Photo: Wellcome Trust

The use of lattice slabs with a precast soffit providing permanent formwork – such as at The Francis Crick Institute in London – reduces the materials used during construction

INSIGHT#2 : RESOURCE EFFICIENCY

The concrete industry is a net consumer of waste

'Doing more with less' is a useful summary for resource efficiency and one frequently used in the context of structural design solutions. But just as embodied CO_2 does not represent a true carbon footprint, resource or material efficiency should not be considered at just a single lifecycle stage. As with so many aspects of sustainable construction, the most effective solutions require a holistic, whole-life approach.

Concrete and masonry can offer material efficiency at each stage of development, providing varied opportunities to do more with less. This is in part demonstrated by the industry project with WRAP and stakeholders that delivered Resource Efficiency Action Plans for ready-mixed concrete, precast concrete and blocks (see overleaf), outlining opportunities from factory gate to end of life.

The ability of concrete producers to use waste and by-products from other industries has enabled the industry to become an overall net consumer of waste. During the production process for cement, the sector can safely burn a wide range of materials as alternative fuels such as solvents, tyres, meat and bone meal, sewage sludge, un-recyclable paper and plastic.

The raw virgin materials in concrete can also be replaced with recycled materials and by-products from other industries. Ground granulated blast-furnace slag (GGBS) is a by-product of iron production and fly ash is from electricity generation. Both are used, in combination with Portland cement, as the cementitious material in concrete and make a valuable contribution towards the durability of concrete and the

IN 2016, THE CONCRETE INDUSTRY USED

116

TIMES MORE RECOVERED AND WASTE MATERIALS THAN IT SENT TO LANDFILL

lowering of its carbon footprint.

Recycled and secondary aggregates can be used in concrete (at levels permitted by British Standards) – and the concrete industry's sustainability strategy introduced a performance indicator to chart this (see page 28). However, due to the logistics of retrieving suitable segregated concrete and aggregates from construction sites and returning them to separate concrete production plants, the CO_2 associated with transport alone can outweigh environmental benefits.

The most efficient investment of resources is in a structure that is designed for longevity, and concrete and masonry have the durability and robustness to achieve this. Infrastructure projects often have a design life of over 120 years; our housing stock needs to be robust to the impacts of climate change; and our commercial buildings need to be designed to be adaptable to future requirements. This can all be achieved with concrete. And when refurbishment is no longer an option, concrete can be recycled.

Concrete is often seen as ubiquitous and low cost and so its use may not be considered as carefully as materials that are scarce or expensive. However, its inherent properties and performance make it an asset to any material-efficient design strategy.

The concrete industry, via The Concrete Centre, provides designers with detailed information on how material use in buildings can be reduced using concrete, including guidance on material-efficient solutions such as post-tensioned concrete.

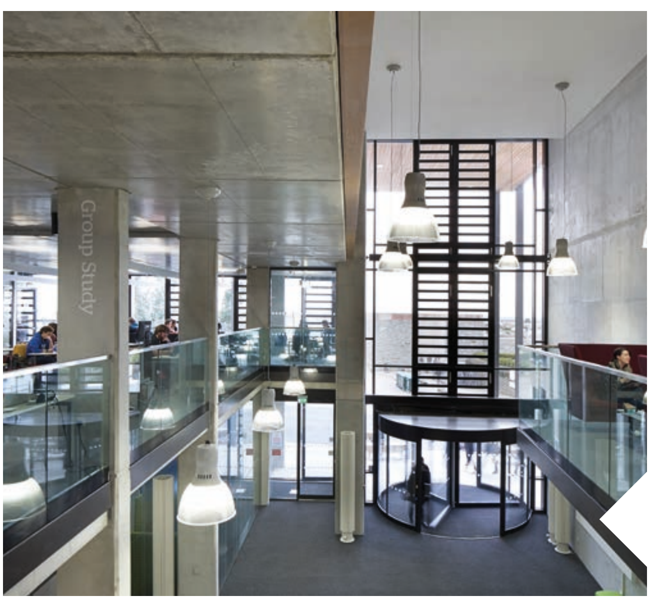

Photo: Hufton + Crow

DESIGNING FOR MATERIAL EFFICIENCY

Reducing the amount of materials required for a project can be achieved by optimising the amount of concrete needed to meet its performance requirements and by using concrete to reduce the need for other materials.

Concrete alone can often meet the performance requirements of structure, fire and acoustic separation, without the need for any other finishing materials. Exposed concrete also optimises the thermal mass performance of the concrete, offering opportunities to make considerable savings on energy and carbon while the building is in use. The durable finish of concrete offers further lifecycle cost savings by reducing the need for maintenance (and replacement) in comparison to other "wearing" finishes.

The design of a concrete structural frame offers opportunities for material efficiency, while maintaining the inherent performance benefits of concrete. Concrete offers a wide variety of solutions including choices between precast, in-situ and hybrid concrete solutions, but also different types and combinations of frame components such as flat slab, ribs, band beams and waffle decks. For example, flat slabs increase the efficiency of the formwork and allow for many subsequent reuses.

The use of prestressed slabs, either precast or post-tensioned (PT) in-situ, will reduce both the concrete and the reinforcement used. Typically, a PT flat slab will be 50-75mm shallower than a normally reinforced one and will use one-third of the steel – this reduces the size of the columns and foundations too. Void formers and hollowcores within the structural slab are another option for reducing the amount of concrete used and hence the self-weight of the structure. This significantly reduces the load to be carried by the slab and the depth of slab needed. The use of lattice slabs with a precast soffit providing permanent formwork reduces the materials used during construction.

Each element of a project affects the others and taking a holistic view can lead to savings in time, as well as materials. Using concrete or masonry as the main structural material offers opportunities to simplify both structure and finishes.

Exposed concrete structures are robust, long-lasting and material efficient because there is no need for additional finishes. This makes them an increasingly popular option for university buildings such as The Exchange in Falmouth by Burwell Deakins Architects

CLOSING THE LOOP: CONCRETE AND THE CIRCULAR ECONOMY

The circular economy is a holistic model wherein, at the end of its life, a product is seen as a resource through the reuse or recycling of its components. This "closed loop" approach is not always easy to apply to construction, where buildings are intended to last for decades, if not centuries, and additional materials have to enter the cycle to meet the need for new infrastructure, housing and so on.

However, if we consider construction's "products" to be end-uses such as schools, homes or bridges, concrete can help designers to harness the underlying principles of the circular economy in a number of ways:

1. Designing for material efficiency (see previous page)

2. Designing for longevity Durable materials such as concrete and masonry can extend the serviceable life of a building/structure. Concrete and masonry products provide a resilience to fire, overheating and flooding. Designers should also ensure that spaces are flexible and able to adapt to occupant needs.

3. Designing for re-use Re-using an existing structure is often the optimum sustainable solution for a redundant building or structure since relatively little energy is required in the process, either for transportation or adaptation of form, and little waste produced. Concrete and masonry structures are durable and robust and frequently able to be adapted for re-use.

The re-use of concrete and masonry elements will be facilitated through tools such as building information modelling (BIM), which will enable them to be tracked, documented and returned to the value chain.

4. Designing for material recovery Concrete is 100% recyclable. Demolished concrete can be relatively simply processed for re-use. This processing and re-use can both take place on site, with crushed concrete providing a cost-effective material for hard core, fill or in landscaping.

New systems will guarantee that products return to the material stream quickly to re-emerge as recycled materials.

David Manley is chair of the concrete industry's Resource Efficiency Working Group

RESOURCE EFFICIENCY ACTION PLANS

A Resource Efficiency Action Plan (REAP) identifies the key challenges and actions needed in order to make improvements to resource efficiency throughout a sector.

The brick, block, ready-mixed and precast concrete industries have developed sector-specific REAPs in partnership with the Waste and Resources Action Programme (WRAP). These are intended to assist the supply chain, which ranges from raw material extraction to the demolition or deconstruction of buildings, in identifying and creating an actionable strategy for improving resource efficiency. It addresses a wider range of issues than other REAPs, covering the main impact indicators of waste, water, carbon (energy use and emissions), materials (primary raw materials and secondary/recycled materials) and biodiversity. As such, it accords with the resource efficiency, low carbon and general sustainability themes promoted by the Green Construction Board (GCB) and Construction 2025 Industry Strategy.

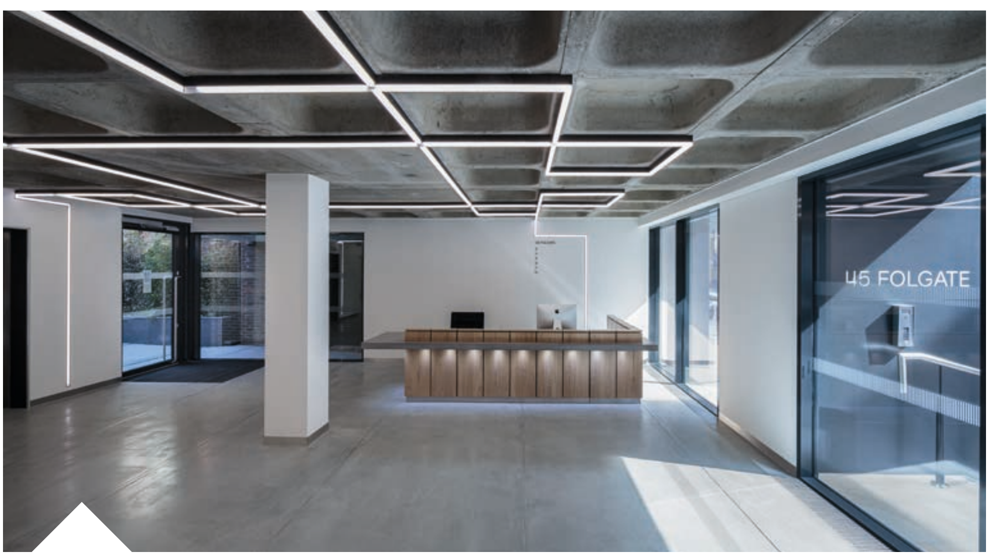

Photo: Dirk Lindner

At Folgate Street in London, a 50-year-old concrete structure has been adapted to create a modern office building. Reusing buildings minimises the need for new materials, while the original waffle slab itself demonstrates a material-efficient approach to design