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DRAINAGE ASSOCIATION

Best practice

Technical Updates

Buried pipeline design standard brought up-to-date

The revised standard for structural design of buried pipelines.

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Buried pipeline design standard brought up-to-date

The revised standard for structural design of buried pipelines will soon bring methods into line with contemporary design practice. Marshalls CPM's director of technical & engineering, **Mark Flavell**, who represented BPDA on the drafting committee, explains the importance of this update.

At the end of October 2019 a revised version of British Standard BS 9295:2010 Guide to the structural design of buried pipelines will be released. The new BSI document will include all relevant design information for all types of buried pipelines, which was previously split across two different standards.

Standards for buried pipelines make it possible to demonstrate that a pipeline is structurally sound, especially when it passes under a highway or motorway. Adopting authorities require uniform documentation, that is understood by all parties, to confirm the infrastructure is fit for purpose and can take the traffic load.

Currently BS EN 1295-1:1997 details the UK nationally established method of design for rigid concrete pipelines, while BS 9295:2010 gives further information on the structural design of buried pipelines under various conditions of loading using the established UK method.

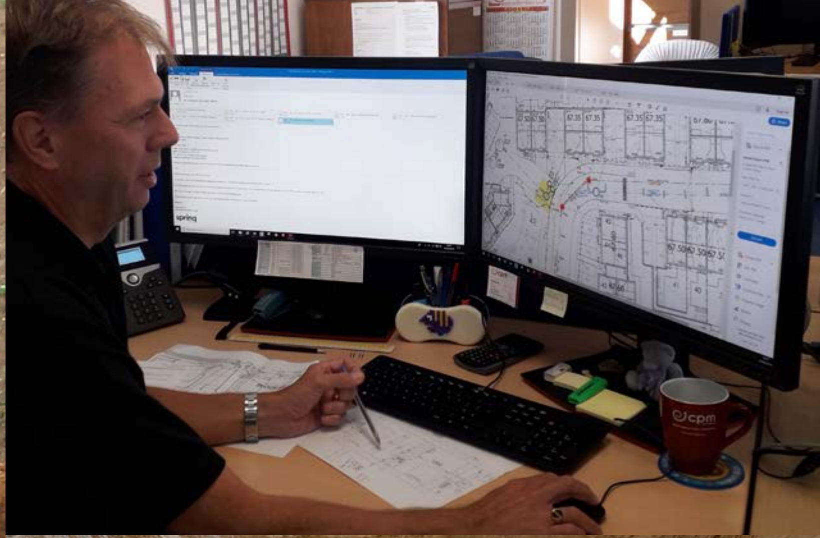
When BS EN 1295-1 came up for its five-year review, BSI's Management Committee for Wastewater Standards gave a mandate to revise and it was decided to withdraw the method of design from this standard and revise BS 9295 to include all the detailed design method together with the guidance on its use.

BS 9295:2019 will be the key standard for anyone in the construction industry that designs or builds drains, sewage systems and underground pipes. Revision of the standard has provided a suitable opportunity to review various shortcomings in current UK design methods which have arisen due to changes in the nature of pipelines over the period since those methods were originally published. In the case of concrete pipelines, this is over 50 years.

The revised standard consolidates and updates the various documents that together describe the UK method and brings practice into line with contemporary design methods. Alignment with the European Eurocode standards for structural design was also considered wherever practical.

The timing of the publication of the revised standard is of particular importance because the HA 40/01 Determination of pipe and bedding combinations for drainage works from the Design Manual for Roads and Bridges (DMRB) is also being revised and will be redrafted around BS 9295:2019.

One of the principal changes to the documentation will be to ensure that traffic loading used is consistent with British and European standard BS EN 1991-2 Traffic Loads on Bridges. This will align pipeline design with design requirements for all other buried structures. It is also consistent with the vertical test loads for manhole cover slabs as specified in BS 5911-3:2014.



The revised standard places more emphasis on consideration of the wide-trench formula for pipe design. Using wide-trench principles increases potential load on pipelines, however higher bedding factors have been introduced for designs using wide-trench design.

Narrow-trench design is still permissible where the designer has sufficient knowledge of the installation conditions to make a well-informed decision on trench width. Narrow trench design has been used by the Industry for many years without any concerns being raised regarding the structural integrity of concrete pipelines.

This demonstrates the robust structure of concrete pipes and the conservative nature of design methods. However, the standard steers designers towards wide-trench as ideally a maximum permissible trench-width should be stated.

Two new tables are included in the revised standard – one for updated bedding factors and one detailing permitted installation cover depths for both narrow and wide trench applications.

A limit state design (LSD) method is introduced for concrete pipelines which means they can be designed to withstand all actions likely to occur during their design life and remain fit-for-use, with an appropriate level of reliability for each limit state.

A limit state is a condition beyond which a structure no longer fulfils the relevant design criteria. The condition may refer to loading or other actions on the structure, while the criteria refer to structural integrity, durability or other design requirements.

The procedure requires both an 'ultimate' and 'serviceability' bedding factor to be calculated and appropriate bedding factor assigned. All Eurocode European standards are based on the LSD concept in conjunction with a partial safety factor method.

Finally, an annex to the section gives typical examples of pipeline designs covering various design situations. This includes a comparison of wide-trench and narrow-trench design for the same diameter pipe and reinforced and unreinforced scenarios.

In summary, the new standard brings methods into line with current design practice while aligning with Eurocodes, introducing LSD and making trench-width a primary consideration. With release of the revised DMRB in 2020, the UK will have a joined-up contemporary approach to buried pipeline design.

Structural Design Calculator update planned

BPDA plans to bring its own Structural Design Calculator app for pipe design into line with the new standard in early 2020. The Calculator, which is available from any app store, simplifies concrete pipeline design calculations.

It offers all the basic values including external design loads and bedding factors and takes into account the pipe crushing strength. It then offers advice on what type of bedding to use. The calculated load, which is the total load a concrete pipe in a trench is required to sustain, is used in the design formula.

www.precastdrainage.co.uk/calculators/structural-design

Concrete pipes shine with whole-life carbon analysis

As the construction industry embraces whole-life models for carbon consumption in projects and products, a forthcoming BPDA study should demonstrate a huge benefit in concrete pipe selection, says **Matthew Butcher**, sustainability & product association executive, British Precast.

The UK government's push for net zero carbon by 2050 will see the developers of infrastructure projects paying much closer attention to the carbon impact of their choices of materials. The BPDA's membership is committed to not only lowering the carbon impact of its product, but also assisting decision-makers by comparing the whole life carbon impact of concrete pipes with their plastic equivalent.

The climate emergency has come to the forefront of international public consciousness through a mixture of alarming scientific reports and public protests such as the School Strike for Climate and Extinction Rebellion. In 2018, the Intergovernmental Panel on Climate Change (IPCC) issued the most extensive warning yet on the risks of rising global temperatures – widely dubbed 'the final call'. **[1]**

Industry must go above and beyond to answer this call from the climate scientists and the civil engineering sector is one of many within the built environment to formally declare its intention to tackle the climate emergency. Civil engineering practices in the UK are being asked to commit to a range of pledges linked to low carbon sustainable construction.

Set out by the Institution of Civil Engineers (ICE) these include an accelerated shift to low embodied carbon materials in all works as well as design principles that enable the UK to become a net-zero carbon economy by 2050. Critically the declaration includes a focus on whole-life carbon assessment, including recognition of the important role extending the life of infrastructure will play in carbon reduction. **[2]**

Two pledges in particular send a strong message to the civils sector to ensure that carbon assessments of products and projects are robust and verifiable. These are:

- To include, as part of the basic scope of all our work, lifecycle costing, whole-life carbon modelling and post-construction evaluation in order to optimise and reduce embodied, operational and user carbon and other resources
- To evaluate all new projects against the need to contribute positively to society and enhanced wellbeing, while simultaneously averting climate breakdown and encourage our clients to adopt this holistic approach using PAS2080 to reinforce sound decision-making

The approach set out in the PAS2080:2016 standard for Carbon Management in Infrastructure seeks to identify the total carbon, that is the sum of carbon consumed across all the lifecycle stages of an asset. This is to avoid making a carbon reduction in one lifecycle stage which leads to an increase in carbon in a later lifecycle stage and therefore to a net increase in whole-life carbon.

The example given by guidance from both the Royal Institution of Chartered Surveyors (RICS) and the Royal Institute of British Architects (RIBA) is that specifiers should make sure that using low carbon materials to reduce capital carbon during installation does not lead to more carbon from material replacements during the operational stage. **[3]**

The BPDA is already actively engaged in producing resources to facilitate decision-making around whole-life carbon and will, in due course, publish a study comparing the cradle-to-grave global warming potential of concrete and plastic drainage systems.

A whole-life carbon focus is important because some plastic pipe studies may have under-reported the true level of embodied carbon emissions in their assessments by not taking account of multiple greenhouse gases or not including all lifecycle stages.

On a limited lifecycle stage assessment of drainage systems it is possible to omit important impacts further into the asset's lifespan or linked to the product's installation. Much like the famous Indian parable where six blind men describe an elephant from touching one feature of the animal, studies that look solely at cradle-to-gate carbon emissions or at single emission sources like transportation can miss the big picture.

The BPDA study was guided by the European standards EN 15978 Environmental Impact Assessment of Buildings and EN 15804 Environmental Product Declarations (EPD). This is important because PAS2080:2016 notes that data consistent with the modular lifecycle assessment (LCA) approach and principles set out in EN 15978 and EN 15804 should be used in a comparison like the one the BPDA is undertaking.

It should be noted that the comparisons carried out by BPDA are not entirely compliant with the standards described because of a lack of verifiably compliant plastic pipe data. The data for the concrete pipes used in this study is however based on the externally verified EN 15804 EPD and calculator. BPDA would be prepared to produce a full set of compliant data if the plastic industry were to do so.

In 2017, the BPDA published an EPD for 1m of DN600 precast concrete pipe with class B bedding. This was an Association declaration using primary data from member companies, covering all lifecycle stages from A1 to C4.

Once published, the BPDA's new carbon report is set to show that at the majority of pipe diameters, and with plastic pipe ring stiffnesses and resin sources evaluated, installed concrete pipes have a lower carbon impact.

For large diameter pipes the difference is the most marked, with the carbon impact of 4kN/m^2 DN2100 plastic pipes as much as 55% higher than that of a concrete equivalent. When the full lifecycle in taken into consideration the BPDA believe that the carbon impact of a plastic pipeline could be more than double the carbon impact of a concrete pipe. This is primarily due to the longer service life of concrete pipes.

Concrete's extended service life, which is more than double that of plastic pipes in many cases, removes the need for replacements within the assets design life. Its durability also extends past the design life, reducing risks associated with current projected 800-year service life requirements of UK water assets. **[4]**

Selecting concrete pipes also reduces bedding requirements, which in turn lowers the amount of imported granular bedding material required for installation. This not only reduces the carbon impact of transporting and quarrying the bedding material, but also increases the material efficiency of the development. The use of plastic has the opposite effect as oil-based products are non-renewable.

Conducting an LCA study of this type not only aids in product comparisons but also allows the sector to perform hotspot analysis. This analysis allows the industry to focus sustainability efforts and bring down the lifecycle carbon of our products.

The ultimate goal being the design and installation of net zero carbon pipelines.

Use of Portland cement replacement products is one area where the UK concrete is already ahead of global trends. Recent media reports suggest that global cement production is responsible for 7-8% of global CO_2 emissions, in the UK this is only 1.5% of UK emissions.

The Concrete Centre's This is Concrete – Ten Years, Ten Insights (2018) publication highlighted that countless innovations have achieved a 28% reduction in the embodied carbon of concrete since 1990. The precast concrete sector specifically has reduced CO2 emissions per tonne by 12.1% since 2012 and is on course to meet its 2020 targets for carbon reduction.

[1] IPPC. Special Report. Global Warming of 1.5°C. **www.ipcc.ch/sr15/**

[2] ICE. UK Civil Engineers Declare Climate & Biodiversity Emergency **www.civilengineersdeclare.com**

[3] RICS. Whole life carbon assessment for the built environment, 2017

[4] Department for Environment, Food & Rural Affairs, Water for life: white paper, 2011

New jetting standard will ease pressure on sewers

Jetting is a critical part of operations to clear sewer blockages but care must be taken to avoid damage from high pressure hoses. With a change in British Standards BS 5911 expected to introduce mandatory tests to concrete pipes, the sector must adapt to this new reality.

With an increasing number of sewer blockages caused by fat, wet wipes and other 'unflushables', the need for high pressure jetting to clear them is more prevalent than ever.

The rise of the fatberg – an impenetrable build-up of fat and non-biodegradable products - is a result of modern lifestyles. Diets have changed to be oilier and more people are flushing products that the sewer system was not designed to deal with, wet wipes being the biggest culprits.

According to Water UK, the trade association representing UK water companies, there are approximately 300,000 sewer blockages annually, costing water companies £100 million every year to clear them.

While public awareness has grown significantly, thanks to better education and high profile campaigns from the water utilities, the problem, particularly in densely populated cities, is unlikely to go away completely. This means sewer jetting will always have a vital part to play.

But with high pressure sewer jetting, comes another risk – pipes splitting and leaking, leading to environmental damage and potentially serious pollution. To reduce this risk, a Code of Practice giving guidance on the safe use of high pressure jetting equipment was published by the Water Research Council in 2001. This was followed up with a second edition in 2005, which set out a maximum jetting pressure for pipeline materials, varying from 1500psi (103 bar), 2600psi (179 bar) for plastic and up to 5000psi (345 bar) for concrete and clay pipelines.

So, it is acknowledged that concrete pipes are likely to withstand higher pressure than plastic, with the European standards for management and control of operational activities in drain and sewer systems EN 14654-1 (becoming EN 14654-3 after 2019) stating: "Maximum working pressures to avoid damage will vary according to the material of the pipe, condition of the pipe and type of nozzle."

The issue is reviewed regularly, with changes to the British Standard BS 5911 for concrete pipes and ancilliary concrete products expected next year, which will introduce mandatory jetting resistance tests to concrete pipes.

As fatberg numbers increase in the UK, the sewerage pipeline sector needs to adapt to this new reality and explore the introduction of robust test regimes for high pressure water jetting. New test regimes can offer assurance that every concrete pipe manufactured in the UK is robust enough to undertake the level of high-pressure jetting normally needed to remove fatbergs.

Drainage contractor Lanes for Drains agreed more resistant pipes were needed in the fight against FOG.

> ...in general, a water jetting pressure of 3,500 to 4,000psi (241 to 276 bar) is capable of breaking through blockages caused by fat and other debris.

Fact Zone

- A study from Water UK found that wipes made up about 93% of the material causing sewer blockages
- The world's most famous fatberg was discovered by Thames Water under Whitechapel in London in 2017. The gruesome discovery weighed 130 tonnes – the same as 11 double-decker buses and made global headlines. Breaking down the fatberg took a team of eight using high pressured jet hoses several weeks
- Many more fatbergs have been discovered since, the most recent being in Sidmouth, Devon in January 2019
- The practice of using high-pressure jetting was unregulated before 2001, with large numbers of sewers succumbing to the strain. The subject was covered extensively by the Select Committee on Environment, Transport and Regional Affairs in the late 1990s, which led to the first Code of Practice in 2001

Michelle Ringland, head of marketing, said: "Our teams conform to all regulations when jetting pipes but there is still always a risk of damage. Protecting the environment is a priority for us and we fully support any measure that allows us to continue to clear sewer blockages effectively, while further reducing any risk of pipe damage. However, as with everything, education is key and people need to stop abusing the drains and sewers. That's why we have created Unblocktober, the world's first awareness month to educate people and get them to change their habits and reduce the need to clear blockages in the first instance."

Safe jetting limits

There has been an understanding for some time within the drains management sector that, in general, a water jetting pressure of 3,500 to 4,000psi (241 to 276 bar) is capable of breaking through blockages caused by fat and other debris. In theory, the best practice guidance in the Code of Practice ensures that damage to pipes due to jetting is avoided. However, such risk of damage always exists.

The code advises that the pipe material needs to be identified before starting any clearance operations. There are no guarantees advice will always be followed, especially when faced with major blockages, where water jetting pressures as high as 3,000 to 4000psi (206 to 276 bar) are sometimes needed.

Some water companies realise such risk and have policies in place to ensure that the sewers they are to adopt meet specific standards and are less prone to damage.

Thames Water requires air tests for certain types of pipe to ensure that no damage was caused by jetting before adoption. Developers are recommended to consider non-polymeric components in areas where sewer air testing is expected to be hard to undertake.

Anglian Water requires adopted sewer pipes to be able to withstand 4,000psi (276 bar) jetting pressure.

Where to find the standards

BPDA keeps a keen eye on national and international standards - this ensures that our members' customers receive the best quality products which are compliant to all relevant standards.

All British and European standards can be found here **https://shop.bsigroup.com**

Sewers for Adoption guidance and water industry standards can be downloaded here **https://www.water.org.uk/publications**

The Sewer Pipes and Resistance to Jetting factsheet is available here **https://www.precastdrainage.co.uk/uploads/downloads/GeneralJettingFactsheetIII_002.pdf**

For more information on Unblocktober, go to **www.Unblocktober.org**

Updated technical guide shaped by members' feedback

BPDA has published a new edition of its technical design guide, containing updates and new content based on feedback and requests from members. The *Complete Technical Design Guide* incorporates information on industry standards, design methodologies and guidance documents published in the last two years.

Information has been added on the design life of precast drainage products and how 100+ years can be achieved using a DC-4 Design Chemical exposure class. As concrete drainage products with lower exposure classes now exist in the UK market it was felt additional information would be useful.

An explanation of European standard EN 16933-2 on hydraulic design of drains and sewers, and terms associated with sustainable drainage systems (SuDS) and oversizing for surface water drainage, have also been added.

All pipeline design load tables have been amended to align to the 10 Eurocode standards specifying how structural design should be conducted. The cover depths have also been expanded to include covers as low as 0.6m and as deep as 10m. The 'light road' loading category has been removed.

A new section includes the structural design of box culverts in accordance with the Eurocodes. There is also a more detailed section on the hydraulic design of box culverts with guidance adapted from CIRIA's Culvert Design & Operation Guide.

More information on innovative pipeline lifting and installation solutions - such as the pipe-lifter - was added, along with a section on the installation of box culverts.

Revision of the BS 9295 Guide to the Structural Design of Buried Pipelines (see page 2), released at the end of November 2019, means more options associated with design, trench-width and bedding factors will need to be introduced.

The *Complete Technical Design Guide* can be downloaded here.
All feedback and comments welcome.

https://www.precastdrainage.co.uk/uploads/downloads/BPDA_Complete_Technical_Design_Guide.pdf

Safety risks flagged after unverified products uncovered

Unverified & potentially non-compliant precast concrete products are being sold into the UK, according to British Precast.

Imported precast concrete drainage products are being placed on the UK market without visible proof of third-party verification or assessment of conformity to relevant European and British standards. These include manhole rings, manhole covers, seating rings, corbels and gully raisers.

Colin Nessfield, technical manager, British Precast, said: "Customers and others in the product supply chain, have a responsibility to ensure the precast drainage products they purchase have the necessary third-party assessments and certification, which is the minimum required by the Construction Products Regulation. Ignoring these requirements plays into the narrative that elements of the construction industry are still unconcerned about product safety, quality and client satisfaction."

UK industry specifications such as Sewers for Adoption, Civil Engineering Specification for the Water Industry and different highways standards and manuals require specific precast drainage products to conform to relevant provisions of British Standards such as BS 5911-3. This can only be assured through third-party certification such as BSI's Kitemark scheme.

Published 2019 © British Precast. The British Precast Drainage Association (BPDA) is the main trade association representing the interests of the manufacturers of concrete pipes, manholes, box culverts and sustainable drainage systems in the UK. The association is active in the research and promotion of the many technical, commercial and environmental benefits of precast concrete drainage systems. BPDA is a product association of the British Precast Concrete Federation Ltd. **www.precastdrainage.org**

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