# British Precast Drainage Association

Publications from the British Precast Drainage Association (BPDA):

BPDA was formed in 2017 from the integration of the Concrete Pipeline Systems Association (CPSA) and the Box Culvert Association (BCA).

Information published by both CPSA and BCA will be rebranded and replaced as BPDA in due course.  New material will be branded BPDA.

All CPSA and BCA web traffic will be redirected to the new BPDA web site at www.precastdrainage.co.uk

# Concrete Drainage
## and Sewerage Products

your sustainable option

The Concrete Centre™
PART OF THE MINERAL PRODUCTS ASSOCIATION

BRITISH PRECAST

cpsa
concrete pipeline systems association

BOX CULVERT ASSOCIATION

# Introduction

Sustainable construction is a priority for most parts of the construction sector, and an increasing demand has emerged to understand how sustainability can be implemented and integrated into different businesses. For suppliers to the water and sewerage industries, the current PR09 price review is a key driver. The new Ofwat PR09 policies place more pressure on water companies to evaluate the environmental and social impacts of their businesses. The same applies to the drainage industry where the first Action Plan produced by the Highways Agency puts more emphasis on greenhouse gas emissions and the carbon footprint of construction, maintenance and operation of highway networks. The concrete drainage products sector realised the scale of the challenge very early on and has successfully adopted sustainable product- and process-based solutions.

The comprehensive precast concrete sector sustainability strategy 'More from less', was launched in November 2007 and a sustainability pledge has been signed by many companies in the sector, including manufacturers of concrete pipeline systems and box culverts. Their efforts have been helped by improvements introduced throughout their supply chain ensuring that concrete pipeline and box culvert products offer a sustainable and competitive solution.

This publication identifies 12 product- or process-based sustainability advantages of using concrete products in water supply and wastewater applications.

1. Reduced energy consumption and emissions
2. No concerns about availability
3. Local suppliers, shorter supply routes
4. Use of recycled materials
5. Minimisation of waste
6. Responsible sourcing
7. Resource efficiency in bedding
8. Durability and long service life
9. Reusability
10. Help with flood mitigation
11. Reduction of home energy consumption
12. Biodiversity and community relations

The Concrete Pipeline Systems Association (CSPA) is the main trade association representing manufacturers of concrete pipeline and manhole systems in the UK. The association is active in research and promotion of the many technical, commercial and environmental benefits of precast concrete pipeline systems.

The Box Culvert Association (BoxCA) comprises the United Kingdom's leading manufacturers of precast concrete box culverts. The Association is actively involved in research and development programmes aimed at extending the application of box culverts and advancing installation techniques to speed construction and maximise efficiency.

The Concrete Centre is the central development organisation for the UK concrete industry. It is our aim to enable all those involved in the design, use and performance of concrete to realise its full potential. The Concrete Centre is part of the Mineral Products Association, the trade association for the aggregates, asphalt, cement, concrete, lime, mortar and silica sand industries.

The British Precast Concrete Federation (BPCF) is the trade association of precast concrete manufacturers in the UK. The main aims of the federation are to promote precast concrete in the construction market and to disseminate information; and through a range of industry representation and by shared knowledge to add value to its member companies. Members' interests are continually developed through a team of dedicated professionals who have extensive connections with organisations in the UK and worldwide.

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# 1 Reduced energy consumption and emissions

The concrete pipeline and box culvert sector has been successful in reducing emissions and environmental impacts throughout its supply chain. This starts with the strictly regulated cement industry, which has reduced considerably its environmental impact over the last two decades. Since 1990, nitrous oxides and sulphur dioxide emissions (emissions contributing to toxicity and eutrophication) have been reduced by 27.8% and 58% respectively. Energy consumption has also been reduced and the amount of energy from renewable resources and bio-fuels has increased substantially.

Concrete pipes outperformed other types of pipeline solutions in a number of the environmental impact categories included in an Environmental Profiling Ecopoint report produced by the Building Research Establishment in 2005 for DN300 and DN450 diameter sewer pipes. These categories included abiotic depletion, fossil fuel depletion (embodied energy), human toxicity levels, and chemical/ hazardous waste generated.

However, a focus for the cement industry is on greenhouse gas emissions, where considerable reductions have been achieved: direct $CO_2$ emissions from cement production have been reduced by over 29% since 1990.

Carbon emissions associated with aggregates (over 70% of concrete) are already low; contributing no more than 8 kg of $CO_2$ per tonne. The use of lower carbon cements (such as CEMII and CEMIII) in the mix helps in reducing the overall carbon footprint of pipeline products - by well over 30%. Manufacturers of box culverts, as well as some concrete pipeline manufacturers, use combination cements and add fly ash directly to the concrete mix to partially replace cement and reduce their products' carbon footprint considerably. Ground granulated blastfurnace slag (GGBS) can also be used to replace cement by 38% in box culverts.

At a concrete drainage products factory, $CO_2$ emissions and energy consumption levels are recognised as being low. This is because the process of manufacturing a pipe, box culvert or a manhole is not energy-intensive and requires a combination of manual and mechanical activities. Average carbon emissions from a concrete drainage products factory are around 10 to 20 kg of $CO_2$ per tonne of concrete product.

# 2 No concerns about availability

The importance of materials availability was highlighted recently by the volatility in prices of raw materials. With considerable reserves of aggregates, future supply is secure in the UK and throughout the world, so it is unlikely that we will run out of aggregates. The same confidence applies to cement, of which abundantly occurring limestone is a major constituent.

The use of recycled steel provides a viable and renewable source of reinforcement steel. In fact, all UK manufactured reinforcement and 95% of reinforcement used in the UK, including imports, is made from recycled material.

# 3 Local suppliers, shorter supply routes

Some 95 to 99% of ingredients used in the production of concrete drainage products are sourced locally from nearby quarries and cement depots. The same applies to reinforcement steel as most is sourced from UK recycling plants. This has a considerable positive impact on the carbon footprint and fuel consumption associated with transporting these materials. Users of concrete drainage products need not be concerned by recent UN reports revealing that $CO_2$ and other pollutants resulting from shipping has been seriously underestimated by about 300%.

# 4 Use of recycled materials

In addition to recycled steel, concrete pipeline products can successfully incorporate a range of sustainable cements incorporating by-products from other industries. Fly ash, a by-product from coal fired power stations, and ground granulated blastfurnace slag (GGBS) from the iron industry can both be combined with Portland cement to produce cements with lower embodied $CO_2$.

The use of both slag and fly ash will also improve the performance of the concrete, including enhanced sulphate resistance (as detailed in current BRE Special Digest 1) and reduce the risk of alkali-silica reaction.

Other materials such as recycled concrete and aggregates made of glass can also be used successfully without adversely affecting the strength or consistency of concrete pipeline products.

# 5 Minimisation of waste

Any concrete waste arising at concrete drainage products factories can be crushed and reused. In addition to their use as aggregate in precast products, these arisings have beneficial applications on construction sites:

- Concrete waste can be graded, screened and washed for use as granular fill material in infrastructure and road construction projects. It can also be wrapped in a geo-synthetic fabric and utilised as coarse drainage material.
- According to the main concrete specification standard, BS 8500, recycled concrete aggregate (RCA) can readily be used as coarse aggregate in concrete up to strength class C40/50 and for durability classes X0, XC1-4, DC1, and XF1.

# 6 Responsible sourcing

The concrete industry was the first construction sector to cooperate with the Building Research Establishment (BRE) on a sector-wide responsible sourcing framework scheme in accordance with the framework standard for responsible sourcing, BES 6001, which describes the certification process and approval of responsible sourcing of construction products.

The concept of responsible sourcing throughout the chain of custody is relatively new in the industry. The framework standard considers the whole supply chain – looking at social, ethical, environmental and quality aspects at different stages of product sourcing. A concrete industry guidance document was launched in December 2008 to help the industry comply with the scheme.


# 7 Resource efficiency in bedding

One of the main advantages of concrete pipes or box culverts is the possibility of employing different types of recycled content for bedding or infill. Concrete pipes can be installed using Bedding Class B, meaning that virgin granular is only used to fill the lower part of the trench (180° Granular). Other classes with more infill and recycled content bedding (such as Classes F and N) are also possible for up to 2 metres depth. The trench can then be filled with the originally excavated material, if it is suitable for compaction. Other secondary and recycled aggregates material can be used for infill, including recycled asphalt, recycled concrete, recycled brick and masonry, recycled glass aggregate, construction, demolition and excavation waste and other secondary material. Box culverts can be laid on 200 mm thick granular bedding with similar attributes to that used for pipelines.

**“concrete pipeline products can successfully incorporate a range of recycled materials…”**

# 8 Durability and long service life

Concrete pipes and box culverts can provide a service life exceeding 100 years, as illustrated by the following examples:

- Concrete sewer pipelines systems installed in the 19th and early 20th centuries are still in service. Sections of a concrete pipe, which was first installed in 1903 in Norwich, were removed a few years ago and tested. The 100 year old pipe successfully passed the British Standard tests.
- Specifications for concrete pipes ensure a long service life. BRE Special Digest 1 (SD-1) offers specifications for a service life of at least 100 years, if required, for pipe and box culvert applications. Likewise, current Highways Agency standards (including the *Design Manual for roads and bridges* BD 82/02 and BD 31/01, read in conjunction with Interim Note 95/07) offer a design life of 120 years.
- The new concrete pipe standard for New Zealand and Australia AS/NZS4058: 2007 states that the manufacture, design, and installation of reinforced concrete pipe should be completed to achieve a long, durable, 100-year service life.
- The Ohio Department of Transport conducted a durability study for concrete culverts. The 10-year study (completed in 1982) found around 92% of the culverts were in an excellent condition, with a further 6 to 7% in an average state. This was prior to advances in concrete mix designs - concrete drainage products today are more resistant to deterioration caused by chemical attack.
- There are indications of an even longer service life for concrete pipes provided by studies at Manchester and Surrey Universities in the late 1990s; these estimated that concrete pipes could have a service life of 400 to 500 years.

# 9 Reusability

With a long service life and strengths that increase over their lifetime, concrete pipes can be recovered and reused:

- In Australia, one thousand 80 year-old spun concrete pipes, manufactured by Humes in the early 1920s and used in the Loveday irrigation project in South Australia, were salvaged and stockpiled at different stages by the Berri Barmera Council. The pipes were tested and found to be suitable to meet the requirements of a modern-day construction project. They were sold to a nearby district council (Renmark Paringa) in 2000 and reused as culverts in the road between the South Australian towns of Lyrup and Berri.
- In Salt Lake City, US, savings of approximately $175,000 were made when 600 metres of pipeline (first installed in 1980) were salvaged in 2007 and reused throughout the city. It was also found that the concrete pipes had grown stronger from the American Class III strength in 1980 to Class V some 27 years later.

# 10 Help with flood mitigation

The devastating floods during the summer of 2007 clearly showed that the UK is in desperate need of additional flood mitigation solutions and improved management of water drainage. With the changing climate and the increased risk of flooding, concrete drainage pipeline systems offer a robust, long-term solution that can help address these emerging challenges. There are a wide range of industry products and systems, from conventional circular pipes, jacking and elliptical pipes to attenuation and storage tanks, soakaways and box culverts. In addition, concrete drainage solutions can be designed and customised to meet specific surface run-off and flooding requirements. Concrete drainage products also offer a volume advantage enabling rapid clearance of water. Used in conjunction with sustainable drainage systems (SUDS), they can play a role in preventing surface water drainage systems becoming overloaded and causing downstream flooding.

# 11 Reduction of home energy consumption

Photo: evr-architecten-Gent, Belgium

Concrete pipes can also be used in non-civil and infrastructure applications and have been used in a number of recent innovative projects such as earth tube ducting for natural ventilation systems. These draw air into the building through long subterranean pipes that cool the air as it passes through them. This method is more effective than conventional natural ventilation. Not only can it be used in the summer for cooling, it can also preheat incoming air during the colder months using the earth's natural heat. If the air outside is 2˚C then it enters the building at a significantly higher temperature of 5˚C. By installing the pipeline system deeper than 2 metres (where a strong and robust system is required) even more temperature stability can be achieved. This illustrates the major role concrete pipes can play in minimising energy consumption in buildings, which use 40% of the energy produced in Western Europe.

# 12 Biodiversity and community relations

Concrete pipes can be installed by jacking. This can help in protecting and conserving wildlife habitats in some locations. Conventional methods of pipeline installation are based mainly on cut and cover techniques but solutions that do not disrupt the ecosystem of such places are usually preferred. Concrete jacking pipes are installed using trenchless underground technology that leaves the surface virtually undisturbed. Their installation also has a lower environmental impact as they do not need imported granular bedding. Concrete drainage product manufacturers also play their part in social sustainability and have been active in building stronger ties with their local communities. One example is the collaboration between F P McCann's factory in Telford, Shropshire (previously Ennstone Concrete Products) and their local fire and rescue services, who used the producer's facilities to train with new, state-of-the-art equipment.

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