CONCRETENE

The problem with concrete: Concretene vs other cementitious additives

After water, concrete is the most widely used substance on Earth.

Staggeringly, it accounts for at least 8% - 10% of global CO_2 emissions, making it the third-largest global CO_2 polluter behind only the USA and China. The UK contributes 2% of global CO_2 pollution.

The production of cement releases CO_2 as a direct by-product of $CaCO_3$ calcination. These direct emissions, in combination with indirect process emissions (transport, process energy etc), represent the majority (80-95%) of the emissions.

Global annual CO_2 emissions from cement production is forecast to reach 5.4bn tonnes by 2030 which, in volume terms would fill the O_2 Arena (London Millennium Dome) every 23 seconds. If the concrete industry can reduce its global CO_2 emissions by just 25%, it will literally reduce their global CO_2 footprint equivalent to an entire country.

These huge pollution figures exclude concrete production, reinforcement and delivery to site. As steel reinforcement is used in virtually all load-bearing concrete structures, the CO_2 footprint increases still further.

With the significant global demand for concrete and cement, the pressure on mining and procurement of raw materials is at unprecedented levels and the industry is constantly trying to seek new technologies that can work with filler materials or new technologies to help reduce the burden on exhausted resources.

The geological impact of the industry with such extensive exploitation of raw materials is also significantly detrimental to the natural environment. Once mined, the logistical footprint of processing and subsequently transporting the material by ship, rail and road only increases the CO_2 footprint. Globally, the mining sector contributes 4-7% of global CO_2 emissions so any technology to help reduce this impact would also be extremely beneficial to help reduce global CO_2 pollution.

Advances in green technology is only exacerbating the problem for the concrete industry globally. The concrete industry often use Supplementary Cementitious Materials (SCMs) in order to reduce the burden on ordinary cement.

SCMs include Ground Granulated Blast Furnace Slag (GGBS) and Pulverised Fly Ash (PFA) which the industry have promoted as "CO_2 reduction technology".

In reality, these are waste products from the steel production industry and originally were cheap to purchase as a waste material and is considered by many to have a small "carbon footprint" for the concrete sector.

As a result, any reduction in cement with a GGBS or PFA substitute enabled the concrete industry to promote this as a CO_2 reduction product.

However, as coal fired power stations and traditional blast furnaces are replaced with sustainable power such as wind, solar, hydrogen power or more modern electric arc furnaces, this waste product is in terminal decline, with sources already proving unreliable.

At present, just to keep up with demand in the UK, GGBS and PFA is being imported from China, Turkey and India.

From a point of principle, it is questionable how such concretes can be deemed as low CO_2 technology, when GGBS created from a coal fired blast furnace in China is shipped to the UK and Europe, placed onto the rail network and used in batching plants as a cement substitute with apparent low carbon footprint.

China increases coal Projects as climate crisis grows – study (irishtimes.com)

There is another significant problem with GGBS and PFA, it simply doesn't perform as well as traditional Ordinary Portland Cement (OPC) in certain performance criteria. This includes:

- More complex cementitious systems which are difficult to understand
- Low early strength
- Long setting times
- High risk of plastic shrinkage and thermal stress
- Decreased strength development rate

With construction Projects often time critical, Clients demanding CO_2 reduction on their Projects and the industry only really able to offer SCMs as an alternative with reduced performance, no financial savings on the material due to increased demand and a questionable CO_2 reduction, the current options for designers and engineers to specify are extremely limited.

Whilst these problems are widely known throughout the professional community, this technology is still pushed as CO_2 reduction, an example being the article below on the 26th April 2022 citing 500t of CO_2 reduction on this current Project but only based upon a CEM1 pure OPC mix alternative.

Low carbon concrete solution provided for Gatwick Airport station | New Civil Engineer

However, the concrete industry continues to try and promote this as CO_2 reduction technology because it struggles to innovate and has very few options to provide a revolutionary CO_2 reduction alternative into its business model.

As a result, the industry is 'open for business' for CO_2 reduction technologies that can be easily incorporated into the current status quo so that:

1. Designers can continue to use existing codes so it can be brought to market easily.
2. Non-disruptive so suppliers can use existing batching plants and technologies
3. Supply chains do not have to fundamentally change.
4. Contractors can use the material on site.
5. It allows for evolution of concrete and can suit any type of potential concrete design.
6. Can allow the potential to be recycled creating a sustainable life cycle.
7. It will either reduce cost or be of equivalent cost to remain commercially viable.