WHY REINFORCED CONCRETE CONSTRUCTION

MAKES THE GRADE

FOR STUDENT ACCOMMODATION

BRITISH ASSOCIATION OF REINFORCEMENT

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The British Association of Reinforcement (BAR) is the trade association of UK manufacturers and fabricators of steel reinforcement products including cut and bent bar and mesh as well as suppliers of associated reinforcement products. BAR aims to add value to the UK reinforcement sector through promotion of good industry and health and safety practices, market and product development, and forwarding the UK reinforced concrete industry as a whole.

INCREASED STUDENT NUMBERS

With the demand for purposed-built student accommodation (PBSA) predicted to soar, reinforced concrete gets top marks for providing cost-efficient and low carbon construction solutions.

The latest student population data from the Higher Education Statistics Agency (HESA) shows that in the 2021/22 academic year, 628,725 full-time, first-year students started their undergraduate degree. Analysis of the UCAS application and acceptance data indicates this high level of new starters is projected to continue, with 618,000 starting in 2022/23 and 622,000 in 2023/24. The Universities and Colleges Admission Service (UCAS) projects that there could be 1 million new university applicants by 2030.

Meanwhile, the number of international students from India and China has more than offset the fall in EU students in the wake of Brexit as the UK continues to be one of the key global destinations for students looking to study abroad. Between 2019/20 and 2021/22, the number of full-time international students rose by 117,500.

Overall, the latest student population figures from HESA, for the 2021/22 academic year, show that the number of full-time students rose by 4%, to over 2.26 million.

DECREASED ACCOMMODATION AVAILABILITY

The increase in student applications and numbers is set against a growing shortage in student accommodation. This shortage is being exacerbated by the falling supply of Houses of Multiple Occupation (HMOs) resulting from landlord regulation and tax changes. Since 2017 there have been over 300,00 buy-to-let mortgage redemptions which has reduced the number of 5-plus bedroom rental properties by 31% since 2019. The reduced supply of private landlord HMO's is increasing the demand for PBSA particularly from overseas students.

The shortage of student accommodation is particularly acute in a number of cities. Bristol, Durham and Manchester have had to house students in other nearby cities, or have offered money to students to defer admission or live at home. Canterbury and Bath have both seen a strong growth in student numbers. In 2022, Canterbury accepted 8,885 more students than in 2021 whilst Bath accepted an additional 3,345 more students than in 2021. The situation is unlikely to improve as there are only 850 extra beds in the pipeline for Bath and just 140 for Canterbury.

The rise in student numbers combined with the fall in accommodation supply is resulting in strong rental growth. Student accommodation providers Empiric and Unite predict rental growth of 7% across their portfolios.

To address the disparity between supply and demand more PBSA needs to be constructed. Importantly, this new accommodation must be constructed both cost efficiently and sustainably and be able to meet a range of performance considerations pertinent to PBSA.

INFORMED CONSTRUCTION CHOICE

Reinforced concrete offers a number of unrivalled performance benefits that means it should be awarded a 1st class degree with honours for the construction of PBSA. These concrete benefits are inherent and built-in. There is no need for any additional products, finishes or chemical preservatives. This significantly reduces both initial capital and the ongoing maintenance costs.

Built-in Fire Protection

The fire resistance of construction materials is a prime consideration for PBSAs particularly when you consider that Firemark, the fire safety products and services provider, report that student accommodation has a potential seven-times higher fire risk as students are often unlikely to consider fire safety.

Concrete is one of the most fire-resistant construction materials. Under European Standards (EN 13501-1:2007-A1:2009), it's classified as an A1 material – the highest grade of fire resistance.

The construction fire safety of concrete is underlined by the fact that it is non-combustible, is non-toxic and has low thermal conductivity.

This means that concrete does not easily transfer thermal heat and does not react easily with other substances (meaning that in the event of a fire there are no noxious gases released). In most cases, concrete does not require any additional fire-protection because of its built-in resistance to fire. Concrete ensures that structural integrity remains, fire compartmentation is not compromised and shielding from heat can be relied upon.

These inherent benefits make concrete one of the safest and most effective materials for structural fire protection. The inherent fire resistance also means that concrete buildings can provide a high level of fire resistance and safety well above that required for life safety. This provides greater evacuation and rescue time plus increased structural integrity and safety for fire fighters entering burning buildings.

Because of concrete's inherent material properties, it can be used to minimise fire risk for the lowest initial cost while requiring the least in terms of ongoing maintenance. Other lightweight construction materials rely on fire protection, fire safety engineering or rate of loss of combustion. The reliance on additional materials and engineering makes these materials susceptible to fire risks resulting from poor workmanship, changes to building use, modification to building structure, compliance with management procedures and errant human behaviour.

Built-in Noise Reduction

Noise reduction provided by sound insulation is important for student accommodation. It provides a valuable contribution to the occupants' health and well-being.

High levels of sound insulation of floors and walls are easily achieved using the inherent mass and damping qualities of concrete construction. This is provided with minimal additional materials, therefore there is less reliance on workmanship and acoustic separation is less likely to be compromised over the lifetime of the building. This reduces capital and ongoing maintenance costs during the lifetime of the building.

The sound insulation properties of concrete floors and walls encompass three key acoustic parameters: mass, stiffness and damping:

- Concrete's mass properties can lead to significant attenuation of sound and vibration at all sound frequencies, but are particularly important for reducing low frequency sound transmission.
- Concrete's stiffness can prevent flexing of walls and floors and this reduces low frequency sound transmission by reducing the capability of the structural wall and floor elements to transfer sound energy into the air of adjoining rooms and cavities.
- Concrete has the highest damping properties of any structural material which enables sound and vibration energy to be reduced before reaching other elements or rooms.

The mass and stiffness of concrete construction offer a further inherent benefit: long-term robustness. Concrete ceilings and walls can be left bare without the need for additional finishes that may need regular maintenance, repainting or replacement.

Built-in Thermal Mass for Increased Energy efficiency

Concrete construction facilitates a fabric-first and passive cooling approach that reduces heating and air-conditioning bills and carbon emissions. Utilising the inherent thermal mass of concrete via exposure of concrete ceilings and walls can reduce reliance on energy guzzling air-conditioning due the summer and retain heat better during the winter.

Often referred to as Fabric Energy Storage (FES), the basic approach is to expose the soffit of concrete floor slabs which can then absorb heat gains during warm weather and so reduce the internal temperature. The use of cooler night-time air ventilation or embedded water-cooling cools the soffits in readiness for the following day. The best level of thermal mass is provided by heavyweight concrete construction. Lightweight construction such as steel and timber structures do not offer a comparable level of heat absorption. When used as part of an integrated passive design solution that includes building orientation, shading and natural ventilation, concrete's thermal mass can reduce significantly the reliance on air-conditioning and so reduce operational carbon emissions.

Some passively cooled concrete buildings may have an initial higher embodied CO_2. However, that will be quickly offset by the reductions in ongoing operational CO_2 which can range from just one to six years. A lightweight constructed building may have an initial lower build CO_2 impact but over the building's operational life time it will most likely have a far higher whole life CO_2 emission impact.

Similarly, during the winter the absorption and slow release of heat by heavyweight concrete construction smooths out the peaks and troughs of internal heat and provides a more balanced internal temperature.

A major benefit of PBSA for students is the all-inclusive rent. This can prove challenging when electricity prices start to rise. The reduction of the need for air-conditioning and heating can have a positive effect on the bottom line of the PBSA provider.

For much of the past decade, there was little to no change in the spot price of electricity in the wholesale market, with prices typically around £50 per Megawatt hour (MWh). However, as the economy emerged from Covid-19 in late 2021 and then Russia invaded Ukraine in 2022, prices rose dramatically, peaking at over £360 per MWh in August 2022. The cost of utilities is a major component of PBSA provider costs. The 2023 annual report from Unite highlights the challenges with the utility cost per bed having risen from £380 in 2020/21 to £470 in 2021/22, a 24% increase. Meanwhile, the Carbon Trust calculates that the energy costs and association carbon emissions of typical air-conditioned building are 30% higher than a naturally ventilated building.

Built-in Sustainability

The issue of sustainability is an important one for PBSAs. Students are some of the most motivated in tackling climate change reducing CO_2 emissions. PBSA providers may find that prospective student tenants may be less likely to choose a place to live if it is clearly out of date, has poor energy efficiency, or is designed and constructed in a way that lacks consideration for the environment.

Admittedly, the use of concrete construction raises questions concerning the level of construction embodied CO_2 when compared to other structural materials such as timber. However, if you have to mechanical ventilate and cool a timber building then the resulting operational CO_2 emissions, over the lifetime of the building, will far outweigh any initial construction embodied CO_2 savings.

Similarly, concrete does need additional fire proofing, sound insulation, wall finishes, flood resilient materials. All of these additional materials have an additional CO_2 impact for their manufacture and installation. With concrete construction all of the above performance benefits are provided without any further environmental cost.

The long-term whole life performance CO_2 reduction of concrete construction compared to other construction solutions is considerable and the reinforcement and cement industries are working hard to significantly reduce the initial embodied CO_2 resulting from the manufacture and steel reinforcement and cement.

All the reinforcement made in the UK is made from recycled scrap steel using the Electric Arc Furnace (EAF) process. The Basic Oxygen Steelmaking (BOS) method is mainly used for structural steel and involves the smelting of iron ore, coal and other raw materials in a two-stage process. The EAF production process involves passing an electric charge through scrap metal, melting it and recycling it into new steel products. Steel production using the EAF method consumes only a third of the embodied energy, emits one sixth of the CO_2 and produces approximately half the amount of co-products (waste) compared with the traditional BOS blast furnace steelmaking process. Reinforcing steel can be recovered, recycled and re-used at the end of a building or structure's service life.

The UK cement industry takes the issue of embodied CO_2 issue seriously and working to a planned strategy to reduce its environmental impact. The industry has achieved an impressive 51 per cent reduction in CO_2 emissions compared to 1990 levels. And while cement produces an average seven per cent of carbon emissions worldwide, in the UK this figure is less than 1.5 per cent and as a whole the sector is decarbonising faster than the UK economy.

This huge reduction has been achieved through innovation and investment in efficient plant, switching from fossil fuels and actively researching net zero fuel mixes and by using low-carbon cement substitutes that are by-products from other industries. For example, adding Ground Granulated Blast-furnace Slag (GGBS) or fly ash – waste materials from the iron and electricity industries – to a concrete mix can help to reduce the carbon of a reinforced concrete flat slab by 35 per cent. Further reductions are possible in the future through greater use of alternative and carbon-neutral biomass fuels, increased use of lower-carbon cements, and lowering indirect CO_2 emissions – for example by using greener energy sources.

LEARNING EXAMPLES

There is a growing number of examples of concrete constructed PBSA's that demonstrate performance benefits of concrete construction.

Ash Court, Girton College, Cambridge

The Ash Court student accommodation realises the range of inherent benefits provided by concrete construction. The concrete frame and masonry construction is passively cooled, has high thermal performance, provides excellent air tightness and has a robustness that meets the challenges of student occupation. Ash Court is designed to a Passivhaus standard and a BREEAM 'Excellent' rating and a 100-year design life.

Bermondsey Spa, London

The concrete frame of this student accommodation provides a number of benefits. The concrete slabs are just 225mm thick. This helped to keep the seven-storey block to an acceptable height. Further benefits include no sound travel between the rooms and exposure of the concrete means that it is durable and does not have to be repainted every summer. The building offers future flexibility too. The concrete frame has 5.5m spans between columns to allow to be it could easily be adapted to flats or offices if required.

One Pool Street, Stratford, London

One Pool Street has sustainability at its core. The use of exposed concrete makes full use of the material's thermal mass which is combined with natural ventilation to moderate internal temperatures during the day that are then purged at night, either through the windows (the shallow building form also enables cross-ventilation) or through the MVHR units installed behind bulkheads in each room. This is part of a strategy that used future 2050 climate models to mitigate against overheating and future proof the building. The use of precast concrete projections that form a ring around each floor limits solar gain while allowing sufficient glazing to make the bedrooms feel light and spacious.

Bromley Place, Lower Parliament Street, Nottingham

The 271-bed PBSA is Unite Students first low carbon concrete project. The construction uses a low-carbon cement substitute – containing ground granulated blast furnace slag. The use of sustainable materials means the property's embodied carbon will be 676kgCO_2e/m² – 11% (100kgCO_2e/m²) less than it would be without using more sustainable building materials. Low energy LED lighting and high efficiency heating and cooling systems will also be installed, further improving the environmental performance of Bromley Place.

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