Concrete commitment to innovation

Concrete is an ancient material, but new types are emerging as engineers develop self-healing, self-cleaning and even bendable and translucent versions.

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**CONCRETE’S ORIGINS** can be traced as far back as ancient Rome, where experiments with lime and volcanic sands (pozzolana) created a Portland cement-like material. When mixed with water and aggregate, this helped realise structures such as the Pantheon.

It is the most widely used construction material in the world – omnipresent in our construction landscape, whether in residential, commercial or civil applications. Yet as old as it is, concrete is continually being refined.

**New types of concrete**
A commitment to innovation and efficiency has led to improvements in constituent materials that in turn have enhanced standard concrete and given rise to new types of concrete.

**Self-healing concrete**
Currently generating excitement are recent developments around self-healing concrete. This has the potential to prolong the service life of concrete structures and therefore reduce associated maintenance or repair costs.

**Bio-concrete**
At Delft University of Technology in the Netherlands, microbiologist Hendrik Jonkers is leading a research team experimenting with limestone-producing bacteria to organically repair concrete.

Bacterial spores are encapsulated within 2–4 mm wide clay pellets and added to the concrete mix with other chemicals and a nutrient agent. The bacteria, which pose no harm to humans, can remain dormant in the concrete for up to 200 years and are activated by moisture penetrating a crack.
Not only do the bacteria consume oxygen to lessen the likelihood of reinforcing steel corrosion, but they also produce carbon ions that react with the calcium in the concrete. This creates a type of limestone mortar that seals the fine crack.

A spray-on mix for existing concrete structures is also being developed.

Jonkers’ patented bio-concrete will become commercially available soon following testing of alternative bacteria encapsulation mechanisms and the weather-tightness achieved by the seal.

**Super-absorbent polymers**

In a separate project, researchers at the University of Ghent in Belgium are also pushing boundaries with self-healing concrete by incorporating super-absorbent polymers into the mix.

When the hardened concrete develops cracks from dynamic or mechanical loads, water penetrates to swell the polymers and prevent further moisture access.

**Smart concrete programme**

Self-healing concrete is also a key component of a coordinated smart concrete programme at Bath, Cardiff and Cambridge Universities. Adopting a holistic approach, the research team is investigating techniques to ensure the wellbeing of concrete structures.

These include bacteria-infused capsules added to the concrete mix that, when exposed to water, feed on nutrients (also added to the mix) to produce a sealing agent.

Tendons that promote crack shrinkage when heated are also being examined, along with interconnected tubes within the concrete through which self-healing agents can be fed.

**Depolluting concrete**

A little further down the evolutionary track is depolluting concrete. A term popularised by building products specialist Michael Chisud, depolluting concrete uses photocatalysts on the concrete surface to stimulate chemical reactions that disintegrate environmental contaminants.

The photocatalysts accelerate the process whereby solar or ultraviolet energy gently break down pollutants. The harmful compounds are decomposed into molecules that have minimal impact on the environment.

The principal catalytic component is titanium dioxide (TiO₂), which takes the form of a white pigment within the specially blended Portland cement. The structure of TiO₂ is altered to create tiny semiconductor particles capable of photocatalysis. These are activated by the energy in light to create a surface charge that reacts with the organic compounds.

The Jubilee Church in Rome is the best-known building to utilise depolluting concrete, but it has also been integrated into the Air France Headquarters at Roisy-Charles de Gaulle International Airport, Paris, and Hotel de Police in Bordeaux.

Other uses include concrete pavements, putting depollution in close proximity to car exhausts. Photocatalysts have also been used in office spaces to neutralise a range of VOCs.

Aside from helping to reduce pollutants and keep structures clean, the reflective properties of photocatalytic concrete’s white colour also help reduce heat gain in urban areas and lessen reliance on mechanical cooling.

**The list goes on...**

Advances in technology have also led to several other new types of concrete:

- Self-compacting concrete - flows under its own weight to fill congested formwork. The benefits include complex shapes, enhanced finish and a safer work environment.
- Bendable concrete - a lightweight composite material that offers good tensile strength and ductility. Available as a sheet or can be applied via a shot nozzle.
- Translucent concrete - contains randomly embedded glass fibres that allow light transmission with stunning results. Available as non-structural blocks or panels.
- Inflatable concrete - a flexible fabric impregnated with dry-mix concrete that can be used to create durable, waterproof and fire-resistant modular shelters that, once inflated, harden on hydration.
- Carbon nanotube-enriched concrete - a high-strength, ultra-low permeability concrete that requires minimal steel reinforcing and is suited to marine and coastal applications.

**What's ahead?**

Recent decades have seen significant technical advances that have rendered concrete production more efficient and innovative.

As the world moves towards a more sustainable approach to conducting business, commercial pressures and environmental responsibilities will dictate that developments like these remain a priority.