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Stronger concrete is more environmentally-friendly

Using high-strength concrete in construction could help to reduce its impact on the environment, according to a study by French researchers. The researchers compared the environmental impacts of bridges built from ordinary and high-strength concrete and found that the high-strength solution had a lower impact on the environment overall.

In Europe, **the weight of minerals extracted** each year to make concrete for buildings is equivalent to 4.8 tonnes per person. Globally, 5-10% of carbon dioxide (CO_2) emissions from human activity are produced by the building materials sector, mostly from concrete manufacturing[1]. According to previous research, using renewable fuels, improving kilns and alternative binding materials to cement could halve emissions, which is a valuable but insufficient contribution to cuts in CO_2 recommended by the IPCC, who advise that global emissions should be reduced by at least 75% across all sectors to avoid uncontrolled climate change.

This study suggested that emissions could be further reduced by increasing concrete's strength, because the volume of concrete required is lower overall. However, concrete affects the environment in other ways besides producing greenhouse gas emissions. Therefore, the researchers took into account a range of environmental effects of building a bridge from ordinary concrete (with low cement content) compared to a similar bridge built from superior strength concrete (with high cement content). They used a life cycle assessment (LCA) method to compare two existing bridges in France, both typical of highway crossing bridges, each around 50 metres long and around 10 metres wide. The LCA approach they used was based on a widely used International Organization for Standardization (ISO) method that has been used in the building sector previously.

In their assessment, the researchers' estimated that the high performance concrete bridge used around two thirds less concrete than the standard concrete bridge (around 280 cubic metres versus around 840 cubic metres). Their assessment considered production of the main materials (concrete, steel and asphalt) used in the construction of the bridge, transport of these materials, and energy required for the construction, maintenance and demolition phases. Each bridge was assessed based on environmental indicators related to material consumption, acidification, eutrophication, global warming, ozone layer depletion, air pollution and toxicity to humans and ecosystems.

The results suggest that the production and maintenance phases make the biggest contributions to environmental impacts for both bridges. For the high-strength concrete bridge, the environmental impacts are about 15% lower for most categories. This is mainly because less cement is used overall, even though the content per cubic metre is higher. This also leads to energy savings in transport of materials, a shorter construction process and easier demolition. However, uncertainties in the data exist because some factors could not be accurately estimated. For example, the researchers did not know exactly how far the materials were transported and the levels of pollutants emitted during cement production vary from plant to plant.

Overall, the difference in impacts between the two bridges was greatest for global warming. According to the researchers, a bridge made with high performance concrete should have a global warming impact (based on CO_2 emissions) that is between 3 to 40% lower than a conventional bridge - depending on various factors, such as the distance between the production site and building site.

When only the global warming impact of concrete production was considered, the saving compared to conventional methods was 50%. The researchers conclude that promoting the use of high performance concrete for bridges is an efficient effort towards the goal of sustainable building.

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1. UNSTATS, 2010. Greenhouse Gas Emissions by Sector (Absolute Values). United Nation Statistical Division, New York, USA.