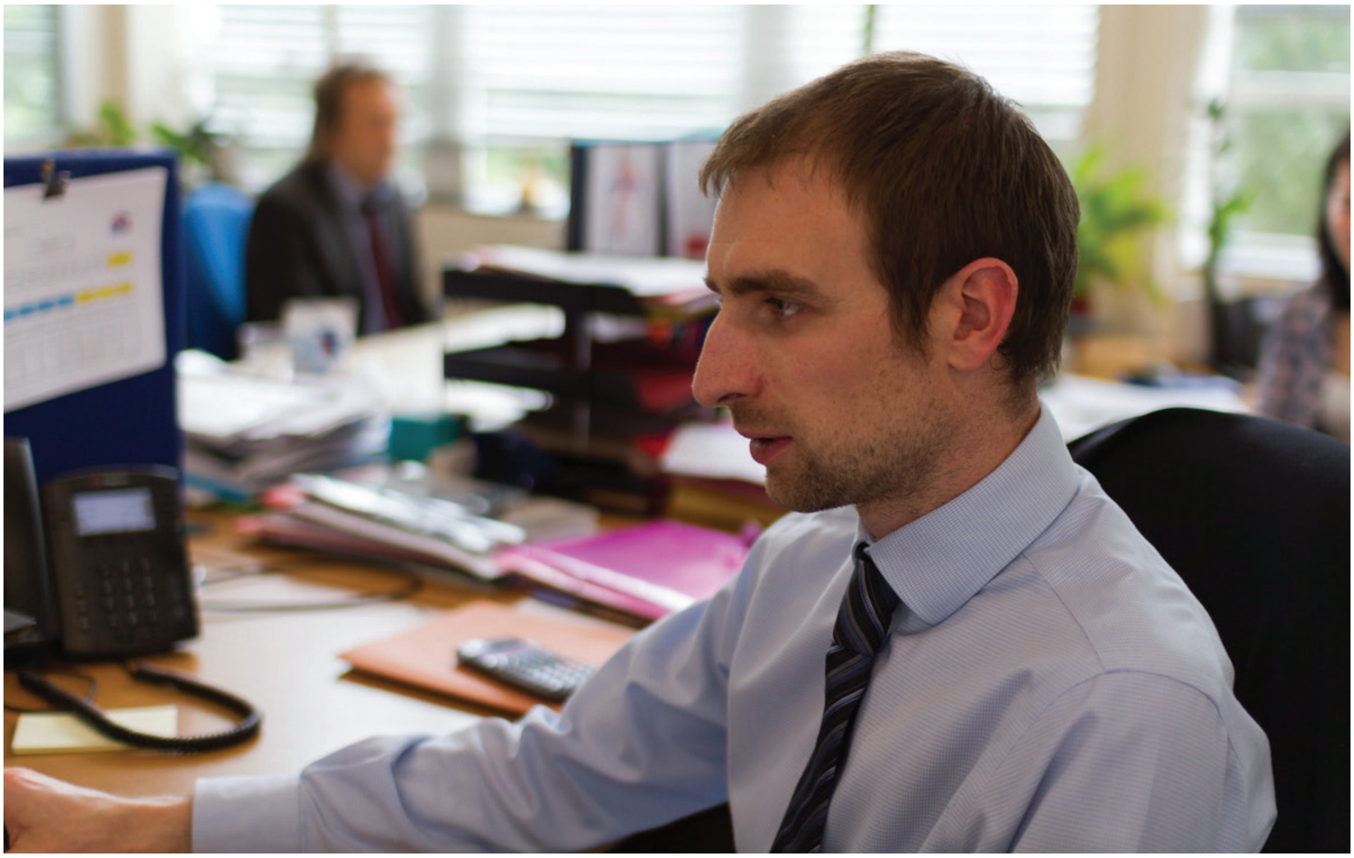
The recognised technical expertise of certification bodies like the BBA plays a vital role in gaining market acceptance of these innovative systems and provides reassurance to the end user that the floor on which they are standing is, and will remain, fit for purpose.

And, above all, safe.

Competencies: Construction Technology, System Specifications, Insulated Flooring, Building Physics

** In 2018 the NHBC prohibited the use of micro-polymer fibres in concrete toppings for all but a few systems on sites for which it offers warranties.

Meet the Team



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Sean Downey is a Team Manager in the Engineering department of the British Board of Agrément. Sean joined the BBA in 2017 and leads a team of structural engineers assessing all forms of structural systems and components.

He qualified as a Civil, Structural & Environmental Engineer at Trinity College Dublin and prior to joining the BBA, specialised in structural testing and instrumentation, with a focus on developing bespoke structural test methods and failure analysis. His experience before and since joining the BBA leads him to identify key areas of performance based on potential failure points and develop robust assessment methods for ensuring fitness for purpose of new and innovative construction products.