

BUILDING A FUTURE, WITH CEMENT & CONCRETE
ADAPTING TO CLIMATE CHANGE BY PLANNING SUSTAINABLE CONSTRUCTION



CLIMATE CHANGE: A REALITY

Climate change is already having an impact worldwide. A report¹ issued in 2007 by the Intergovernmental Panel on Climate Change (IPCC) concludes that the years from 1995-2006 “rank among the twelve warmest years in the instrumental record of global surface temperature” since 1850.

The IPCC report also highlights rising sea levels and decreases in snow and ice extent, consistent with global warming. In addition, it notes that heat waves are “likely” to become more frequent. The Stern report² adds that climate change will have serious implications for the world economy if society fails to adapt whilst at the same time taking action to cut greenhouse gas emissions to mitigate further changes.

Across Europe, the effects of climate change could range from lower rainfall in some parts of the continent, higher rainfall and sea-level rises in others, warmer winters, hotter, drier summers and extreme weather events. The potential consequences include impacts on soil stability, coastal erosion, flooding and heat waves.



MITIGATION NECESSARY; ADAPTATION ESSENTIAL

The Kyoto Protocol and any following international agreement will determine how governments and businesses respond to the threat of climate change over the coming decade in terms of mitigation.

It is clear that efforts must be made to mitigate the causes of climate change³, by reducing greenhouse gas production, for example. In fact, Europe is the first region to have implemented an emissions trading scheme with the aim of reducing CO₂ emissions.

Nevertheless, despite mitigation, climate change is a reality now and, as such, society needs to adapt and protect itself from the consequences today and in the future. Technical and innovative solutions that help Europe, and the rest of the world, to adapt are already necessary. It must be borne in mind that cli-

mate change is a worldwide phenomenon. It is therefore imperative that the solutions found be extended to other, less developed, parts of the world to provide them with the necessary protection when confronted by, for example, extreme weather conditions resulting from global warming.

Accordingly, it is essential to adapt to climate change by adopting, amongst other things, new building regulations and standards. Failing to take proactive measures now, will only necessitate more expensive measures later on.

1. The AR4 Synthesis Report (17 November 2007) available from www.ipcc.ch.

2. Stern Review on the Economics of Climate Change: http://www.hm-treasury.gov.uk/sternreview_index.htm

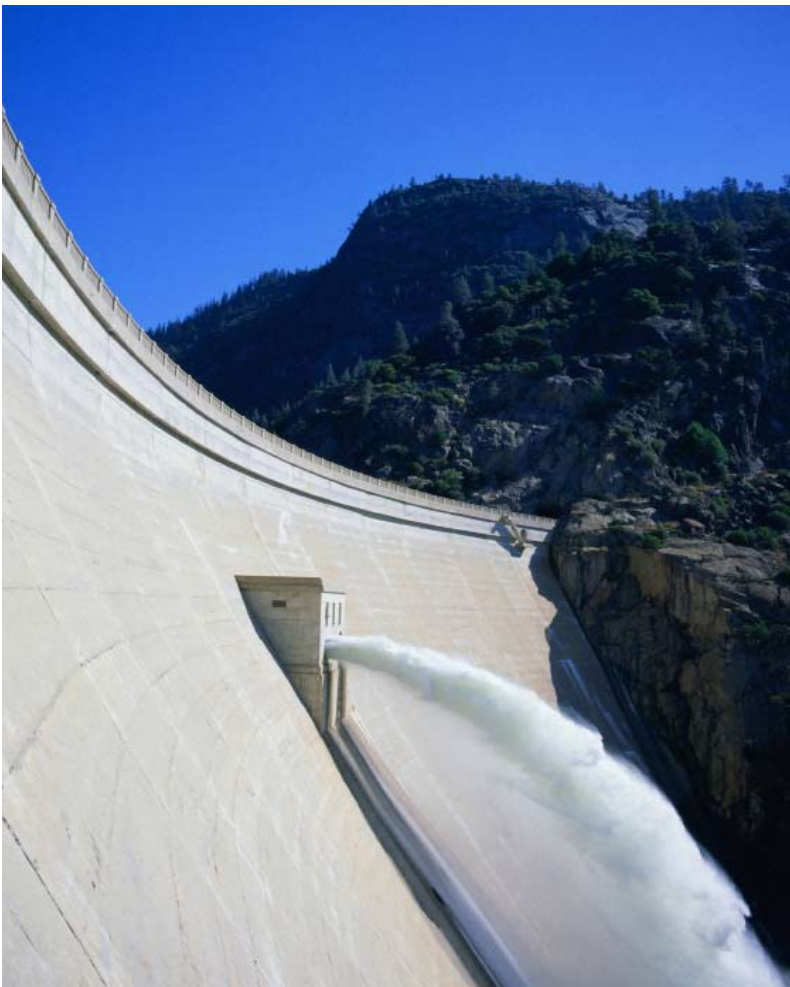
3. Please refer to page 9 of this publication for more information on efforts undertaken by the European cement industry in terms of mitigation.

ADAPTING TO CLIMATE CHANGE: CONCRETE SOLUTIONS

Experts predict that extreme weather events, such as flooding, sea-level rises and natural disasters, will make unprecedented demands on society. This will necessitate the urgent construction of secure new buildings and infrastructure. Concrete, a cement-based material, has a key role to play in helping society adapt and face the impacts of climate change in an affordable way.

Concrete products can help combat and prevent the detrimental consequences of climate change by protecting people, property and the environment. Being a robust and versatile material, concrete can provide the level of climate proofing that will become mandatory as national building codes are revised to cope with more extreme weather events.

In addition, concrete is extremely durable. Properly designed and constructed homes, schools, hospitals, and dams will provide solutions not only for existing generations but also for the future, due to their longevity. Furthermore, concrete works recover quickly in the event of, for example, water damage, thereby reducing the amount of time needed to repair the affected area.



FOCUS

FLOOD PROTECTION AND WATER MANAGEMENT

Floods damage human health, the environment, infrastructure and property. Since 1998, floods in Europe have caused about 700 deaths, displaced approximately half a million people and generated insured economic losses in excess of €25 billion⁴.

One-third of the European Union population is estimated to live within 50km of the coast and some 140,000km² of land (slightly greater than the surface area of Greece) is currently less than 1m above sea level. Flood protection and water management is therefore essential. In this regard, concrete can be used in:

- ▮ flood barriers⁵ and other protective structures;
- ▮ hydraulic works and coastal defences
 - sustainable urban drainage systems (SUDS) that can cope with heavy rainfall and protect the built environment against flash floods;
- ▮ water conservation and management in dams and reservoirs.

Concrete can also help to guarantee a safe, secure drinking water supply, preventing outbreaks of waterborne diseases such as dysentery.

4. Commission staff working document accompanying the White Paper "Adapting to climate change: Towards a European framework for action" – Climate Change and Water, Coasts and Marine Issues - SEC(2009) 386/2

5. Based on laboratory tests conducted by CIRIA, a report from the UK Department of Communities & Local Government (CLG), Improving flood performance of new buildings: flood resilient construction, concluded that the building materials most effective for excluding water include engineering bricks, aircrete blocks and cement-based materials including concrete and dense stone.

1. PROTECTING PEOPLE

During extreme weather events, a safe environment is essential for the protection of citizens. For example, long periods of drought can result in extensive fires. In addition, significant and frequent rainfall can increase the risk of flooding. Concrete can be used to provide comprehensive fire and flood protection including protection of people, animals, goods, property and the environment. It also plays a key role in guaranteeing a safe, secure supply of drinking water and power. Furthermore, it does not only protect people physically from extreme events. Thanks to its high thermal mass, concrete enhances thermal comfort by minimising or avoiding overheating during heat waves especially when combined with natural ventilation and appropriate building architecture. This also reduces the need for air conditioning, thereby reducing CO₂ emissions from energy consumption.

2. PROTECTING THE ENVIRONMENT

Climate change also has an impact on the environment and its resources. Flood protection as well as capture and storage of water are just two areas to which concrete can contribute as a solution. In addition, it can be used to protect coastlines vulnerable to changes in sea level, preserve vital water supplies (through dams and reservoirs, provided that the correct environmental impacts and risk/benefit analyses are carried out), managing rainwater, drinking water, drainage and sewage.

FOCUS

THE WORLD HEALTH ORGANISATION (WHO) ENDORSES A LONG-TERM APPROACH TO CONSTRUCTION

As the WHO points out⁶, extreme temperatures can have a significant impact on human health. In the summer of 2003, a severe heat-wave struck much of Western Europe and 12 European countries reported over 70,000 more deaths than the averages for the five previous years. For populations in the EU, the estimated increase in mortality will be 1-4% for each degree increase in temperature above a cut-off point.

The WHO backs a long-term approach that includes making healthcare facilities disaster-proof and constructing new buildings that provide thermal and indoor air comfort and protection from extreme weather conditions.

Concrete is one of the best materials available for naturally mitigating temperature extremes.



6. Protecting Health in Europe from Climate Change, 2008: <http://www.euro.who.int/document/e91865.pdf>

3. PROTECTING PROPERTY

The more robustly homes and infrastructure are built, the less adverse social and environmental impact future meteorological events will have. Concrete structures are both robust and flood-resistant and provide a high degree of protection against flying debris during extreme events (e.g. hurricanes and tornadoes). For example, the Texas Technology University's Wind Engineering Research Center⁷ found that only concrete wall systems were proven to withstand 100% of all hurricane-force winds, and over 99% of tornado-force winds.

4. AGRICULTURE AND FARMING

A 2007 report⁸ on the agricultural sector by the AEA Energy & Environment and Universidad de Politécnica de Madrid concludes that while "some aspects of climate change such as longer growing seasons and warmer temperatures may bring benefits, there will also be a range of adverse impacts, including reduced water availability and more frequent extreme weather". For example, excessive heat in summer can lead to heat stress in dairy cattle. The heat inertia of buildings housing cattle can attenuate heat stress, with concrete providing a solution due to its passive cooling qualities.

In terms of providing a solution to reduced water availability, concrete is one of the materials of choice for irrigation systems linked to water management facilities.



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OPTIMISING LAND USE

"Brownfield sites" are previously developed land often used for industrial and commercial purposes, which may be contaminated, but have redevelopment potential. In recent years, they have increasingly become the focus of attention, owing to the shortage of green spaces available for commercial, industrial, residential or community developments.

For example, the UK is committed to making the development of brownfield sites a priority, and the British government advocates building at least 60% of new homes on previously developed land. This target was already exceeded in 2008.

The recycling of brownfield land is made possible by the use of cement-based materials, which play an important role in reclaiming contaminated industrial sites: contaminated soils and waste can be stabilised with cement and isolated from the environment by vertical, impermeable, cement-based cut-off walls. Cement stabilised soils used for infrastructure construction replace primary resources like sand and aggregates, which avoids the dumping of excess soil in landfill sites, thus preserving the open countryside.

In addition, concrete basements allow land to be used more efficiently by reducing the plot size required to achieve a given floor area and, at the same time, increasing the number of units on a development.

These two elements increase the land use potential, which is relevant when taking into consideration the loss of inhabitable areas as a result of climate change as well as potential migration.

7. <http://www.wind.ttu.edu/>

8. Adaptation to climate change in the agricultural sector: http://ec.europa.eu/agriculture/analysis/external/climate/ex_sum_en.pdf

CASE STUDIES



THE ITALIAN 100K€ HOUSE PROJECT

This project involves the recovery of a disused industrial area which will be transformed into an urban area with the construction of thirty 100m² modular houses in Italy. The research has focussed on creating a 100m² house with zero CO₂ emissions thanks to an architecturally integrated photovoltaic system, special solar panel surfaces for capturing energy during the winter, optimum interior air circulation for the summer months and all the other passive strategies required to turn the building into a bioclimatic machine. Low construction costs have also been achieved by using a light, flexible form of concrete prefabrication, including structural elements, technical systems and mobile components. To make the residential unit as adaptable as possible and guarantee total freedom in terms of layout, a structural grid framework in reinforced concrete has been designed to “surround” the unit.

More information:
<http://www.casa100k.com>

ADAPTING TO CLIMATE CHANGE BEYOND EUROPE'S BORDERS

Antibacterial concrete controls bacteria growth, helping to maintain clean environments.

Innovative products that bring social and environmental benefits while reducing their environmental impact.

In 1999 a special antibacterial concrete to be used in hospitals, laboratories and as flooring in low-income houses was developed. Other applications include free-flowing foundation concrete and concrete used by livestock farmers who need surfaces that can withstand the acid environment of silage storage.



PORTUGAL - THE DOURO JETTIES

The Douro jetties were constructed with the aim of stabilising the margins of the river Douro, Cabedelo and the coastal areas next to Foz, to improve the safety and navigational conditions in strong tides and the preservation of environmental, landscape and aesthetic values. The Douro Jetties are passable and it is also possible to visit the interior of the North Jetty.

Two protection jetties were built to the north and to the south of the Douro River Bar. Both were mainly built in concrete (60,000m³ of concrete, 30,000m³ of high density concrete, 17,100kN of steel reinforcement, 285,000m³ in rock filling and 210,000m³ in dredging) and are approximately 450m in length.

An environmental impact assessment, carried out before construction started, concluded that one of the major advantages of this infrastructure would be the reduction in the risk of floods occurring in the coastal areas of Porto and Gaia.



THE NETHERLANDS

After the 1953 floods in the south-west of the Netherlands, the Eastern Schelde, (a vital link in the Delta Works), was due to be completely closed off with a regular dam. However, opposition against a complete closure of the Eastern Schelde mounted because of potential environmental effects. In 1978 it was decided that the Eastern Schelde wouldn't be completely closed off from the sea building, opting instead for a barrier with movable components that would only have to be closed in the event of a storm. The Netherlands already had extensive experience in the field of large scale hydrological engineering works. Many problems, however, had to be overcome using completely new technologies. The seafloor of the Eastern Schelde had to be strengthened using mats in order to install 66 huge concrete pillars, each weighing 18,000 tonnes that were constructed in giant docks and moved to the dam site. The building of the barrier meant a giant step forward in the technology for the use of concrete for sea-based structures. The Eastern Schelde storm surge barrier was completed in 1986.

CEMENT MANUFACTURING

Cement is a finely ground, non-metallic, inorganic powder which, when mixed with water, forms a paste that sets and hardens. Through its use in concrete, it plays a key role in our lives, as it is a basic material used in all types of construction, including housing, roads, schools, hospitals, dams and ports. Cement occurs naturally in the environment (“Puzzolana”), but the quantity produced by nature is insufficient to meet demand, so man-made cement is essential.

Cement is made by heating limestone and other ingredients to 1,450°C in a kiln. The resulting material (clinker⁹) is then ground with a small amount of gypsum into a powder (cement) which is used to produce concrete. The production of cement generates carbon dioxide emissions from two different sources: combustion (40%) and calcination (60%). Combustion-generated CO₂ emissions are related to fuel use. CO₂ emissions due to calcination are formed when the raw materials (mostly limestone and clay) are heated and CO₂ is liberated from the decomposed limestone.

The most important use of cement is in the production of concrete, binding the other key ingredients of concrete (water, sand and gravel). Cement typically accounts for up to 12% of the entire concrete mix.

Cement-based materials have a clear role to play in helping European society adapt to climate change - hence the need for competitive and efficient building materials. Security of supply is of strategic importance not only for electricity, but also for building materials. This should be taken into account in all debates, more particularly when considering the risks of carbon leakage, i.e. substituting imports to domestic EU production, thereby relocating CO₂ emissions and even increasing them with shipping. As such, clinker and cement production should be maintained in Europe.

Cement is essential to economic and social development. Through its downstream products, it provides society with what it needs in terms of safe, comfortable housing and reliable modern infrastructure.

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ENERGY EFFICIENCY IN BUILDINGS

Concrete can buffer a large proportion of heat gains. The high thermal mass of concrete in buildings optimises the benefits of free solar gains and decreases heating fuel consumption by 2-15% compared to equivalent lightweight buildings in a range of European climates, from Sweden to Portugal¹⁰.

The passive cooling qualities of concrete can limit the need for air conditioning during warm summers. Intelligent combinations of heating, natural ventilation, solar shading and structural features can together reduce energy consumption associated with cooling (and their related CO₂ emissions) by up to 50%.

Concrete helps to prevent overheating in warming climates, keeping buildings cool when temperatures rise, thus providing thermal comfort for users.

Finally, exposed concrete surfaces can reflect light deep into buildings' interiors, saving on energy costs for artificial lighting.



9. Clinker, one of the main constituents of cement, is produced from raw materials (mainly limestone and clay) which are heated by a 2000°C flame in rotary kilns.

10. “Concrete for energy efficient buildings – the benefits of thermal mass”. European Concrete Platform, 2007

THE EUROPEAN CEMENT INDUSTRY'S COMMITMENT TO CO₂ REDUCTION

It is essential that society's current needs and expectations for the built environment are met, whilst minimising the environmental impact and its consequences on future generations. Cement manufacturing is an energy intensive process and has an initial high carbon footprint. Nevertheless, the lifecycle benefits and durability of cement-based product applications can result in significant energy and CO₂ savings.

The European cement industry is committed to reducing CO₂ emissions in the manufacture of cement and to reducing air emissions (due to dust, gases, noise and vibrations). It is developing more environmentally friendly products and enhancing innovative processes. In 1993, the cement industry was already close to the limit of what could be achieved through technical improvements and rationalisation, with an independent study commissioned by the European Commission assessing the potential for further improvements at 2.2%¹¹. Information recently published by the Cement Sustainability Initiative (CSI)¹² confirms that existing clinker-making technologies do not provide potential for significant improvement in terms of energy-efficiency. More details on this report can be found on the website of the World Business Council for Sustainable Development (www.wbcsd.org).

This is where the use of waste, both as alternative fuels and raw materials, comes as a major breakthrough. Co-processing of alternative fuels and raw materials in the cement industry is the optimum way of recovering energy and material from waste. It offers a safe and sound solution for society, the environment and the cement industry, by substituting non renewable resources with societal waste, such as used tyres, fly ash and slags, under strictly controlled conditions. Alternative fuels and raw materials currently meet around 18% of the European cement industry's requirements, reducing overall CO₂ emissions, preserving valuable raw materials and minimising waste management costs and landfilling or incineration¹³.



FOCUS

ENVIRONMENTAL AND ECONOMIC BENEFITS OF CONCRETE ROADS

From a climate adaptation perspective, roads melting in hot weather constitute a mounting problem. During the summer of 2006, this phenomenon became a major issue in the UK, necessitating repairs running into millions of GBP. The melting of roads is also a common occurrence during the summer in southern Turkey. As concrete roads are not affected by this problem, they provide a good alternative.

Concrete pavements are long lasting and low maintenance. This means less disruption for the travelling public and commercial hauliers, which in turn helps to reduce greenhouse gas (GHG) emissions. Low maintenance also represents lower costs¹⁴. Extensive studies confirm that fully loaded tractor-trailers consume less fuel when travelling on rigid concrete pavements than on flexible pavements¹⁵. This is true over a wide temperature range and, again, contributes to reducing GHG emissions.

11. "Energy Technology in the Cement Industrial Sector" Final Report for Directorate-General for Energy (XVII) Contract NO XVII/4.1000/E/91-6

12. The Cement Sustainability Initiative (CSI) launched its "Getting the Numbers Right" (GNR) project to obtain current and robust data for CO₂ and energy performance of clinker and cement production at regional and global levels across cement companies worldwide.

13. More information on this topic can be found in the CEMBUREAU publication "Sustainable cement production. Co-processing of alternative fuels and raw materials in the European cement industry"

14. Bituminous and continuously reinforced concrete pavements for motorways – An economic comparison", Walloon Ministry of Infrastructure and Transport, 2006

15. National Research Council of Canada (NRCC)

IN A NUTSHELL

Impacts of climate change	Solutions provided by cement-based materials (concrete)
Extreme weather events	Concrete buildings and infrastructure are robust and stable, providing a safe built environment for society.
Floods & rising sea levels	<p>Concrete can provide solutions through flood protection and prevention structures, coastal defences, hydraulic works and water management.</p> <p>Managing rainwater: sewers and drainage systems capable of coping with heavy rainfall and containing flash floods. Sustainable urban drainage systems (SUDs) enable the water to filter into the ground soil and alleviate the problems of over-loaded drainage systems and the containment of flash floods.</p>
Rising temperatures, heat waves	<p>Concrete provides thermal stability and comfort, as well as ensuring energy efficiency in buildings. Its passive cooling qualities can be used to make buildings and infrastructure more sustainable and climate proof, hence reducing CO₂ emissions.</p> <p>The air tightness properties of concrete help create healthy indoor living conditions, which is of particular importance to those most at risk (such as the elderly) during heat waves.</p>
Spread of diseases, epidemics	Concrete structures are durable, resistant to vermin and pests and can guarantee a safe supply of drinking water.
Optimising land use	Cement is used for reclaiming brownfield sites and for soil stabilisation, where it replaces primary resources, eliminating the need to dump excess soils in deposit sites.

→ EUROCODES

Eurocodes are one of the most advanced suite of structural codes in the world. They embody the collective experience and knowledge of whole of Europe. The aim of the Eurocode 2 is to lead to a common understanding of the design principles of concrete structures for owners, operators and users, design engineers, contractors and the manufacturers of concrete products. Like many current national codes in Europe, Eurocode 2 (EC 2) for concrete structures draws heavily on the CEB Model Code. Ultimately, Eurocode 2 will be the one design code for all concrete structures in Europe.

ACTION AT EU LEVEL

Cooperation is key. Industry, policymakers and other stakeholders must work together to help Europe adapt to climate change.

A sustainable built environment, capable of meeting future challenges, must therefore:

- have a long life (to avoid building, demolition and rebuilding);
- consume little energy throughout its entire life;
- be "loose fit" (allowing for future flexibility and adaptability).

Unfortunately, some design approaches adopted to mitigate climate change take no account of adaptation. Worse still, some national design codes and standards place undue emphasis on minimising embodied impacts and energy use of products, whilst little or no attention is paid to the whole-life performance of buildings.

The benefits of heavyweight materials used in construction works should be recognised in existing and future legislation, such as the Energy Performance of Buildings Directive (EPBD). In addition, national compliance tools for assessing both energy consumption and sustainable performance of buildings need to be amended to take due account of thermal mass and climate change.

Concrete is capable of playing a strategic and indispensable role in adapting to climate change.

CEMBUREAU therefore calls upon the EU to help future generations by:

- ensuring that all new infrastructure and buildings are constructed to meet the demands of a changing climate;
- taking due consideration of all long-term economic and societal aspects of climate change to build a secure future for those most affected, including making low and/or zero-energy homes affordable for "average" households;
- considering the overall environmental and energy performance of the whole building or infrastructure throughout its entire service life;
- taking full account of thermal efficiency and the major benefits of durable heavyweight materials in building codes within the context of climate change - both passive and active use of thermal efficiency should be quantified and pre-calculated;
- establishing planning and land use guidelines to maximise, for example, the reuse of brownfield land and avoid construction on flood plains.



CEMBUREAU, the European Cement Association based in Brussels, is the representative organisation of the cement industry in Europe. Currently, its Full Members are the national cement industry associations and cement companies of the European Union (with the exception of Cyprus, Malta and Slovakia) plus Norway, Switzerland and Turkey. Croatia is an Associate Member of CEMBUREAU.

In 2007, CEMBUREAU Members produced a total of 325Mt of cement. The average per capita consumption in the CEMBUREAU member countries in 2007 was 546kg. In the 27 Member States of the European Union, production reached an estimated 270Mt, accounting for nearly 10% of world production.



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