Editorial

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In civil engineering the most amazing structures and buildings are erected. Architects can become very famous through the design of their structures. As some examples, Santiago Calatrava comes to mind with his Transit Hub for the World Trade Center, or Frank Gehry with his design for the Guggenheim Museum in Bilbao, Spain (Figure 1). However, hardly anybody recognises the innovation and ingenuity of the design at a materials level that was needed to construct and build these famous structures. Therefore, the spotlight is put now on the materials design. And what better platform than in *Construction Materials*.

Materials design is at the core of the Institution of Civil Engineers' *Construction Materials* journal. Understanding how a material reacts to external forces or our environment and then altering the material in a smart way to make it stronger, tougher or useable in more extreme conditions, that is a basic component of material design.

In this issue we serve you with four articles that all try to change the properties of the final material by changing its compositional design. How can the ingredients be manipulated in such a way that something that seems impossible can still be achieved? As basic ingredients for this issue we use lightweight aggregates, carbon-fibre, mud and crumb rubber. And these ingredients are used to build high-strength concrete, columns with an aspect ratio greater than 2, housing and roads to serve in freezing temperatures.

In the first article, by Evangelista and Tam (2020), the aim is to produce a concrete with a design strength of 45 MPa and a density of less than 1800 kg/m³. Such a material could be an interesting alternative for use in, for example, offshore platforms, bridges built by the cantilever method and floating bridges. As the authors point out from past research, lightweight concrete with a strength above 55 MPa is challenging because lightweight and porous aggregates tend to limit the mechanical performance of concrete.

Still, read in their article the design path in which they seek to use lightweight aggregates from clay and shale to keep the weight down; how they play with superplasticisers, silica fume and particle packing to create a stable mix; and how in the end they found a composition with an average compressive strength after 28 days of 64.3 MPa at a density of only 1770 kg/m³.

An example of material redesign, so to speak, can be found in the article by Vuggumudi and Paramasivan (2020). They looked at retrofitting of columns using carbon-fibre-reinforced polymer. These carbon-fibre wrappings are recommended for their high tensile strength and modulus, and ease of application.

It is known that columns with a circular cross-section experience a significant increase in strength and ductility after wrapping, but what happens in case of columns with a rectangular cross-section? The conversion of such a cross-section into an elliptical or circular cross-section is time consuming, adds a lot of dead weight and occupies space.

Figure 1. The Guggenheim Museum, Bilbao, Spain (source: PA / CC BY-SA (<https://creativecommons.org/licenses/by-sa/4.0>))

In their article Vuggumudi and Paramasivan study rectangular columns with an aspect ratio greater than 2, which are strengthened with composite wrapping without chamfering the corners. They demonstrate that even in this case the load-carrying capacity was easily enhanced by 25%.

Material improvement at a lower strength class, but with potentially more impact, is the research work from Muhammad *et al.* (2020). They look at a material in which approximately 30% of the world's population is living: mud bricks! Besides being an economical construction material, mud bricks have great significance due to their insulating properties. They report that a mud brick house can be 56% cooler in summer and 41% warmer in winter when compared to a concrete brick house.

With all these great properties it is a bit sad to read that mud bricks may erode due to rain impact. For a material that is made by mixing soil and water, this can be understood. So, Muhammad *et al.* take on the challenge to improve the material. Experimenting with wheat straw, rice husk and lime, they were able to reduce shrinkage cracking and even produce shapes for interlocking mud bricks. Contrary to what you may have expected, the addition of lime did not produce much improvement. The addition of fibres and rice husk did improve the overall properties of the mud bricks.

The last paper of this issue takes us to the cold winter climate of Changchun, China, where the temperature is more often below zero degrees Celcius than above. In such a climate, sub-grade frost damage because of seasonally frozen areas seriously affects the normal use and maintenance of roads. The question to the materials engineers on duty, Wei *et al.* (2020), was if they could come up with a solution. In their article they report on their quest using, amongst others, silty clay, fly ash soil, and silty clay modified by fly ash and crumb rubber.

Their results show that waste coal fly ash and rubber tyres can contribute to solve the road engineering challenges in a cold-weather environment. However, the materials manipulation does need to be done with care as fly ash decreases the freezing temperature, whereas crumb rubber had the opposite effect.

Hence, a full issue filled with materials design and manipulation. If you do like this type of research and you have suitable qualifications please send your CV to the journal office for an application as a panel member, as we are always looking for new members.

Can't wait to read the latest articles? Please know that our most recent articles are published ahead of print on our Virtual Library homepage. For this printed issue of *Construction Materials*, I wish you lots of learnings and enjoyable reading with the presented articles.

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