Sustainable concrete

Chris A Clear  BSc PhD CEng MICE FICT FIMMM
Technical Director BRMCA
Concrete is sustainable - it would be impossible to have sustainable development without concrete.
Concrete is sustainable...

Homes

Health

Sea defence

Water

Energy

Business

Transport

mpa british ready-mixed concrete association
Sustainable options

Hard engineering
Coastal railway, Dawlish UK

Soft engineering
Flood alleviation scheme, Maidenhead UK
Concrete is sustainable - but we need to supply evidence
Sustainable Construction

EN 15643  Sustainability of construction works -
Assessment of buildings -
Part 1: General Framework
Part 2: Framework for the assessment of environment performance
Part 3: Framework for the assessment of social performance
Part 4: Framework for the assessment of economic performance

The scope of the sustainability of construction works is being expanded to cover the assessment of civil engineering works
## EN 15643-4 Economic indicators

<table>
<thead>
<tr>
<th>Cost</th>
<th>Financial value</th>
</tr>
</thead>
<tbody>
<tr>
<td>– economic performance expressed in cost terms over the life-cycle</td>
<td>– economic performance expressed in terms of financial value over the life-cycle</td>
</tr>
</tbody>
</table>

Cost and value

mpa british ready-mixed concrete association
### EN 15643-3 Categories for social aspects

<table>
<thead>
<tr>
<th>Health and comfort</th>
<th>Accessibility</th>
<th>Maintenance</th>
<th>Safety/security</th>
<th>Loadings on the neighbourhood</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Thermal performance</td>
<td>- Accessibility for people with specific needs</td>
<td>- Maintenance requirement</td>
<td>- Resistance to climate change</td>
<td>- Noise</td>
</tr>
<tr>
<td>- Humidity</td>
<td></td>
<td></td>
<td>- Fire safety</td>
<td>- Emissions</td>
</tr>
<tr>
<td>- Quality of water for use in buildings</td>
<td></td>
<td></td>
<td>- Security against intruders and vandalism</td>
<td>- Glare</td>
</tr>
<tr>
<td>- Indoor air quality</td>
<td></td>
<td></td>
<td>- Security against interruptions of utility supply</td>
<td>- Shock/vibrations</td>
</tr>
<tr>
<td>- Acoustic performance</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Visual comfort</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Thermal performance, maintenance, flood & fire resistance, security...**
## Thermal performance

### The ZERO CARBON HOME - 2016

<table>
<thead>
<tr>
<th>Carbon Compliance level* kgCO₂(eq)/m²/year</th>
<th>Low-rise Apartment Block, average per unit</th>
<th>Mid-terrace house</th>
<th>End terrace house</th>
<th>Detached house</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>11</td>
<td>11</td>
<td>10</td>
<td></td>
</tr>
</tbody>
</table>

* In addition to meeting the CO₂ targets 2016 compliance will also require that the fabric performance requirements specified in the Fabric Energy Efficiency Standard (FEES) for zero carbon homes, these are currently set at 39 kWh/m²/year for apartment blocks and mid-terrace houses, and 46 kWh/m²/year for semi-detached, end of terrace and detached houses.
Thermal mass - overheating and operational energy

Overheating, two consecutive days and intervening night - 1 June to 15 September

<table>
<thead>
<tr>
<th>Region</th>
<th>Day max, °C</th>
<th>Night min, °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>North East England</td>
<td>28</td>
<td>15</td>
</tr>
<tr>
<td>London</td>
<td>32</td>
<td>18</td>
</tr>
</tbody>
</table>

mpa british ready-mixed concrete association
Cumulative CO₂ emissions, air-conditioned

CO₂ Emission (Tonnes)

Year

2000  2020  2040  2060

Additional embodied CO₂ offset in 11 years

Lightweight house

Medium weight house

mpa british ready-mixed concrete association
Performance of a UK 1968 traditionally built house [+cavity wall insulation, double glazed, 2008 boiler]
### EN 15643-2 Further environmental indicators (informative)

<table>
<thead>
<tr>
<th>Environmental impacts (LCIA impact categories)</th>
<th>Resource use (environmental aspects) non-renewable</th>
<th>Resource use (environmental aspects) renewable</th>
<th>Other environmental information (environmental aspects)</th>
</tr>
</thead>
<tbody>
<tr>
<td>biodiversity</td>
<td>use of non-renewable resources other than primary energy</td>
<td>use of renewable resources other than primary energy</td>
<td>use of environmentally sustainably managed materials (grouped per material type e.g. PEFC, FSC, responsibly sourced materials BS 8902:2009)</td>
</tr>
<tr>
<td>ecotoxicity</td>
<td></td>
<td></td>
<td>use of environmentally sustainably managed fuels (grouped per fuel type e.g. Sustainability criteria for bio-fuels ISO 13065)</td>
</tr>
<tr>
<td>human toxicity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>land use change</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Responsible sourcing...
responsibly sourced

this is concrete

This concrete is responsibly sourced and certified to BES6001

mpa british ready-mixed concrete association
### EN 15643-2 Environmental indicators

<table>
<thead>
<tr>
<th>Environmental impacts (LCIA impact categories)</th>
<th>Resource use (environmental aspects) non-renewable</th>
<th>Resource use (environmental aspects) renewable</th>
<th>Other environmental information (environmental aspects)</th>
</tr>
</thead>
<tbody>
<tr>
<td>- abiotic depletion potential (elements and fossil fuels)</td>
<td>- use of non-renewable (NR) primary energy excluding NR primary energy resources used as raw materials</td>
<td>- use of renewable (R) primary energy excluding R primary energy resources used as raw materials</td>
<td>- components for reuse</td>
</tr>
<tr>
<td>- acidification of land and water resources</td>
<td>- use of NR primary energy resources used as raw materials</td>
<td>- use of R primary energy resources used as raw materials</td>
<td>- materials for recycling</td>
</tr>
<tr>
<td>- destruction of the stratospheric ozone layer</td>
<td>- use of NR secondary fuels</td>
<td>- use of secondary materials*</td>
<td>- materials for energy recovery</td>
</tr>
<tr>
<td>- eutrophication</td>
<td></td>
<td>- use of R secondary fuels</td>
<td>- non-hazardous waste to disposal</td>
</tr>
<tr>
<td>- formation of ground-level ozone</td>
<td></td>
<td>- use of freshwater resources*</td>
<td>- hazardous waste to disposal (other than radioactive waste)</td>
</tr>
<tr>
<td>- global warming potential</td>
<td></td>
<td></td>
<td>- radioactive waste to disposal</td>
</tr>
</tbody>
</table>

Resource efficiency, global warming potential, waste.

**mpa** british ready-mixed concrete association
Resource use - permitted UK reserves of aggregates for 40 years

Land won sand and gravel
Sand and gravel inactive sites
Crushed rock
Crushed rock inactive sites

Geological map of Britain and Ireland

mpa british ready-mixed concrete association
Simplifying Environmental and other impacts into a single score, E-points

Environmental impact of 1 tonne of cement equivalent to 2 tonnes of aggregate?
Aggregates, always recovered and reused
Comparison of construction materials

Reinforced Concrete  Steel  Timber

mpa  british ready-mixed concrete association
## Impacts - Office and Healthcare

<table>
<thead>
<tr>
<th>Material</th>
<th>kgCO$_2$e /kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structural steel</td>
<td>0.89</td>
</tr>
<tr>
<td>Reinforcement</td>
<td>1.40</td>
</tr>
<tr>
<td>Concrete</td>
<td>0.10</td>
</tr>
</tbody>
</table>

**Resource use**

**Global warming potential**

mpa  british ready-mixed concrete association
Resource use

Structural quantity, kg/m²

- Rebar
- Steel
- Concrete

- Office A
- Office B
- Healthcare A
- Healthcare B

mpa  british ready-mixed concrete association
Global warming potential

Global warming potential, kgCO₂eq/m²

- Rebar
- Steel
- Concrete

Office A
Office B
Healthcare A
Healthcare B

mpa british ready-mixed concrete association
Concrete is sustainable...

Sustainability benefits

*Cost and value*

*Thermal performance, maintenance, flood & fire resistance, security...*

*Responsible sourcing...*

Sustainability calculations

*Resource efficiency, global warming potential, waste*
Specifying Sustainable Concrete

www.sustainableconcrete.org.uk
Green concrete, sustainable concrete

Garden bridge, footbridge across Thames