A concrete example: more eco-friendly options

Concrete is the mainstay of the building industry. Made from cement (a binder), aggregates (gravel and sand) and water, it's well known that it has high embodied energy from the process of kiln firing the binder and mining of the aggregates. It has been estimated that the CO_2 emissions from one tonne of structural concrete can be up to around 180 kg, or around 410 kg per cubic metre, although the current figure given by The Concrete Centre in the UK puts it around 100 kg/tonne; it will vary depending on the location of manufacture.

More eco-friendly versions replace part of the cement binder with waste materials such as blast furnace slag (waste from iron production) and fly-ash (waste from coal-fired power generation), while aggregates can be replaced with crushed recycled concrete.

One eco-friendly option available now is geopolymer concrete, which removes all Portland cement from the mix, replacing it with a geopolymer to activate fly-ash and slag as the binder.

A geopolymer is a polymer (long chain molecule) which is based on silicon rather than carbon, so it is basically a mineral-based polymer.

The amount of cement that is replaced by more eco-friendly materials varies depending on the concrete product and the manufacturer, with some manufacturers replacing virtually all of the cement and aggregates with eco-friendly alternatives. Examples of more environmentally friendly concretes include Wagners EFC (earth friendly concrete, see www.wagnerscft.com.au/products/efc) which reduces the greenhouse emissions of the cement portion of the concrete by 80% to 90% compared to standard concrete.

Independent Cement & Lime (www.independentcement.com.au) make their Ecoblend concrete, which contains a minimum of 30% cement replacement materials in the form of slag and fly-ash. This blend reduces CO_2 emissions of the cement by around 29%, as well as having other advantages such as reduced heavy metal content and water use.

Taking a different approach is Eco-Cement from TecEco, which contains magnesium oxide (also called magnesia) as a binder instead of Portland cement. Compared to Portland cement, magnesium oxide requires less energy to manufacture, and it absorbs CO_2 as it hardens, locking up carbon.

Magnesium oxide-based concretes have other advantages, including higher strength than regular concrete and the ability to be made into pervious (porous) concrete simply by leaving out the fines (small particles such as sand).

Interestingly, magnesium oxide-based concretes were actually in widespread use before Portland cement was developed in 1824. Blending magnesium oxide mixes was something of an artform and continued up until the mid twentieth century. However, by the late nineteenth century Portland cement based concretes had become the dominant form of concrete, despite the negative attributes of lower strength, hydrophilic properties and the health issues associated with its use (powdered cement can cause illness and even lung cancer).

Another approach to reducing the environmental footprint of concrete is the use of additives to reduce the need for Portland cement. Boral's Envisia product (see www.boral.com.au/envisia) uses Boral's cement activator called ZEP to achieve a Portland cement reduction of up to 65%, while improving some of the material's qualities, compared to regular concrete.

But what about the aggregates in concrete? These include crushed rock and sand, both of which are mined, often at considerable environmental cost.

As mentioned, some eco-concretes replace these materials with recycled materials such as crushed concrete. An example of this is MetroMix's GREEN RCC, developed in conjunction with Fairfield City Council, where the coarse and fine aggregate is 20 mm recycled crushed concrete instead of gravel and sand.

There are other ways that concrete can be strengthened while displacing some of the usual aggregates. This includes adding fibre materials such as fibreglass, or the use of sawdust as an aggregate, such as with Timbercrete (www.timbercrete.com.au), where the use of timber wastes from sawmills offsets the use of other aggregates, reducing the environmental footprint of the concrete by locking up carbon, while making a lighter and better insulating material.

Lastly, another concrete-like material is Hempcrete, which is made from a mixture of hemp hurd (the inner part of the stalks), lime and water. Hempcrete hardens by absorbing CO_2, locking up carbon while forming a (non-structural) vapour permeable infill material.

↑ Magnesium oxide based concretes not only capture CO_2 while hardening, they can be made into interesting materials such as this pervious concrete from TecEco, designed to reduce run-off from hard surfaces.