BRITISH READY-MIXED
CONCRETE ASSOCIATION

Guidance Document on 'Sustainable Concrete Design and Rating Systems'

1 CONTENTS

This publication is designed to assist all those involved in the management, specification and building of residential properties.

Introduction

This document is intended to offer guidance on the design process and considerations to be taken into account when using ready-mixed concrete to deliver Sustainable Construction, focusing upon the Green Guide, BREEAM & the Code for Sustainable Homes and their associated rating systems.

The above documents are part of a building assessment tool kit designed to help deliver sustainable construction. The Green Guide feeds into the 'Materials' sections of both BREEAM and the Code for Sustainable Homes, and the scores achieved by specification of A+ to E ratings within the Green Guide represent a maximum of 7% of the overall building score. The Green Guide currently applies to 'Low rise' housing only, with a specific 'High Rise' version under development.

To achieve the most sustainable building design, a balance between material impacts and in-life performance is required. Often elements that do not score the highest ratings within the Green Guide are actually proven to be the most sustainable option in terms of 'In-use' and 'Whole-life' performance.

Currently, concrete designed with a large proportion of Recycled Concrete Aggregate (RCA) as a replacement for virgin/primary aggregate will achieve significantly higher scores, owing to the weighting system applied to 'mineral resource depletion' within the Green Guide.

However, the effect of increased cement contents associated with the introduction of RCA into fresh concrete are not currently considered in terms of overall environmental impact and additional CO_2 emissions. Hence, we seek to examine this in more detail within this document.

Indeed, greater benefits can be achieved by better overall design, taking account of Thermal Mass and the use of High Strength Concrete (HSC) offering a form of temperature regulation and increased floor space respectively.

Basically, concrete acts as thermal sponge, absorbing heat during the summer and so cooling a building, and storing heat from the sun or heaters to release it at night (This is explained further on page 5).

In this regard, it should be noted that ready-mixed concrete scores extremely highly within the 'Code for Sustainable Homes' via the BRE 'Responsible Sourcing' standard and 'Part L' of the Building Regulations (something which cannot be matched by competing products).

Ready-mixed concrete is an extremely versatile and sustainable construction material. It offers the designer enormous flexibility in terms of its basic performance, together with a wealth of 'whole-life' benefits.

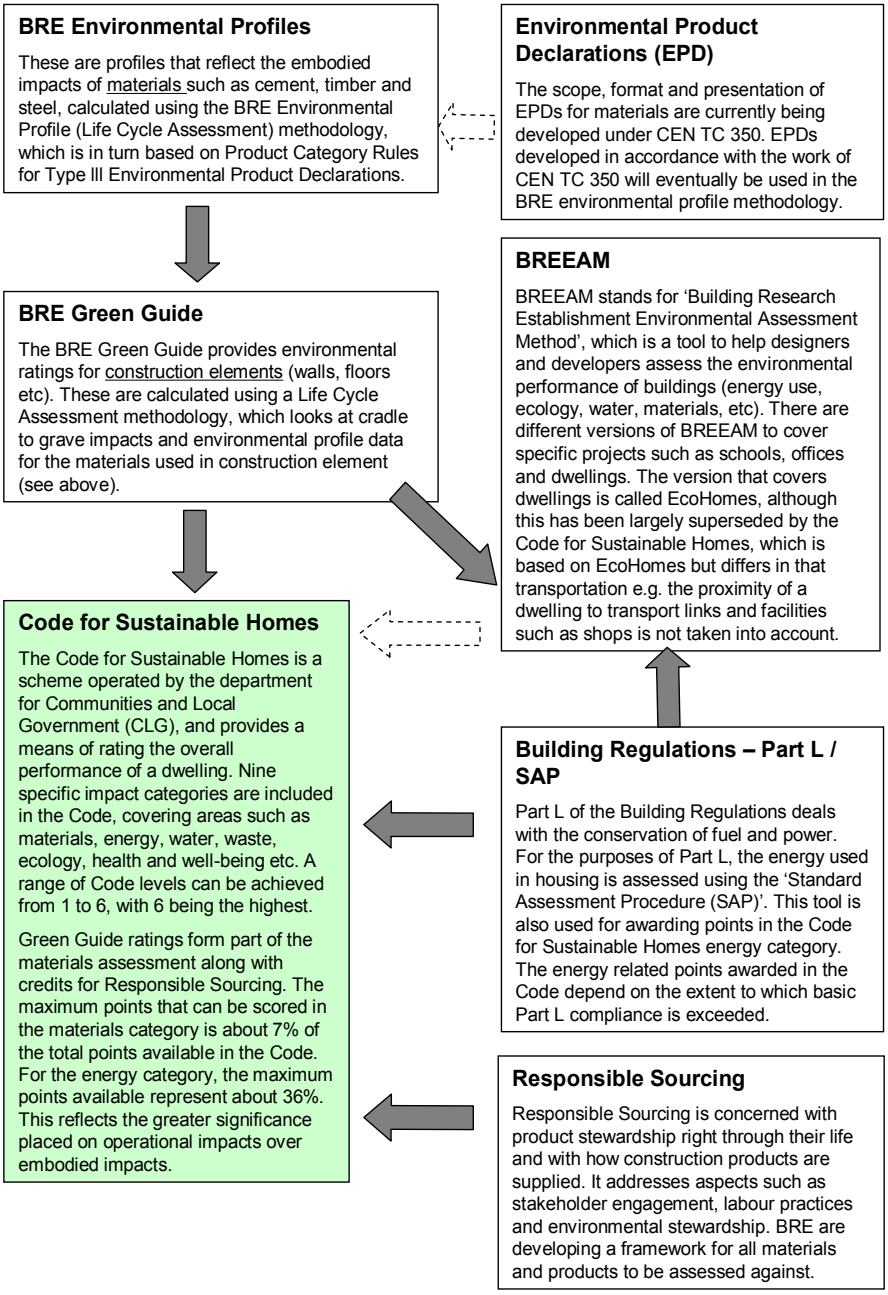
This document explains how maximum sustainable performance can be achieved when using this exciting method of construction.

Section 1 – Designing in concrete against the Green Guide, BREEAM and the Code for Sustainable Homes to achieve higher ratings

Section 2- Summary of ready mixed concrete sustainability & responsible sourcing credentials

Section 1 – Designing in concrete against the Green Guide, BREEAM and the Code for Sustainable Homes to achieve higher ratings

How the codes fit together:



Summary Information –The Concrete Centre[8]

The Green Guide

The Building Research Establishment (BRE) Ecopoint ratings provide a convenient means of expressing and comparing the overall embodied environmental performance of construction materials and products. The lower the score, the lower the impact. As a benchmark, 100 Ecopoints are equivalent to the annual impact of the average EU citizen. To put this in perspective, a cubic metre of ready-mix concrete typically scores around 1.9 Ecopoints, which is largely determined by two factors, the emission of carbon dioxide together with the energy needed to make Portland cement and the mineral resource depletion.

Since walls and floors etc. are generally made up of several different products, the BRE produce aggregated Ecopoint scores for construction elements, which include maintenance and disposal impacts based on a 60-year life.

THE CODE FOR SUSTAINABLE HOMES™

These form the basis of the BRE Green Guide which provides environmental ratings of A+ to E for a broad range of construction elements used in housing and they are grouped under various headings such as external walls, roofs, windows etc.

The ratings are in bands with the sum of the band widths set by the highest and lowest Ecopoint score. The difference in Ecopoints between A+ and E could be 1 or 10 Ecopoints and a construction system falling within one band may not be statistically different to a system falling into a different band.

Whilst the Green Guide ratings focus largely on the embodied environmental impacts of materials, it should be recognised that it is the operational impacts of a building that are the most significant.

Key operational issues such as long term durability (beyond 60 years), acoustic performance, flood resilience, fire resistance and energy in use should also be considered.

These issues are outside the scope of the Green Guide, but they need to be taken into account when evaluating the likely in-use performance of materials. Relying solely on the embodied environmental performance of materials is unlikely to identify the most sustainable solution.

Of the 13 environmental impact categories that make up a Green Guide rating, global warming potential is judged to be the most significant, i.e. the greenhouse gases associated with the manufacture, use and disposal of a product.

However, the embodied CO_2 emissions associated with the construction phase of a building and the impact reflected in the Green Guide rating represents only a fraction of the CO_2 that is emitted during the in-use phase of a building's life.

The ratio of embodied to in-use CO_2 depends largely on building type/use, life span, and thermal efficiency, and is typically between about 1:10 and 1:4.

The Green Guide methodology assumes the same level of thermal insulation for each type of construction element to aid direct comparison. However, it takes no account of their varying thermal masses.

As discussed previously, thermal mass relates to the ability of construction materials to absorb, store and release heat.

Nightingale Estate, Hackney, which use the high thermal mass of ready-mixed concrete together with passive solar design

Ready-mixed concrete provides a high level of thermal mass, which helps regulate the internal environment of buildings, reducing the energy needed for heating and avoiding or minimising the need for air conditioning.

In this regard, it should be noted that an office that avoids air conditioning through the use of thermal mass in concrete floors in combination with natural/mechanical ventilation will typically reduce its CO_2 emissions by around 20% per year [1] or be used to form part of a zero-carbon solution.

The cumulative saving this provides outweighs the difference in embodied CO_2 between concrete and alternative construction materials in a fraction of the building's life [2].

The benefits from utilizing thermal mass in providing passive heating for housing are described in reference [3] and this can reduce heating fuel consumption by up to 11% and in as little as 11 years show a lower total energy consumption (construction and use).

Hence, based upon the above, it should be recognised that the Green Guide ratings are a first step and are designed to be taken forward into BREEAM and the Code for Sustainable Homes, to then contribute to an overall score.

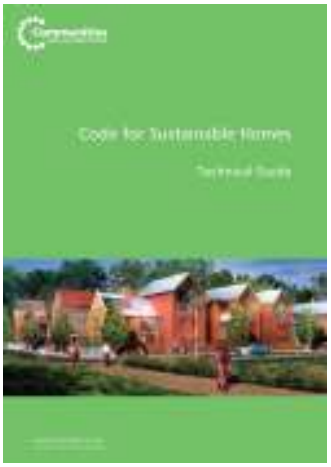
Therefore, the exclusion of certain materials at the preliminary design stage by the specification of, for instance, 'A+ to C ratings only' should be avoided in order to ensure a truly sustainable whole life solution.

BREEAM and the Code for Sustainable Homes

BREEAM stands for the 'Building Research Establishment Environmental Assessment Method', which is a tool to help designers and developers assess the environmental performance of buildings (energy use, ecology, water, materials etc.)

There are different versions of BREEAM to cover specific projects such as schools, offices and dwellings.

The version that covers dwellings is Called EcoHomes, although this has largely been superseded by the Code for Sustainable Homes, and it is this document that we will now concentrate upon.



The Code for Sustainable Homes [1] has six levels and these are linked to minimum standards for certain categories which include energy and water efficiency (see Table1 over page).

The Code starts at Level 1, which Requires a 10% improvement on Approved Document L.2006 [2] which is the current regulatory standard.

To achieve Level 1, 36 points are required. Level 6 is an aspirational standard based on the goal of zero carbon; 90 points are required to achieve Level 6.

To achieve points, credits gained from the environmental impact categories are converted using an environmental weighting factor.

This information is contained in the technical guide that supports the code; this document is being updated at regular intervals and in order to stay up to date, the latest version available online from the Communities and Local Government website should be used [3].

There are nine categories within the Code and each of these contains a number of issues which contribute to a sub total credits which are converted through the weighting for each category into points. Within each category there are a maximum number of points which can be scored.

The summation of the points from each category identify which Code level has been achieved. This assessment is carried out both at the design and the post completion stages to ensure the required performance has been delivered. All of the categories and issues are listed in the following table together with the credits and points available.

Concrete can contribute to gaining credits in all of the categories within the Code for Sustainable Homes.

There are also areas where the inherent performance benefits of concrete do not gain credits, but their importance should not be overlooked as they influence the design and purchase of a building. These include aesthetics, security, affordability and maintenance.

Concrete offers the benefits of thermal mass as well as excellent acoustic and vibration performance.

Many of the benefits such as inherent fire resistance, air tightness, durability and security are requirements of Building Regulations and the Loss Prevention Standard for Innovative Dwellings – LPS 2020, developed by BRE Certification to provide an effective method of assessing the performance and design of new methods of construction [6].

Summary of the environmental issues and credits available

Table 1: Achieving a sustainability rating in the Code					
Minimum Standards					
Category	**Energy**		**Water**		**Other**
Code Level	**Standard % over Part L .2006[2] / day**	**Points Awarded**	**Standard (litres/person /day**	**Points Awarded**	**Minimum Points required**
1(*)	10	1.26	120	1.5	33.24
2(**)	18	3.77	120	1.5	42.73
3(***)	25	6.28	105	4.5	46.22
4(****)	44	10.04	105	4.5	53.46
5(*****)	100 [4]	17.57	80	7.5	58.93
6(******)	zero carbon [5]	18.83	80	7.5	63.67

Category definitions and credit data is taken from the Code for Sustainable Homes Technical Guide [1]. Tables/Summary information (points to note for concrete construction) – The Concrete Centre[8].

Categories	Credits	Comments	Points to note for concrete construction
1. ENERGY/CO2	**29**	**Maximum Points = 36.4**	
Dwelling Emission Rate (DER) Aim: To limit emissions of carbon dioxide (CO2) to the atmosphere arising from the operation of a dwelling and its services.	15	Credits are awarded based on the % improvement in the DER below the Target Emissions Rate (TER). DER and TER are as defined in Approved Document L1A:2006. The estimate is based on CO2 emissions in kg per m2 p.a. arising from heating, hot water and lighting. The assessment is based on SAP 2005 and Part L of the Building Regulations.	Passive solar design using thermal mass can maximise operational energy savings. Work is currently underway to recognise this benefit within the BREEAM family of assessment tools and thus gain credits. For more details see the Concrete Centre publication " Energy and CO_2"
Building Fabric Aim: To future proof the energy efficiency of dwellings over their whole life by limiting heat losses across the building envelope.	2	Credits are awarded based on the Heat Loss Parameter for each dwelling. SAP 2005 and Part L of the Building Regulations is part of the assessment methodology.	A U value of 0.2 W/m^2K is likely to be appropriate for Code levels 3 and 4. Low air leakage levels can be achieved with ready mixed concrete. Insulated Concrete Formwork (ICF) is also an effective means of achieving or exceeding this requirement. Concrete Basements are thermally efficient (warm in winter and cool in summer)
Internal Lighting Aim: To encourage the provision of energy efficient internal lighting.	2	Credits are awarded for the provision of fixed dedicated energy efficient internal light fittings. Evidence at design and construction stages is required.	Passive design solutions encourage the use of orientation and exposed concrete finishes which can contribute to improving day-lighting and reduce artificial lighting.
Drying Space Aim: To minimise the amount of energy used to dry clothes.	1	Credits are awarded based on the provision for drying space for each dwelling type.	
Energy Labelled White Goods Aim: To encourage the provision or purchase of energy efficient white goods.	2	Credits are awarded where information is provided relating to the provision of energy efficient white goods, or where the energy efficient white goods are supplied.	

Categories	Credits	Comments	Points to note for concrete construction
External lighting Aim: To encourage the provision of energy efficient external lighting.	2	Credits are awarded where all external space lighting not fixed to the external surface of the dwelling is provided by dedicated energy efficient fittings.	
Zero/low Carbon (ZLC) Energy Technologies Aim: To reduce pollution by encouraging local energy generation from renewable sources.	2	Credits are awarded based on the % reduction in total carbon emissions that result from using ZLC technologies.	Low grade heat sources e.g. ground source heat pumps are generally more effective with higher thermal mass construction, such as concrete.
Cycle Storage Aim: To encourage the wider use of bicycles as transport by providing adequate and secure cycle storage facilities.	2	Credits are awarded where adequately sized, safe, secure, convenient and weather-proof cycle storage is provided.	
Home Office Aim: To reduce the need to commute to work by providing residents with the necessary space and services to work from home.	1	Credits recognise the provision of space and services that enable a room to be used effectively as a home office. Evidence at design and construction stages is required. Sufficient room, space and services, including ventilation and windows/ daylight factor, are part of the requirements.	Concrete construction provides the structural integrity for a room in the roof to be a feasible space for a home office. Basements are a great space to accommodate the lifestyles of occupants, including use as a home office.
2. Water	**6**	**Maximum Points = 9**	
Internal Consumption Aim: To reduce the consumption of potable water.	**5**	Credits are awarded based on the predicted average household water consumption. Litres per head per day (l/h/d)	Average (l/h/d) is about 150. Below 100 would require use of recycled water.
External Consumption Aim: To encourage recycling of rainwater and reduce the amount of potable water used in landscape /garden watering.	**1**	One credit is awarded for providing a system to collect rainwater for use in irrigation	Concrete products are available that are suitable for water storage and offer the benefits of being rot and vermin proof. A SUDS system can be used for rainwater harvesting.
3. MATERIALS	**24**	**Maximum Points = 7.2**	
Aim: To encourage the use of materials with lower environmental impacts over their life cycle. **This section is based on information obtained from The Green Guide[7].**	**15**	Credits are awarded where at least three of the following five key elements achieve a relevant green guide rating of A+ to D: roof, external walls, internal walls (including separating walls), upper and ground floors (including separating floors) and windows.	Generic profile ratings from the green guide can be used or product specific profiles may be available from the product manufacturer. Specifications not in the green guide can be provided by the BREEAM office as a bespoke rating. Different environmental ratings can be achieved with different concretes. The use of admixtures and byproducts from other industries, such as ground granulated blast furnace slag (ggbs) and fly ash can be used to improve the elements rating.

Categories	Credits	Comments	Points to note for concrete construction
Responsible Sourcing Basic Elements Aim: To recognise and encourage the specification of responsibly sourced materials for the basic building elements.	6	Credits are awarded where materials used in the key building elements (frame, ground floor, upper floor, roof, external walls, internal walls, foundations/substructure and staircase) are responsibly sourced. EMS certification, ISO 14001 and evidence of the use of reused materials and recycled materials are part of the assessment methodology.	Currently, concrete product manufacturers can provide information to demonstrate responsible sourcing. The industry is working with BRE to integrate existing activity into a pan-industry scheme for responsibly sourced concrete products which will gain additional credits.
Responsible Source Finishing Elements Aim: To encourage the specification of responsibly sourced materials for the finishing elements.	3	As above, with finishing elements identified as stair, window, door, skirting, panelling, furniture, fascias and other.	
4. SURFACE WATER	4	**Maximum Score = 2.2**	
Reduction of Surface Water run-off from site Aim: To reduce and delay water run-off from the hard surfaces of a housing development to public sewers and watercourses, thus reducing the risk of localised flooding, pollution and other environmental damage.	2	Credits are awarded where rainwater run-off is attenuated. Evidence including manufacturer's data and design/proof of rainwater attenuation.	Sustainable Urban Drainage Systems (SUDS) may use permeable concrete solutions to manage run-off and facilitate rainwater storage. As well as protecting utilities and property, it can also reduce the impact of a deluge of contaminated water on flora and fauna. Green roofs can also be used and the strength and durability of concrete provides an ideal roof structure.
Flood Risk Aim: To encourage developments in areas with low risk of flooding or if developments are to be situated in areas with medium risk of flooding that appropriate measures are taken to reduce the impact in an eventual case of flooding.	2	Credits are awarded where evidence is provided to demonstrate that the risk of flood is low or measures are taken to reduce the impact. Flood probability and manufacturer's data covering flood protection are part of the assessment methodology.	If the demand for housing requires building on flood plains, concrete structures are resilient and less susceptible to damage caused by exposure to flood water. Advice given by the Association of British Insurers includes: • Replace timber floors with concrete and cover with tiles • Replace gypsum plaster with more water-resistant material, such as lime plaster or cement render [8].
5.WASTE	7	**Maximum Points = 6.4**	
Household Waste Storage and Recycling Facilities Aim: To recognise the importance of having adequate internal and external storage space for waste.	4	Credits are awarded for the provision of storage space for household and recycling waste.	

Categories	Credits	Comments	Points to note for concrete construction
Composting Aim: To encourage developers to provide the facilities to compost household waste.	1	Credits are awarded where home composting facilities are provided in houses with gardens or LA kitchen waste collection/communal/community composting services.	
Construction Site Waste Management Aim: To recognise the importance a Site Waste Management Plan has on the efficient use of resources during construction and demolition, and to promote the reduction of site waste.	2	Credits are awarded based on the site complying with the criteria set out in the Code for Sustainable Homes. A Site Waste Management Plan must be produced and implemented as part of the assessment methodology.	Concrete has a number of benefits that can assist in reducing site waste. For example your concrete supplier can offer: - Takeback schemes for un-used ready-mix concrete. - Just-in time delivery. Also concrete is 100% recyclable, which reduces any waste should the structure be demolished at end of life.
6. POLLUTION	4	**Maximum Points = 2.8**	
NOx emissions Aim: To reduce the emission to air of nitrogen oxides (NOx).	3	Credits are awarded on the basis of NOx emissions arising from the operation of space heating and hot water systems.	
Global Warming Potential (GWP) of Insulants Aim: To reduce global warming potential from the manufacture, installation use and disposal of foamed thermal and acoustic insulating materials.	1	Credits are awarded where all insulating materials in the elements avoid the use of substances that have a significant GWP. Elements are roofs, walls, floors, hot water cylinder, and cold water storage.	When using concrete systems with in-built insulation, such as sandwich panels or Insulated Concrete Formwork (ICF) please ask your product manufacturer for more information.
7. HEALTH AND WELLBEING	12	**Maximum Points = 14**	
Daylighting Aim: To improve the quality of life in homes through good daylighting and to reduce the need for energy to light the home.	3	Credits are awarded for the dwelling meeting criteria based on a minimum average daylight factors.	The use of passive solar design solutions encourages the use of orientation and exposed concrete finishes that can contribute to improving day lighting and reducing need for artificial lighting.
Sound Insulation Aim: To ensure the provision of improved sound insulation to reduce the likelihood of noise complaints from neighbours.	4	Credits are awarded for achieving higher standards of sound insulation than those given in Approved Document E of the Building Regulations and demonstrating it by either using post-completion testing or Robust Details.	Concrete's mass and damping qualities are exceptional and can be used to achieve good acoustic performance. Increasing the mass of a wall or floor improves the sound insulation of a room, provided all gaps are sealed. Currently 60% of the approved systems under Document E, (Robust Details) for separating walls and floors use concrete and masonry. Credits available under the Code see: www.robustdetails.com

Categories	Credits	Comments	Points to note for concrete construction
Private Space Aim: To improve the occupiers' quality of life by providing an outdoor space for their use, which is at least partially private.	1	Credits are awarded for an outdoor space that meets the criteria of size and access.	The flexibility and versatility of concrete products means there are a number of solutions that can provide or enhance this private space. Landscaping products for ground floor and communal areas as well as concrete solutions for balconies and roof terraces.
Lifetime Homes Aim: To encourage the construction of homes that are accessible to everybody and where the layout can easily be adapted to fit the needs of future occupants.	4	Credits are awarded where all the principles of Lifetime Homes have been complied with. Lifetime Homes is a principle developed in 1991 and the scheme involves the incorporation of 16 design features.	Many of the areas covered relate to the design and layout of the home and can be easily delivered using concrete solutions. In addition, concrete produces robust structures that can be flexible and allow for the future adaptability of the dwelling.
8. MANAGEMENT	**9**	**Maximum Points = 10**	
Home User Guide Aim: To recognise and encourage the provision of guidance to enable home owners/occupiers to understand and operate their home efficiently and use local facilities.	3	Credits are awarded for the provision of a simple user guide that covers information relevant to the 'non-technical' tenant/owner on the operation and environmental performance of their home.	To achieve efficient, comfortable and healthy buildings training occupants to understand the environment is vital. Passive design solutions e.g. those that exploit the energy savings that can be offered by concrete's thermal mass, will require good quality user information.
Considerate Constructors Scheme Aim: To recognise and encourage construction sites managed in an environmentally and socially considerate and accountable manner.	2	Credits are awarded based on a commitment to comply with best practice site management principles. Schemes that contribute to credits include the Considerate Constructors Scheme.	These are areas where credits can be gained based on site activity and the project team, including the contractor, should be made aware of this requirement.
Construction Site Impacts Aim: To recognise and encourage construction sites managed to mitigate environmental impacts.	2	Credits are awarded based on a commitment and strategy to operate site management procedures.	These are areas where credits can be gained based on site activity and the project team, including the contractor, should be made aware of this requirement.
Security Aim: To encourage the design of developments where people feel safe and secure and where crime and disorder, or the fear of crime, does not undermine quality of life or community cohesion.	2	Credits are achieved by complying with section 2 - Physical Security from 'Security by design – New Homes'.	Homeowners and residents, particularly in high crime areas, can be confident of their security when concrete construction has been used rather than more fragile options. Concrete construction in all its forms - blockwork, precast panels or cast in situ are capable of providing strong durable structures that are resistant to unauthorized forced entry.

Categories	Credits	Comments	Points to note for concrete construction
9. ECOLOGY	**9**	**Maximum Points = 12**	
Value Aim: To encourage development on land that already has a limited value to wildlife.	1	Credits are awarded where the site is defined as land of inherently low ecological value.	Cementitious products can provide effective remediation for contaminated land in order to support an increase in the ecological value of a site.
Enhancement Aim: To enhance the ecological value of a site.	1	Credit is awarded based on a commitment to enhance the ecological value of the development site.	
Protection Aim: To protect existing ecological features from substantial damage during construction works.	1	Credits are awarded based on a commitment to maintain and adequately protect features of ecological value during site preparation and construction works.	
Change in value Aim: To reward steps taken to minimise reductions and to encourage an improvement in ecological value.	4	Credits are awarded based on a measured resulting change in ecological value.	Concrete and masonry can provide structures and elements needed to support Green Roofs, vegetation against walls as well as roosting and breeding sites for birds and bats. Concrete elements in landscaping can also encourage appropriate places for flora and fauna.
Footprint Aim: To promote the most efficient use of a building's footprint by ensuring that land and material use is optimised.	2	Credits are awarded based on the ratio of combined internal floor area of all dwellings on the site to their footprint.	Basements are a potential solution for increasing the floor area of the dwelling, without increasing the footprint of the building. The standard height of the building can be maintained so no planning issues are created.

The concrete design process

Overall design

Table 1 gives in volume terms the quantities of materials used to make a typical structural concrete used for housing (designated concrete RC20/25).

A concrete has to be designed to provide the necessary strength and durability to meet the specification while also ensuring its consistence (workability) and fresh properties are suitable for the intended method of placing, compacting and finishing.

BS 8500-1 provides recommendations on how to specify these requirements and also provides recommendations for all cements and combinations[1] for which there is established UK experience.

Table 1 — Typical volume proportions of a 'green' RC20/25 designated concrete

Portland cement	4% if used with ggbs to 7% if used with fly ash
Ground granulated blastfurnace slag (or fly ash)	5% (or 4% if fly ash)
Active component of admixture	0.025%
Free water	17%
Fine aggregate	30%
Recycled concrete aggregate	9%
Natural coarse aggregate	35%

Constituent materials – Cements

As can be seen, while the proportion of Portland cement clinker is relatively low in volume terms, it has been identified in the Ecopoint system as a main contributor to the global warming potential of concrete.

It is therefore essential that during the design process, full consideration is given to the constituent materials affecting the overall cement content of concrete.

In sustainability terms, the following cements or cement combinations should be specified wherever possible:

- For normal construction: specify IIB-V or IIIA cements or combinations;

- For foundations specify: IVB-V or IIIB cements or combinations.

These cements/combinations (shown in Table 2 below) provide a balance between technical requirements and sustainability and are suitable for almost every application.

In specification terms, it is better to allow either 'fly ash' or ggbs' as ready-mixed concrete suppliers are likely to stock only 1 of the 2 materials at any given plant.

Table 2 — Cement/combination types

Cement or combination designation	Proportion of fly ash/ground granulated blastfurnace slag
IIB-V	21% to 35% fly ash
IIIA	36% to 65% ggbs
IVB-V	36% to 55% fly ash
IIIB	66% to 80% ggbs

[1] A 'combination' is a cement made in the concrete mixer, e.g. Portland cement and ggbs or fly ash are added as separate components into the concrete mixer.

Constituent materials – Aggregates

The draft Construction Products Regulation [4] includes a new 'Essential Requirement 7: *Sustainable use of natural resources'*, which will have to be implemented into harmonised European standards and form part of CE-marking.

Sustainable use of natural resources is an important issue, and in this regard, primary/virgin aggregate is widely recognised and classified as 'sustainable' as a result of the extensive world wide available resource.

However, the Green Guide Ecopoint system currently uses a simple mineral resource depletion approach regardless of availability or scarcity and

consequently a heavy 'weighting' is applied to the use of virgin aggregate, which impacts greatly on the overall Ecopoint rating of ready-mixed concrete.

It should be recognised that this approach does not deal with the issues raised within the new 'Essential Requirement 7: Sustainable use of natural resources', and as such if the scoring systems were to be modified to take account of world wide mineral resources, ready-Mixed concrete would achieve at least a C ratings when using primary aggregate alone, and even higher ratings if recycled aggregates were then introduced (at controllable levels described below).

Ready-mixed concrete producers use locally available aggregates wherever possible, whilst also recognising that a balance has to be reached between aggregate quality, transportation distance and the cement content needed to achieve the specified strength.

Aggregate quality has a significant affect on the cement content of concrete and therefore its overall environmental impact.

Hence, the introduction of Recycled Aggregate (RA) or Recycled Concrete Aggregate (RCA) should be considered fully, as their introduction in high proportions will, in general terms significantly increase cement contents.

Indeed, further consideration should be given to the importation of aggregates and the overall environmental impact in terms of CO_2 emissions. Therefore from a sustainability viewpoint, close examination of the overall benefits of using a locally sourced material as against an alternative imported material is essential.

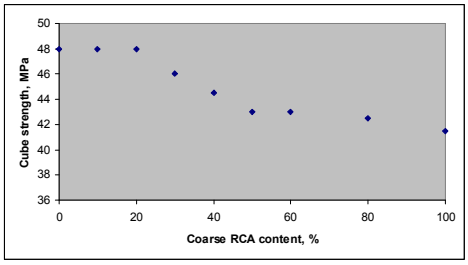
The Mineral Planning system manages the planning consent process to maintain availability of aggregates to meet demand.

In the UK the demand for aggregates for all uses is approximately 270 million tonnes per year, with 70 million tonnes of this demand coming from secondary and recycled aggregates.

Recycled aggregates (RA) comprise a wide range of hard construction and demolition wastes. Recycled concrete aggregate (RCA) is a particular type of RA that comprises at least 85% crushed concrete. The properties of RCA are well established and BS 8500-2 makes provision for the appropriate use of coarse RCA.

Provided the RCA is sourced and used locally in modest amounts in concrete, its use may result in a more sustainable concrete.

However, when the proportion of coarse RCA exceeds about 30% of the primary coarse aggregate, the strength of the concrete reduces, leading to the need to use more cement to obtain the same strength.



Example of impact on cube strength of replacing natural aggregate with RCA [5]

Based upon the above, it is clear that coarse RCA can be successfully introduced into concrete designs, but that the percentage replacement should be decided upon following liaison between all parties to ensure its best and most effective use.

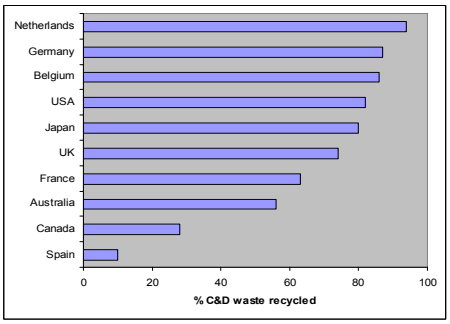
The use of RA presents more technical issues than RCA as the range of materials is so great.

The outstanding issues relate to durability and in particular resistance/contribution to alkali-aggregate reaction and internal sulfate attack. Recent data [6] shows that RA varies widely and as such presents production challenges in terms of controlling strength, density and yield.

It is therefore advisable to use RCA in concrete rather than RA.

From a waste reduction viewpoint, this is not a problem as Government research has indicated that virtually all hard construction and demolition wastes are already used in the aggregates market.

The UK is already exceeding the proposed European Union 2020 target for recycling hard construction waste of 70%.



Percentage of hard construction and demolition that is recycled [7]

There are a number of secondary aggregates such as china clay wastes and slate wastes that are consistent in quality and density and such materials are suitable for use in concrete.

Constituent materials – Water

A cubic metre of fresh concrete contains about 140 to 190 litres of water. Water is also used to clean out the truck and for recovering aggregates from returned concrete.

Usually, this wash water is not wasted but it is used in the production of further batches of concrete.

Water is needed to provide the fresh concrete with a suitable consistence (workability).

This water content may be reduced by using chemical admixtures and by doing so there is a major benefit of reducing the cement content (see Table 4) for the same consistence, strength and durability.

Ninety percent of concretes in the UK contain a water-reducing admixture or the more powerful superplasticizing admixture.

Table 4 — Potential cement reduction resulting from water reduction

Water reduction, l/m^3	Perc. water reduction	Cement reduction at w/c ratio of 0.55, kg/m^3	Cement reduction at w/c ratio of 0.40, kg/m^3
10	5.6	18	25
15	8.3	27	37
20	11.1	36	50
25	13.9	45	62
30	16.7	54	75

[a] Based on $180l/m^3$ for a concrete without an admixture.
[b] In practice the potential reduction in cement content may be limited due to the need to satisfy other criteria such as fresh concrete properties, e.g. cohesion, and specified minimum cement/combination content.

Moving from using a water-reducing admixture to a superplasticizing admixture with the consequential reduction in the cement content may be sufficient to achieve the required Ecopoint reduction.

However, care has to be taken to ensure that the concrete contains enough fine material to give a closed structure, an essential requirement for durability.

Technically, this may be achieved by using a filler aggregate or by a low level of air entrainment where strength is not the controlling factor in the mix design.

In the longer term, part of the water in fresh concrete is chemically bound in the cement hydration products, part held by various forces within the pore system and, in the right drying conditions, some will slowly evaporate into the air.

Transport

Many ready-mixed concrete plants are located within or close to aggregate quarries/gravel pits and in some urban areas, such as London, aggregates are also delivered by rail or ship.

Additionally, it should be noted that eight of the 13 cement works within the UK have rail links and these are used to transport cement to depots where it is stored before the final stage of transport by road to the ready-mixed concrete plants.

Furthermore, the average delivery distance for ready-mixed concrete is only six miles, which is considerably less than that associated with competing materials.

Note - Transport regulations prevent the ready-mixed concrete producers using larger vehicles and reducing the number of vehicle movements by this means.

Wastage and returned concrete

The current Ecopoint calculation is based on a wastage figure of 7.5%, which is widely regarded as being too high and is not supported by industry data.

For information, BRMCA have provided additional data to BRE which is currently under consideration, indicating a waste figure of 2.5% maximum, which would significantly reduce the current Ecopoint ratings of ready-mixed concrete.

It should be noted that any concrete that is returned in a ready-mixed concrete truck is rarely wasted.

Where possible and technically appropriate it may be re-assigned to a lower use. If not, it is used to produce recycled concrete aggregate or the aggregate is recovered.

Mobile crushing plant

The recycled concrete aggregate process often involves the addition of extra water. The concrete is then re-mixed and discharged into a storage area.

Periodically a mobile crushing plant is then brought in and the hardened concrete is crushed.
All this crushed material, including the fines, is used in small amounts (about 5%) in further batches of concrete.

Recovery is the process by which the fresh returned concrete is washed and the washed aggregates are returned to the aggregate stockpile. The wash water and fine material are used in further batches of concrete.

Recovery system

A number of systems are available within the UK and provide a fast and efficient method of dealing with 'returned concrete', thus enhancing the sustainable credentials of the material.

Section 2- Summary of ready mixed concrete sustainability & responsible sourcing credentials

Introduction

In 2007, 239 million tonnes of primary aggregates were used in the UK construction industry. In addition another 26 million tonnes were used for a wide variety of industrial, environmental and agricultural applications.

The use of recycled and secondary materials in GB aggregates markets reached 71 million tonnes in 2007. This accounted for 25% of the total aggregates market, more than three times higher than the European average of 8%.

Average carbon dioxide emissions per tonne of output of aggregates and value added products were about 6.0kg per tonne.

On-site carbon emissions in the aggregates sector accounted for 0.51% of the UK total, and the QPA has made a carbon reduction 'Statement of Intent' to generate significant reductions in sector emissions.

Over 86,000 jobs were dependent on the industry, including 36,000 people directly employed.

Over 35 million tonnes of aggregates were moved by rail and water, with road delivery distances for aggregates averaging 21 miles, for asphalt 17 miles and ready-mixed concrete less than 6 miles.

Certified Environmental Management Systems were recorded at 1072 QPA member locations.

172,000 trees and over 11 kilometres of hedgerows were planted. The area of land restored following quarrying continued to be higher than land prepared for new extraction.

The area dredged for marine aggregates was equivalent to 0.016% of the area of the UK seabed.

The quarrying industry has made much progress in recent years to improve its sustainability:

- We have worked to reduce adverse impacts such as noise and dust.
- We have worked to generate positive impacts such as greater biodiversity through site restoration.
- The UK aggregates sector has the best recycling record in Europe by a significant margin.
- We have supplied the materials which have enabled improvements to our buildings and infrastructure, and therefore to our standards of living and quality of life.

Given below is a summary of the sustainability & responsible sourcing credentials of concrete

Sustainability

ALL BRMCA members operate 'Sustainability Standards' and the QPA is a member of the United Kingdom Green Building Council.

BRMCA member companies are committed to utilising 'Sustainable Resources', protecting the environment for years to come and reducing CO_2 emissions

BRMCA and its members formally 'Signed up' to the 'Sustainable Construction Strategy for the concrete industry' led by Jonathon Porritt 30 July 2008.

BRMCA members are committed to:

- Sustainability management - Working with Government & The Building Research Establishment (BRE) to enhance current performance and reduce CO_2 emissions
- Governance and business ethics
- Working with local communities
- Environmental performance
- Responsible sourcing & procurement

Concrete industry 'Sustainability' initiatives & achievements:

Ready Mixed Concrete is one of the most 'ECO-Friendly' construction materials used today:

- Concrete is a small net contributor to global warming, responsible for only 2.6% of UK CO_2 emissions in 2002. This compares with 33% of total CO_2 emissions from transport and 47% from buildings in use.
- The majority of concrete contains cement produced as a by-products of other industries such as fly ash from coal-fired power stations and ground granulated blast-furnace slag from the iron industry; both these would historically have gone to land-fill.
- Concrete has inherent thermal mass properties. When used in buildings concrete reduces need for air conditioning and so saves energy and CO_2 emissions.
- The average delivery distance is 6 radial miles - saving on transport fuel and reducing CO_2 emissions
- At the site, the 'plastic' product is placed into purpose-made moulds (formwork), and with good site supervision this results in virtually zero waste.
- Any excess concrete returned from site is re-constituted and is very rarely sent to tip.
- All reinforcement bars produced in the UK are manufactured from recycled scrap
- At the end of a building's life, the in-situ concrete and reinforcement can be totally recycled and re-used in construction.
- The durability of concrete is proven by the continued existence today of buildings up to two thousand years old.
- Life Cycle Assessment (LCA) of other construction products does not stack up against concrete.

Responsible sourcing

ALL BRMCA members operate 'Responsible sourcing standards' and via the association are actively involved in the production of a government recognised 'responsible sourcing' document/standard for the industry as a whole.

BRMCA members are committed to:

- **Utilising locally available constituent materials wherever possible**
- **Material suppliers demonstrating ongoing efforts to reduce CO_2 emissions**
- **Fair trade products**
- **Research & development to find alternative and/or more 'ECO friendly' products**
- **Abolishment of slave & child labour across the world.**

Example of restoration and biodiversity process

Concrete industry 'Responsible sourcing' initiatives & achievements:

- The majority of concrete is produced using UK Sourced cementitious materials
- A large proportion of constituent materials are transported by rail or barge, thus reducing CO_2 emissions.
- All Cement products are produced by BS EN ISO 9001 certifies suppliers, also operating BS EN ISO 14001 & OHSAS 18001certified systems
- The majority of aggregates used within concrete are sourced locally and travel minimal distances to Ready Mix Concrete plants.
- The Quarry Products Association (QPA) has developed specific environmental and sustainability strategies to ensure its products are responsibly sourced and produced:

The QPA is committed to:

Biodiversity and geodiversity

Restoration

The Natural environment

For more information please visit www.qpa.org

Health & safety

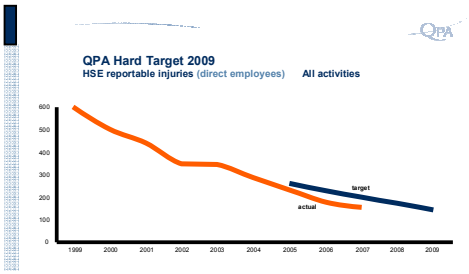
The Quarry Products Association (QPA), to which BRMCA belongs, takes the issue of health & safety very seriously and in 1999 agreed with the then Health and Safety Commission to a voluntary hard target initiative for reducing recordable injuries by 50% in 5 years.

The outcome was the notable achievement of a 52% reduction. At the start of 2004, the QPA set its own 5-year hard target for a further 50% reduction. After 4 years (up to the end of 2007) the target was already close to being met.

During 2008, the QPA – and therefore the BRMCA – will be finalising plans to implement an agreed Hard Target for the period 2009-2014.

In addition to these interim targets, the overarching expectation of the QPA is for Zero injuries.

Furthermore, it is a condition of QPA Membership that member companies supply health and safety performance data to the QPA. It is pleasing to report that 100% compliance is achieved routinely.



Social aspects

QPA members take their stewardship of the land responsibly and after use they take great care to restore the land for further use.

Examples abound of uses for farmland, woods, conservation/wildlife, recreational activities and housing/industrial. Best practice is encouraged by having a yearly awards ceremony, which has been running for two decades.

Few industries interact with society at so many levels as quarrying. Its products are as essential in keeping the nation's infrastructure going as they are to satisfying the needs of a typical family for a new home.

Civilisation as we know it would quite literally grind to a halt without the materials with which to maintain what we already have. Further progress - whether a modern hospital, new school or improved transport links - would be impossible.

Ready-mixed concrete is produced locally, creating jobs and benefiting the local and national economy.

The sector employs a very large number of people directly and supports many thousands of jobs indirectly, many in rural communities where other sources of income and employment may be limited.

The QPA has a long-established education programme which is designed to facilitate links between operational sites and local schools and colleges.

Projects are regularly set up with other organisations to tackle research into areas of technical development.

A number of these have been enabled through the Aggregates Levy Sustainability Fund, for example researching additional uses for materials generated during the production of premium aggregates, such as quarry fines.

Details of such research can be obtained from the Mineral Industry Research Organisation (MIRO).

Each relationship across this wide spectrum has been established to tackle, in partnership, a specific issue.

The industry always finds that working with other organisations adds strength and credibility to the outcome. Such partnerships can contribute across the full spectrum of sustainable development issues.

Our sustainable development strategy will act as a catalyst to both improve and extend our relationships with stakeholders.

This engagement will help to define priorities in terms of sustainability and identify any new partnerships that would be beneficial.

Simply counting these areas of engagement is not a meaningful way of accounting for the activity and its contribution to sustainable development. We would like to encourage feedback on this challenge and ask for suggestions on what we should measure and report.

End of life

It should be noted that the vast majority of Ready-Mixed concrete is 100% recyclable as aggregate for concrete.

References & acknowledgements

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