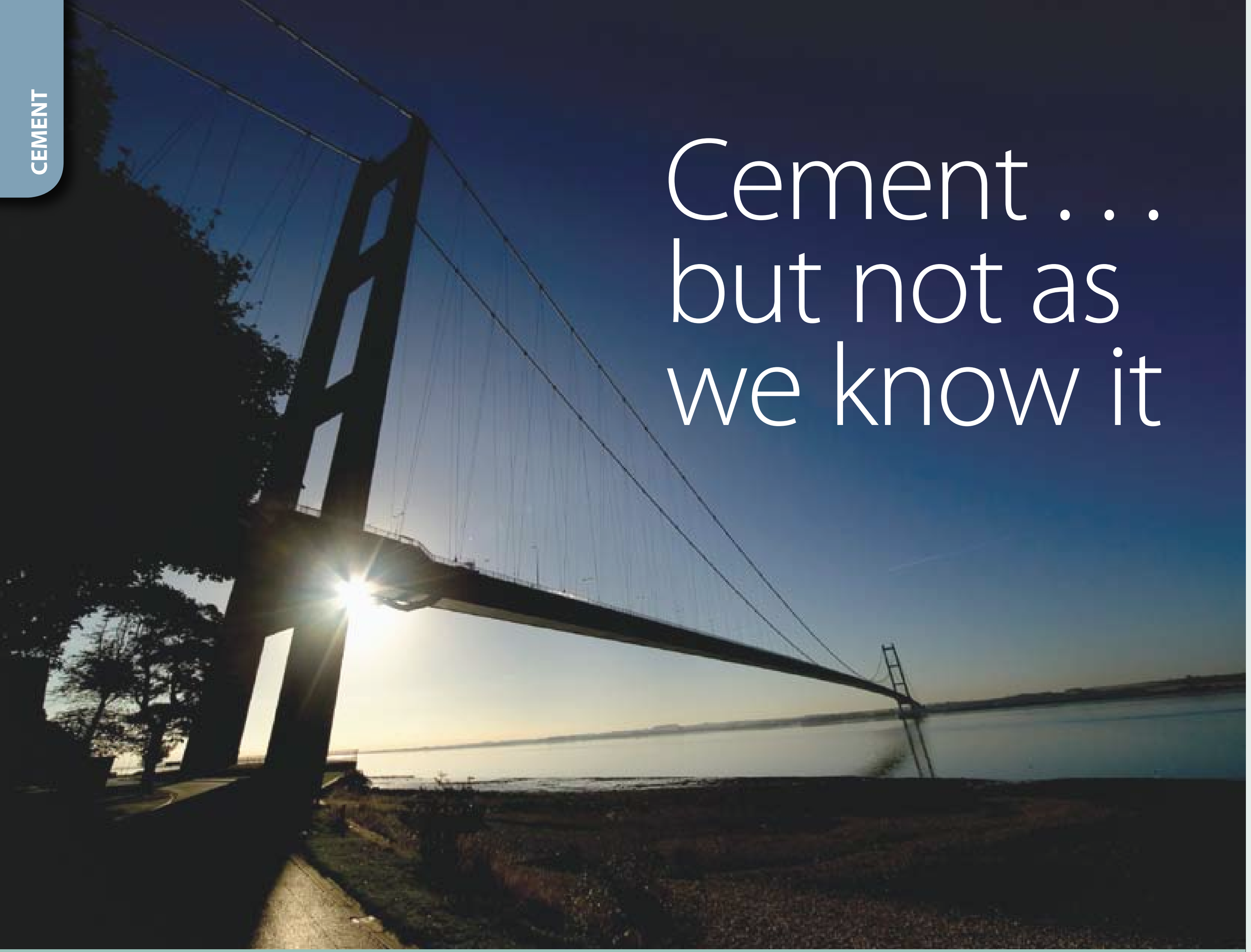


Cement . . . but not as we know it

We take for granted the inherent strength of structures like the Humber Bridge (pictured). The fabric of our world depends upon traditional Portland cement. But it comes at a cost to the environment because the huge heat and chemical change that are essential in making cement also results in carbon emissions. The industry is working hard to reduce them - but are there any long-term alternatives?

IT is hard to think of cement as anything other than basic. While the contribution it makes to our world is far from ordinary, the product that makes it all possible remains (for most of us) a nondescript grey powder.

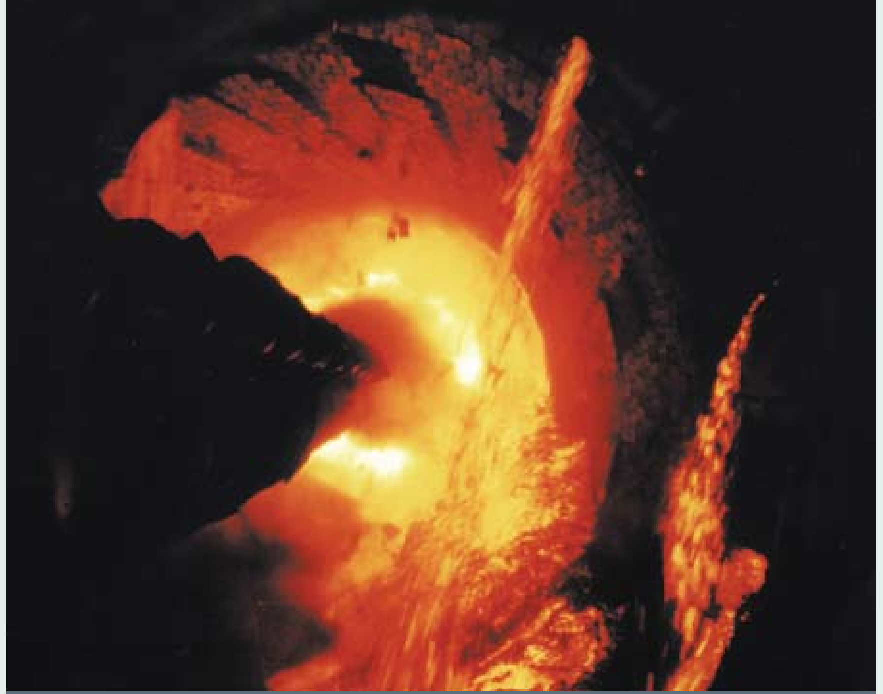
The prospect of "novel" cements may then be a little hard to take seriously. Until, that is, you explore the work underway within the industry and beyond to advance the cause of carbon reduction. There remain some daunting hurdles to be crossed but there is ultimately the prospect of an entirely new breed of cements that embody a fraction of the carbon that is of necessity locked into traditional Portland cement.

In the meantime, the industry has already taken great strides in developing second generation cements that are more sustainable. They involve use of Portland cement as an activator for mineral additions such as fly ash from power stations and slag from the steel industry, both of which would otherwise be landfilled.

Added to that is the increasing use of alternative waste-derived fuels instead of finite fossil fuels, plus heavy investment in new energy-efficient technology. As a result, MPA Cement members in the UK managed to achieve CO_2 emissions in 2009 that were 7.7 million tonnes lower than in 1990. The question now is whether a further generation of novel cements can do still better.

> "There is a future for new or novel cements but there really is a long way to go."

To put the quest for low-carbon cements into perspective you need to appreciate that the industry worldwide is responsible for five per cent of all CO_2 emissions (two per cent in the UK). The 10 million tonne annual cement output from the UK's 14 plants is but a tiny fraction of the three billion tonnes manufactured worldwide. With growth in China and India both spiralling, the prediction is for global output nearer five billion tonnes by 2020 with obvious CO_2 consequences.



Volcanic heat is essential to today's process

Cements have been around since Roman times, but while the technology has changed greatly, the process still relies on the same basic raw materials and on volcanic heat (around 1,450°C) to bring about the fundamental chemical change. Therein lies the CO_2 problem.

On the plus side, this traditional cement is made from abundant natural raw materials and is relatively low cost per tonne produced. Most importantly, concrete made from it is highly durable – it literally puts the backbone into our built environment.

The big question is therefore: can science give us a new generation of cements that use less, or no limestone, and less energy? And when can we expect to see them? The short answer is that they are already here, but don't hold your breath on when you can expect to see them in everyday use. Research is still largely confidential but is well underway.

Dr Pal Chana, executive director of MPA Cement, is cautious. "Some of these novel cements are showing early potential but it is important to remember that they have yet to be produced in the sort of volumes needed for the global construction industry," he says.

"To produce cement in the billions of tonnes needed for the construction industry takes huge amounts of investment and rigorous testing. Establishing fitness-for-purpose for any cement is neither a simple nor a linear undertaking and the more unfamiliar the cement type the more exacting will be the validation process.

It goes without saying that any material that plays quite such a crucial role needs to be safe, but also long-lasting and without need of excessive maintenance."

Confidence building is then one central issue for any new cement and it is likely that early uses would be non-structural.

The other major barrier could be cost given that Portland cements benefit greatly from economies of scale. It is unlikely that any new cement could compete on a cost per unit basis until it achieved acceptance that justified production in industrial quantities.

"There is a future for new or novel cements," says Pal Chana. "But there really is a long way to go before they can make substantial inroads into the market.

"In the meantime, it is critical that we continue to reduce carbon through every other route and that Governments of the world support the development of carbon capture technology."

Next generation?

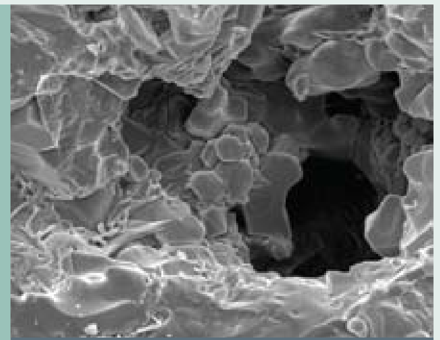
The challenge of identifying novel cements with genuine long-term commercial potential is being taken up worldwide. Alternatives are being investigated in Australia, China, Japan and the Netherlands

The UK is, however, amongst the front runners with *Novacem*, a project led by engineers at Imperial College that uses magnesium silicates rather than calcium carbonate as its main feedstock. Magnesium silicates provide the main component in talcum powder.

Without getting into the details of the chemical process, the crucial factor is that the heat required is relatively low, which means that biomass fuels can do the job. Whereas manufacturing a tonne of conventional cement emits 0.8 tonnes of carbon, the equivalent for *Novacem* is claimed to be minus 0.11 tonnes. An industrial sized pilot plant should be operational in 2011.

Other novel cements at varying stages of development include:

- **CALERA – a mixture of calcium and magnesium carbonates, and calcium and magnesium hydroxides.**



Strength to match – cement's microstructure

- **CALIX – produced in a reactor by rapid calcination of dolomitic rock in superheated steam.**
- **GEOPOLYMER CEMENT – uses wastes from power stations and the steel industry plus concrete waste to make alkali-activated cements.**