be aware

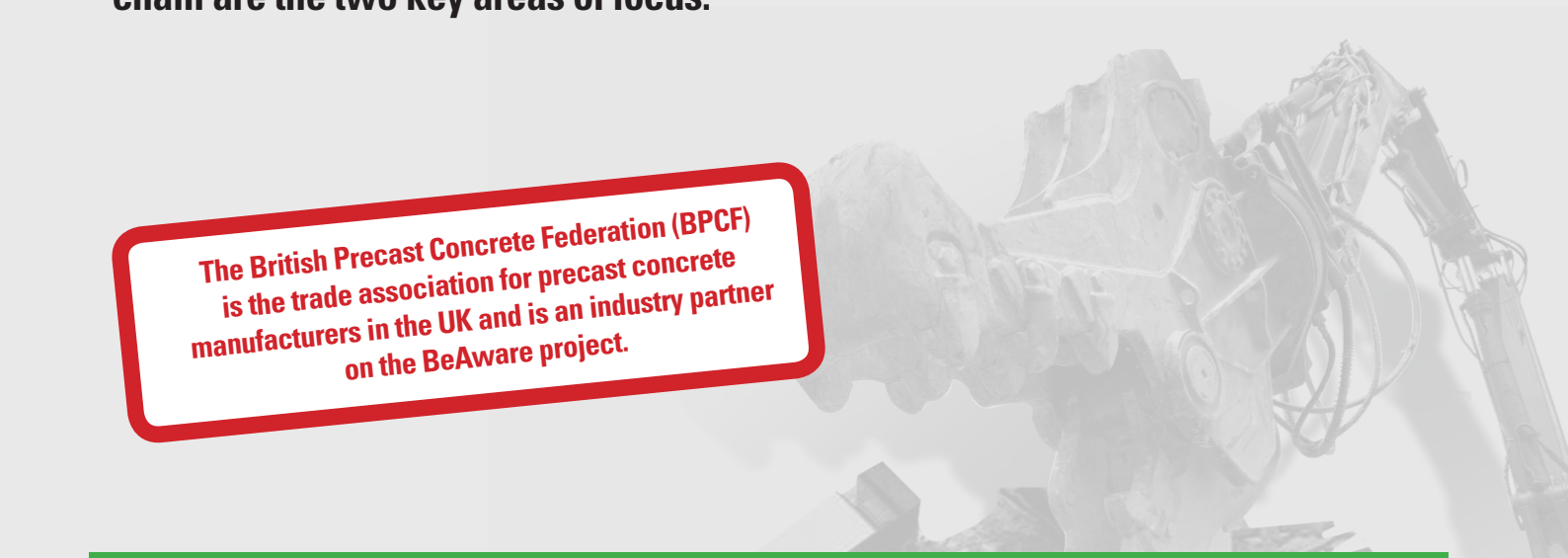
Improving resource efficiency in construction product manufacture

BeAware Supply Chain Resource Efficiency

Sector Report

Precast Concrete

BeAware is a TSB[1] and industry funded project helping construction product manufacturers to make more efficient use of materials and processes. Use of resources and waste generation associated with the product across its supply chain are the two key areas of focus.



The British Precast Concrete Federation (BPCF) is the trade association for precast concrete manufacturers in the UK and is an industry partner on the BeAware project.

Project background

Resource efficiency improvements should always be addressed within the context of the overall environmental impact of the product. A simplified environmental assessment was carried out on 20 construction products as part of the BeAware project, using life cycle assessment (LCA) data. See the *Overview of Methodology* document for further details on how this was carried out.

The supply chain for each product was also investigated to ascertain where resource efficiency improvements could be implemented. This involved examining how a product is distributed, installed, maintained and eventually disposed of. Identified areas of improvement included reduction of waste, efficient raw material use, material substitution, recycled content, packaging materials and options, and diversion of waste from landfill.

This guidance has been developed for those working in, representing or advising the precast concrete sector to raise awareness of the importance of reducing material resource usage across a product's lifecycle. Much of the information contained herein was generated at a workshop held in April 2008, attended by 10 manufacturers of precast blocks, walling units and pipes.

Rising costs of materials, the drive to divert waste from landfill and an increased focus on protecting the environment are the key drivers to improving resource efficiency. Moreover, using materials efficiently and reducing waste can produce significant cost savings, as well as improving productivity and contributing to a company's triple bottom line.

This document builds on existing industry advice and activities whilst highlighting additional sector based improvements to further improve resource efficiency. It is a part of a series of reports that are free to download from the BeAware website[2]. Similar sector guidance is available for polymers, timber windows and modern methods of construction (MMC).

1. Previously DTI, now the Technology Strategy Board (TSB) under the Department for Innovation, Universities and Skills (DIUS) http://www.berr.gov.uk/dius/innovation/technologystrategyboard/page40217.html
2. http://www.beaware.org.uk

The precast concrete sector

The precast concrete sector produces a range of products including architectural cladding, flooring units, masonry (blocks and walling), piles and foundations, paving, roof tiles, structural components, drainage and railway products.

The sector has started to report annually (via British Precast) against a number of performance indicators, including resource usage. For every tonne of precast concrete produced in 2006[4]:

- 28% of cementitious materials used were secondary materials (e.g. pulverised fuel ash (PFA) or ground granulated blastfurnace slag (GGBS)).
- 16% of aggregates used were recycled or secondary aggregates (remainder was primary aggregate).
- 3kg of packaging materials were used, of which 82% was timber and 17% plastic.
- 32kg of waste was produced, of which 29% was recycled onsite, 57% recycled offsite and 14% was landfilled.

These indicators will act as benchmarks for future performance figures.

British Precast encourages its members to sign and commit to a Sustainability Charter, a set of industry-based principles which contribute to the economic viability, social progress and environmental responsibility in the sector. Members continue to seek ways of reducing waste through manufacture, use primary materials more efficiently and promote the use of secondary materials.

Raw materials

The British Standards which govern the manufacture of precast concrete products set performance criteria for products irrespective of individual components. Many precast concrete products (for example, block pavers and aggregate concrete blocks) can therefore incorporate a high recycled content (within both the aggregate and the cement binder) without affecting end-product performance.

Recycled content currently ranges anywhere between 5-100%[5] and many manufacturers have been actively using recycled or secondary materials as a feedstock. This contributes to the overall life cycle assessment score (e.g. EcoPoints) and high recycled content specification.

For example, producers of block pavers and precast elements routinely use recycled materials derived from their own concrete production waste as an aggregate. Aircrete and aggregate block manufacturers in particular will use PFA and recycled or secondary aggregates on a routine basis[6].

Around 800 factories are responsible for producing over 36 million tonnes of precast concrete products (worth over £2.3 billion) every year in the UK[3].

3. British Precast Concrete Federation (BPCF), Sustainability Matters: Third Annual Progress Report from the Precast Industry, February 2008 http://www.britishprecast.org/documents/SM_v6.pdf
4. British Precast Concrete Federation (BPCF), Sustainability Matters: Third Annual Progress Report from the Precast Industry, February 2008 http://www.britishprecast.org/documents/SM_v6.pdf
5. Enviroblock from Masterblock. Information at http://www.masterblock.co.uk/index.html
6. BRE IP 14/98 Blocks with recycled aggregates, RJ Collins. Also WRAP Recycled Products Guide

Environmental impact of precast concrete products

Like other concrete products, the environmental impact of precast concrete generally decreases with the Portland cement content. Efficiency of the cement plant and the source of materials used (predominantly fuel) also have an influence. Environmental impact can be assessed in terms of the EcoPoint score of the material, which in turn feeds into the Green Guide rating for a particular construction element.

For example, external walls have a significant contribution towards the environmental impact of a building and can also account for around 30% of building costs[7]. With careful thought at the start of a project, building design can and should take a holistic and integrated approach, incorporating technical, cost and environmental considerations into the design strategy.

Within the Green Guide, specifications for external walls have a range of environmental ratings depending on the type of construction. For instance:

- Brick or stone (outer leaf), blockwork (inner leaf) cavity wall specifications all have ratings of A+
- Rendered or fairfaced blockwork cavity wall specifications mostly have A+ ratings, with some A ratings
- Load-bearing precast concrete systems have ratings ranging from B to E
- Internal masonry partition walls have specifications which can range from A+ to E depending on the materials used.

In terms of embodied CO_2 equivalent, concrete blocks have a relatively low environmental impact (around 75-120 kg/tonne depending on density)[8]. Other products will have a different embodied CO_2 value and precast structural reinforced elements will typically be higher.

Manufacturing

Due to the wide range of precast concrete products, very different processes are used during the manufacturing stage. Those producing highly repetitive units can use durable moulds which once created, mean very little waste is produced during their (long) lifecycle. Manufacturers have a small margin of error built into their systems and therefore allow for a small level of waste which is recaptured back into the manufacturing process.

Those producing larger bespoke units tend to use flexible, highly-accurate moulds which have to be made from scratch. Due to the work involved in making these (and altering them to fit other units), waste is designed out at an early stage and nearly all the material used goes into the final product.

7. BRE Green Guide to Specification http://www.thegreenguide.org.uk
8. http://www.sustainableconcrete.org.uk/main.asp?page=210

Transport and installation

As with manufacturing, the range of precast products available means that packaging and transport requirements vary depending on the type of product. Large bespoke precast concrete units do not require much in the way of packaging as they are usually loaded directly onto trailers and delivered to site ready to install, requiring no onsite storage. However, a certain level of packaging is needed to ensure the quality and security of some products as well as fulfilling heath and safety requirements.

This form of 'just in time' delivery is one of the key factors as to why specifiers choose precast concrete. There are also an increasing number of companies offering a take back scheme, whereby broken, damaged or unused precast elements are collected and reused after the project is complete, thereby diverting from landfill. This has been acknowledged by the precast industry as a big step in the sector[9].

End of life

Typically precast products share the service life of the structure on which they are utilised[10]. For instance, concrete blocks are commonly used in the frame of buildings, comprising the internal or internal and external leaf, particularly in cavity wall construction for housing. They will only become waste when the structure is demolished or has its layout changed.

This is also true of large precast wall elements, concrete beams and columns, however, due to the durability of some of these products, these may be reused in other buildings or refurbishment projects.

There are many other precast elements which can be reused / recycled at the end of their intended use, such as concrete pipes and railway sleepers which have a long service life. Some companies now offer a take back service on precast concrete units so that they may be repaired and reused. For example, concrete pipeline systems in the USA have been found to be in serviceable condition even after 100 years. These are typically manufactured to a high performance specification and are well suited to reuse.

In terms of recycling, precast concrete products can be crushed to form recycled aggregate and used in a number of applications. It is estimated that 90% of concrete products are currently either reused or recycled[11].

9. Moving the Industry Forward 2008, British Precast. Available from http://www.britishprecast.org/publications/download-publications.php
10. BRE Green Guide http://www.thegreenguide.org.uk
11. Agreed waste management routes for the Green Guide to Specification

Supply chain resource efficiency: opportunities and barriers

An interactive workshop was held with British Precast in April 2008, whereupon product manufacturers discussed targeted actions to improve resource efficiency in the sector. Discussions centred around the key areas of waste reduction, diverting waste from landfill (reusing, recycling and recovery) and using recycled materials.

Opportunities and barriers were considered for each stage of the supply chain including design/procurement, manufacture, packaging and distribution, installation/use, and end of life. Actions for the industry were prioritised and the major points form the basis of the sector action plan detailed later in this document.

Some of the key workshop discussions and outcomes are listed below.

Opportunities for resource efficiency across the supply chain

Design and procurement

Move towards performance based standards to enable the flexibility in products to alter the specification. Undertake greater research and development to enable the widening of acceptable specifications.

Manufacture

Use more recycled raw materials (e.g. production waste, crushed stone as aggregate).

Use waste materials as constituent ingredients to the concrete mix. For example, trials demonstrated by BeAware using ground glass reinforced plastic in precast concrete elements.[12]

Further use alternative binders (e.g. PFA, GGBS).

Carry out surveys to establish causes of waste.

Packaging and distribution

Extend the use of returnable cradles/pallets where appropriate.

Reassess transportation schedules to reduce empty loads and improve planning of journeys.

Work more closely with hauliers and couriers.

Installation

Reduce waste generated through design changes, over ordering and installation mistakes by providing comprehensive training for designers, sales reps and installers.

Increase waste take back schemes.

End of life

Develop and promote mortars that aid the reuse of certain precast products such as blocks.

Investigate different methods of dismantling.

Barriers to resource efficiency across the supply chain

Design and procurement

Specifications are often much tighter than necessary and therefore only highly quality virgin material can be used.

Manufacture

There are potential quality and inconsistency issues when using waste(s) as raw materials; need to ensure good quality control of materials and a consistent supply. There are also technical issues (e.g. water demand limits proportion that can be used).

Lack of technology and local facilities available to recycle products effectively and commercially.

Health and safety issues around the use of recycled products or recycling plant.

Lack of collection infrastructure.

Packaging and distribution

Cost of investigating and changing current packaging methods could be high.

Cancelled full loads, handling damage and distance to site can reduce the ability to offer take back of packaging materials and damaged/surplus products using reverse haulage.

Installation

Lack of education regarding installation.

Unsafe storage can increase waste output although this is something the product manufacturer has little influence over.

End of life

Products can be bonded together using mortars or adhesives to prevent separation of the elements at end of life, thereby preventing reuse of the product.

12. For further details on these studies, visit http://www.beaware.org.uk

Action plan: The way forward for the precast concrete sector

Note: The recommendations below are designed to reduce environmental impacts through avoiding waste and diverting it from landfill. Due to the range of precast concrete products on the market, these actions may apply to some products more than others.

1.

Increase level of repair and reclamation of precast elements

Issue:

Precast concrete elements are often demolished at the end of their service life, even though with a little repair work, they could be used again. Consequently, the most common option is to crush these products for recycling.

Action:

Increase reuse potential with minor repairs or servicing. Some manufacturers offer to take back old units for repair/crushing as aggregate.

What next:

Ensure demolition contractors are prepared to remove units with care and that designers of buildings reuse those units which still meet the performance criteria required. This will require generation of appropriate information on precast concrete products in use and using demolition contractors with the ability to deconstruct.

Barriers:

Information on the service history (mix design, service condition) needs to be preserved. Acceptance tests or tagging systems need to be developed to provide reassurance of structural performance and durability.

Who to take it forward:

Precast concrete manufacturers and demolition contractors.

2.

Encourage changes to the design specification process

Issue:

Specifiers are unaware of the manufacturing processes involved and specifications are therefore often much higher than necessary to meet the criteria of the designer/specifiers. As a result, unless a waste product can improve the quality of the concrete, there is little drive to use it.

Action:

Increase awareness amongst designers and specifiers on the importance of minimising waste from the outset.

What next:

Educate specifiers and designers on the capabilities of precast concrete units, their manufacture and the associated impact on waste generation. Ensure specifiers are aware that waste products in the element will not be detrimental to the quality of the final product. Ensure designers are aware of any constraints at the time of placing an order.

Who to take it forward:

Precast concrete industry.

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www.beaware.org.uk

BeAware is managed by BRE. The project is carried out in partnership with an industry consortium, led by a steering group chaired by the Construction Products Association. The consortium includes representative bodies from the timber and woodworking, plastics, composites and concrete manufacturing industries, the packaging sector, modern methods of construction, construction clients and advisors, waste processors and technical experts.