

Potential for updating/revision of BRE Special Digest 1



BRE has been publishing guidance on concrete in sulfate-bearing ground and groundwater for more than 75 years, in the form of BRE Digests. These have steadily grown in length and complexity as research and experience of the performance of concrete in the ground has been gained. Andrew Frost of DB Group discusses an Innovate UK project to look at AACMs in aggressive ground – to update IP17/05⁽¹⁾ and obtain data to update Special Digest 1⁽²⁾.

Over many years, BRE has carried out long-term laboratory and site exposure tests to identify the mechanisms by which sulfates cause concrete to deteriorate and to recommend concrete specifications to resist sulfate attack. From the 1970s, cementitious materials such as fly ash and GGBS became available, which showed great promise in enhancing concrete durability in many environmental exposure conditions. Further research was carried out to provide guidance on their use.

Special Digest 1 (SD 1⁽²⁾) was first published in 2001 and a slightly revised edition followed in 2003. A four-year programme of Government-funded research into the thaumasite form of sulfate attack (TSA) was initiated at BRE and several UK universities to address some key topics where knowledge was lacking. The latest (2005) edition of SD 1 was the first to take on board the findings of this national TSA research programme.

Scope and coverage

SD 1:2005 deals with the specification of concrete for buildings and civil engineering construction that will be in contact with aggressive ground in the UK. It gives procedures for the specification of concrete in commonly encountered conditions but does not cover all contaminated ground.

Developments

The most recent edition of SD 1 is now more than 15 years old and needs updating to reflect:

- Low-carbon cements based on different chemistries to Portland cement (PC), such as calcium sulfoaluminate (CSA) cements and alkali-activated cementitious materials (AACMs), or on new PC combinations currently being commercialised and that are not included in EN 197-1⁽³⁾, such as ternary blended PCs. These cements are not covered by SD 1 or the concrete Standard BS 8500⁽⁴⁾. There is evidence that some of



Above: HP11 secant piled reception shaft excavated to formation level, immediately after excavation, April 2020.

Left: Hanson delivering Cemfree concrete to the HS2 Austrey-Barston gas pipeline diversion, February 2020.

these cements have excellent sulfate resistance and there is a great deal of interest in introducing them into mainstream construction to help meet the industry's zero-carbon agenda.

- PC blends with high proportions of GGBS for use in secant piling are covered by BRE Information Paper IP17/05 but they are not included within SD 1.
- Editorial changes/references to Standards in SD 1 need to be refreshed/updated.
- New developments in additional protective measures (APMs) may need to be taken into account.
- Other developments – BRE is planning to convene an industry stakeholder group, with the support of its industrial partners to consider updating of BRE SD 1 in light of developments since 2005, including the following matters.

AACMs

A new Innovate UK and industry-funded project, LOCOWAG, will develop and assess (via laboratory testing and site pilots) innovative concrete formulations in which PC is replaced with AACMs. The two-year project will be led by the AACM manufacturer DB Group (Holdings), together with J Murphy and Sons, Centrum

Pile and BRE, which will carry out the laboratory testing essential for updating guidance. The newly launched Association of Alkali-Activated Cementitious Materials (A³CM UK) will support by facilitating the supply of a broad range of AACMs for testing by BRE and facilitating stakeholder workshops.

The LOCOWAG project will demonstrate and de-risk the adoption of AACMs in foundations for buildings and infrastructure. It will carry out laboratory tests to assess durability, AACM-based concrete formulations in sulfate-rich conditions (and other key performance characteristics) and compare with those of PC-based and other concretes. We will work with Standards bodies and key stakeholders to address Standards-related barriers to market uptake. An industry stakeholder group (with representation from regulators, manufacturers and end users) will help guide the development of outputs (eg, BRE documents) and address barriers to mainstream use. The project will assess and address barriers to market (especially the need for industry-wide guidance and acceptance, such as BS 8500 and BRE SD 1).

Multi-component PCs with limestone

BRE is currently assessing a range of multi-component cement in concretes with

combinations such as cement–GGBS–powdered–limestone and cement–fly–ash–limestone in aggressive conditions, including sulfate exposure. BRE joined the project, led by industry body the Mineral Products Association (MPA), to develop new low-carbon multi-component cements for UK concrete applications. The research and demonstration activities are part-funded by the Government under the BEIS Industrial Energy Efficiency Accelerator programme, which is managed by the Carbon Trust and Jacobs. The project is due to conclude in 2021. The consortium includes the MPA, Hanson, BRE and Bison Precast.

Relationship between SD 1 and BS/EN Standards

For several decades, there has been liaison between groups responsible for guidance in BRE Digests on concrete in aggressive ground and the British Standards dealing with the specification of concrete, the latest of which is BS 8500. Consequently, there has been a basic harmony between these documents in respect of concrete specification for general use in the ground. Clarke⁽⁵⁾ describes the background since the early 1990s.

In other respects, the BRE Digests and Standards have been complementary. BRE

guidance has presented more background information on chemical attack, and given detailed guidance on ground assessment and on the specification of concrete in certain precast concrete products, such as pipeline systems and masonry blocks. In contrast, BS guidance for concrete has integrated the provisions for resistance to chemical attack into the numerous other requirements for practical concrete specification, such as strength class and consistence, resistance to alkali–silica reaction (ASR) and chloride content in respect of corrosion of reinforcing steel.

SD 1 is an example of this collaboration, as BS 8500 was revised in parallel. Both revisions took the numerous European Standards for concrete constituents into account.

Concluding remarks

BRE and its project partners are currently carrying out research on the durability of unfamiliar cements that are not currently covered by Standards or BRE's SD 1. The aim is to provide evidence for a revision of SD 1.

BRE will be convening a dedicated stakeholder group to consider the potential revisions of SD 1 in 2020/2021. If you would like to be involved, please contact: Andrew Dunster (principal consultant, BRE) andrew.dunster@bregroup.com. ■

Further information:

For more information on the LOCOWAG project please visit: www.locowag.com or contact andrew.frost@dbgholdings.com

References:

1. QUILLIN, K., NIXON, P.J., MATTHEWS, J.D. and LONGWORTH, T.I. *Concretes with high GGBS contents for use in hard/firm secant piling*. IP 17/05, BRE Press, Watford, 2005.
2. BUILDING RESEARCH ESTABLISHMENT. *Concrete in Aggressive Ground*. Special Digest 1, BRE Press, Watford, 2005.
3. BRITISH STANDARDS INSTITUTION, BS EN 197-1. *Cement. Composition, specifications and conformity criteria for common cements*. BSI, London, 2011.
4. BRITISH STANDARDS INSTITUTION, BS 8500. *Concrete. Complementary British Standard to BS EN 206. Part 1 – Method of specifying and guidance for the specifier. Part 2 – Specification for constituent materials and concrete*. BSI, London, 2015+A2:2019.
5. CLARKE, J.N. Concrete in aggressive ground. *Concrete*, Vol.39, No.6, June 2005, pp.29–31.

Further reading:

PROVIS, J.L. and VAN DEVENTER, J.S.J. *Alkali-Activated Materials: State-of-the-Art Report*. TC 224-AAM, RILEM, Paris, 2014.

MINERAL PRODUCTS ASSOCIATION. *Low-carbon multi-component cements for UK concrete applications*. MPA, London, 2019, available at: <https://bit.ly/36wMG03>.

The BEIS Industrial Energy Efficiency Accelerator (IEEA) <https://bit.ly/2GtyOcj>.



Hanson working with Murphy Ground Engineering to place Cemfree, February 2020.