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Sustainable development and climate change initiatives

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Abstract

In the present paper we argue that the cement and concrete industry is contributing positively to the Climate Change Initiative by:

* Continuously reducing the CO_2 emission from cement production by increased use of bio-fuels and alternative raw materials as well as introducing modified low-energy clinker types and cements with reduced clinker content.
* Developing concrete compositions with the lowest possible environmental impact by selecting the cement type, the type and dosage of supplementary cementitious materials and the concrete quality to best suit the use in question.
* Exploiting the potential of concrete recycling to increase the rate of CO_2 uptake.
* Exploiting the thermal mass of concrete to create energy-optimized solutions for heating and cooling residential and office buildings.

Keywords: Sustainability (new); Cement manufacture (E); Clinker (D); Blended cement (D); Concrete

1. Introduction

Sustainable development has been defined by the World Business Council for Sustainable Development (WBCSD) as: "Forms of progress that meet the needs of the present without compromising the ability of future generations to meet their needs" [1].

The WBCSD continues: "Given the scale of world poverty today, the challenge of meeting present needs is urgent. But we must look ahead and do our utmost to ensure that what we do today for our ever-growing population does not compromise the environmental, social and human needs of our descendants".

Concretes made with hydraulic binders (almost all based on Portland cement) are by far the most widely employed construction materials worldwide in terms of volume, and as such have a huge impact on the environment and also on sustainable development. Produced using readily available raw materials, being easy to use and possessing good strength and durability, concrete is indispensable for meeting modern society's needs for infrastructure, industry and housing. The fast growth in developing economies such as China or India can only be sustained if an inexpensive construction material with low environmental impact is available. Concrete fulfils these requirements.

In the present paper we argue that the cement and concrete industry is contributing positively to the Climate Change Initiative by:

- Continuously reducing the CO_2 emission from cement production by increased use of bio-fuels and alternative raw materials as well as introducing modified low-energy clinker types and cements with reduced clinker content.
- Developing concrete compositions with the lowest possible environmental impact by selecting the cement type, the type and dosage of supplementary cementitious materials and the concrete quality to best suit the use in question.
- Exploiting the potential of concrete recycling to increase the rate of CO_2 uptake.
- Exploiting the thermal mass of concrete to create energy-optimized solutions for heating and cooling residential and office buildings.

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Much scientific evidence links climate change to greenhouse gas (GHG) emissions of which carbon dioxide (CO_2) ranks amongst the most important, accounting for 82% of the total. It is estimated that the cement industry produces approximately 5% of global manmade CO_2 emissions, but it emits almost no other GHGs. When all GHG emissions generated by human activities are considered, the cement manufacturing industry is found to be responsible for only about 3% of total anthropogenic GHG emissions.

Apart from emissions linked with the energy used for clinker burning, grinding and other operations, there is a natural release of CO_2 associated with the de-carbonation of limestone to give the calcium silicates and aluminates in clinker. This "Raw Materials CO_2 Emission" is roughly equal to 0.53kg per kg of clinker. The total CO_2 emitted in cement manufacture includes, in addition, the "Fuel-Derived CO_2" and also takes into account the dilution of clinker by other cement ingredients. Humphreys and Mahasenan [2] report that the cement industry emitted in 2000, on average, 0.87kg of CO_2 for every kg of cement produced (worldwide cement production in 2000: 1.57billion tonnes, in 2004: over 2billion tonnes).

>An analysis carried out by Battelle [2] shows that cement sector CO_2 emissions are set to rise dramatically in the coming decades. Demand for cement in industrial nations is increasing slowly, but in developing countries it rose by 55% in the 1990s. It is expected that, by 2020, global demand will have increased by 115–180% from 1990 levels, with a four-fold increase likely by 2050. It is critical that the CO_2 emissions associated with such growth in cement production be reconciled with international efforts to reduce GHG effects. The cement industry is fully aware of the sustainable development stakes and, over the past decades, has been actively involved in seeking ways to consume less energy and natural resources, and emit less CO_2 per unit of cement produced. Recent innovations such as self-compacting concrete, high-performance concrete and surface-active materials further contribute to sustainable development by reducing the costs of construction and maintenance, improving health and safety as well as the outdoor and indoor environment.

2. Global warming

Climate change has become an issue of global prominence and, in today's society, often provokes animated debates over its origins. Most of the scientific evidence, however, links increased GHG emissions to the average warming of our planet.

How do GHG emissions affect the climate? The Sun's radiation heats the surface of the Earth, which in turn radiates energy back to space. Some of this radiation (almost all in the infrared spectrum) is trapped in the atmosphere by GHGs, which have strong absorption bands in the infrared range. The trapped radiation warms the lower atmosphere (troposphere). This heat then finds its way back down to the Earth's surface, making it hotter than it would otherwise be. This is similar to what happens in a greenhouse.

There is strong evidence which suggests that a significant proportion of the warming observed over the past century is attributed to human activities. Here are a few key examples of trends and projections [3]:

- *GHG concentrations*: CO_2 concentration has increased from its pre-industrial level of 280ppm to the 2003 level of 375ppm (+ 34%), with an accelerated rise since 1950. The total rise in all GHG since the pre-industrial era amounts to 170ppm CO_2-equivalent, with contributions of 61% from CO_2, 19% from CH_4, 13% from CFCs and HCFCs, and 6% from NO_2. If no climate-driven policy measures are implemented, a further increase to 650–1215ppm CO_2-equivalent is projected to occur by 2100.
- *Global and European air temperature*: The Earth's average surface temperature has increased by 0.7 ± 0.2°C over the past 100years. Europe has warmed more than the global average, with a 0.95°C increase since 1900. The 1990s were the warmest decade in the observational record; 1998 was the warmest year, followed by 2002 and 2003. Without policy measures, from 1990 to 2100, the global average temperature is projected to increase by 1.4–5.8°C and 2.0–6.3°C for Europe.
- *Glaciers, snow and ice*: From 1850 to 1980, glaciers in the European Alps lost approximately one third of their area and one half of their mass, a trend that is continuing. By 2050, about 75% of the glaciers in the Swiss Alps are likely to have disappeared. The northern hemisphere's annual snow cover extent has decreased by about 10% since 1966. It is projected to decrease further during the 21st century. The total area of Arctic sea ice shrank by more than 7% from 1978 to 2003. Projections show a predominantly ice-free Arctic Ocean in summer by 2100.
- *Rise in sea level*: It is estimated that the current rise in sea level of 0.8–3.0mm/year will continue over the 21st century and intensify by 2.2 to 4.4 times the present value.

The climate change issue is, however, only a part of the larger challenge of sustainable development. As a result, climate policies can be more effective when consistently embedded within broader strategies designed to make various development paths more sustainable.

World leading cement producers are fully aware of their part of the responsibility in implementing all the necessary measures and, in 2002, ten international companies set out to help the industry play a stronger role in support of sustainable development. In June 2005, under the auspices of World Business Council for Sustainable Development (WBCSD), a Progress Report was published which was undersigned by 16 companies.[1] It lists the *Key Performance Indicators of the Cement Sustainability Initiative*:

- Climate change management
  - Number of facilities and percentage using WBCSD CO_2 protocol
  - Company-wide total CO_2 emissions, tons/year
  - Company-wide gross and net CO_2 emissions per ton of cementitious product

[1] The sixteen companies were: Ash Grove Cement Company, Cemex (including RMC), Cimpor, Corporacion Uniland, CRH plc, Gujarat Ambuja Cements, HeidelbergCement, Holcim, Italcementi, Lafarge, Secil-Companhia Geral de Cal e Cimento, Shree Cement, Siam Cement Industry, Taiheiyo Cement, Titan Cement, Votorantim.