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Construction materials –

Alkali-activated cementitious material and concrete – Specification

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Foreword

Publishing information

This PAS was sponsored by High Speed Two Ltd. Its development was facilitated by BSI Standards Limited and it was published under licence from The British Standards Institution. It came into effect on 30 April 2016.

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Acknowledgement is also given to the members of a wider review panel who were consulted in the development of this PAS.

This PAS is not to be regarded as a British Standard. It will be withdrawn upon publication of its content in, or as, a British Standard.

The PAS process enables a specification to be rapidly developed in order to fulfil an immediate need in industry. A PAS can be considered for further development as a British Standard, or constitute part of the UK input into the development of a European or International Standard.

Figure B.1 is taken from BS EN 60812:2006. The complete British Standard can be purchased from the BSI online shop: http://shop.bsigroup.com/ProductDetail/?pid=000000000030101028

Hazard warnings

WARNING. This PAS calls for the use of substances and/or procedures that can be injurious to health if adequate precautions are not taken. It refers only to technical suitability and does not absolve the user from legal obligations relating to health and safety at any stage.

Product certification/inspection/testing

Users of this PAS are advised to consider the desirability of third-party certification/inspection/testing of product conformity with this PAS. Users seeking assistance in identifying appropriate conformity assessment bodies or schemes may ask BSI to forward their enquiries to the relevant organizations.

Assessed capability

Users of this PAS are advised to consider the desirability of quality system assessment and registration against the appropriate standard in the BS EN ISO 9000 series by an accredited third-party certification body.

Test laboratory accreditation

Users of this PAS are advised to consider the desirability of selecting test laboratories that are accredited to BS EN ISO/IEC 17025 by a national or international accreditation body.

Use of this document

It has been assumed in the preparation of this PAS that the execution of its provisions will be entrusted to appropriately qualified and experienced people, for whose use it has been produced.

Presentational conventions

The provisions of this PAS are presented in roman (i.e. upright) type. Its requirements are expressed in sentences in which the principal auxiliary verb is "shall".

Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.

Where words have alternative spellings, the preferred spelling of the Shorter Oxford English Dictionary is used (e.g. "organization" rather than "organisation").

Requirements in this PAS are drafted in accordance with *Rules for the structure and drafting of UK standards*, sub-clause **J.1.1**, which states, "Requirements should be expressed using wording such as: 'When tested as described in Annex A, the product shall ...'". This means that only those products that are capable of passing the specified test will be deemed to conform to this PAS.

Contractual and legal considerations

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a PAS cannot confer immunity from legal obligations.

Particular attention is drawn to the following legislation:

- Carcinogens and Mutagens Directive 2004 (2004/37/EC) [1];
- Chemical Agents Directive 1998 (98/24/EC) [2];
- CLP Regulation 2008 [3];
- Commission Regulation (EC) No 1907/2006 (REACH) [4] and associated amending and enforcement regulations;
- Control of Substances Hazardous to Health (Amendment) Regulations 2004 [5];

- Control of Substances Hazardous to Health (Amendment) Regulations (Northern Ireland) 2005 [6];
- Construction Products Regulation 2013 [7];
- Health and Safety at Work etc Act 1974 [8];
- Personal Protective Equipment Regulations 2002 [9];
- Pregnant Workers Directive 1992 (92/85/EEC) [10];
- Protection of Young People at Work Directive 1994 (94/33/EC) [11];
- Provision of Health and Safety Signs Directive 1992 (92/58/EEC) [12];
- REACH Enforcement Regulations 2008 [13].

0 Introduction

The UK's *Construction 2025: Industrial strategy for construction – government and industry in partnership* [14] sets a range of targets, including:

- lower emissions – a 50% reduction in greenhouse gas emissions in the built environment;
- lower costs – a 33% reduction in the initial construction and whole life cost of built assets;
- faster delivery – a 50% reduction in the overall time, from inception to completion, for new build and refurbished assets; and
- improvement in exports – a 50% reduction in the trade gap between total exports and total imports for construction products and materials.

Low carbon cements using alkali activators have been and continue to be developed in the UK. These cements can assist in reaching all of the targets in this strategy by:

- reducing the quantity of carbon dioxide released during the manufacture of cement and concrete;
- avoiding increasing costs associated with energy sources and the capture and storage of carbon from cement production processes and potentially reducing other production costs;
- providing an alternative range of materials for precasting products, as this mode of production can enable faster delivery; and
- helping UK product developers bring their products to market and develop exports.

In addition to these benefits, concrete produced using alkali-activated cementitious material (AACM) can have performance benefits [15] such as improved chemical and fire resistance and/or lower permeability to water and aggressive agents. The properties are influenced by the specific type of AACM used.

Major projects in the UK are actively looking for ways to meet the targets set out by *Construction 2025* [14], particularly in the sector of publicly-funded infrastructure development.

The primary objective of this PAS is to specify performance requirements of AACMs and the resulting concretes, and to facilitate and encourage their use in construction projects, where appropriate.

These new AACM products do not generally fit into the standard framework for traditional concretes and common cements covered by BS EN 197-1, BS EN 206, BS 8500-1 and BS 8500-2. While many of the tests and considerations relevant to traditional concretes and common cements may broadly be applied to AACMs, some of the details do not and this may impede the use of AACMs when the existing standards are specified for a project.

To specify a concrete, it is normally necessary to specify a combination of its performance requirements and any prescribed constituents. By definition an AACM Concrete is required to include AACM, and Clause **4** of this PAS sets out requirements for AACM. Clause **5** of this PAS sets out the requirements for AACM Concrete. Clauses **6** and **7** relate to both AACM and AACM concrete.

This PAS aims to facilitate the use of AACMs within construction by providing alternative specification approaches. It is intended to help specifiers, product manufacturers, materials suppliers and construction clients understand how AACMs can be incorporated into construction projects having confirmed the suitability of an AACM for the intended use. It is important to note that the group of materials described as AACMs covers a wide range of materials, and the

AACM manufacturers will generally need to be consulted to identify the most appropriate AACM and working methods.

Annex A provides guidance for executing a project using these materials.

For some intended uses of an AACM, the risk and opportunities assessment may indicate a need for additional durability tests. It is also noted that this PAS does not include explicit requirements for determination of long-term properties such as creep or drying shrinkage under service conditions, and in circumstances where such properties are critical, additional testing beyond the scope of this PAS may be required. Such additional tests would need to be agreed in writing between the specifier, the AACM manufacturer and the user, as necessary.

1 Scope

This PAS specifies the performance requirements for alkali-activated cementitious material comprising aluminosilicate main constituents and an alkali activator. An AACM (including the activator) may contain Portland cement only at a content of less than 5% mass of binder solids, and may contain subsidiary constituents not exceeding 25% of the mass of the cementitious material. It also specifies a means of assessing concrete obtained through the use of such cementitious material for performance and durability, and sets requirements for the alkali-activating component and the aluminosilicate powder component of these concretes.

NOTE 1 The term "geopolymer" is not used in this PAS, but this does not exclude its use for descriptive purposes in conjunction with alkali-activated cementitious materials.

This PAS does not:

- set detailed requirements for the composition of the alkali-activated cementitious material;
- specifically address applications for such materials as renders, screeds, mortars or repair materials, although it does not exclude the possibility that such materials could be used for such purposes; or
- cover the use of any material classified as hazardous waste.

NOTE 2 Hazardous waste is defined in the Technical Guidance of the UK Environment Agency (https://www.gov.uk/how-to-classify-different-types-of-waste) and includes radioactive materials [16].

This PAS is for use by manufacturers of alkali-activated cementitious material, producers of prefabricated concrete elements containing alkali-activated cementitious material and producers of concrete containing alkali-activated cementitious material which is to be precast, delivered ready-mixed, or mixed in situ. It is also of interest to designers and specifiers as it provides a means of assessing the suitability of AACM concrete mixtures for typical construction uses.

NOTE 3 Attention is drawn to The Personal Protective Equipment Regulations 2002 [9] and The Health and Safety at Work etc Act 1974 [8].

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

Standards publications

BS 8500-1, *Concrete – Complementary British Standard to BS EN 206 – Method of specifying and guidance for the specifier*

BS 8500-2:2015, *Concrete – Complementary British Standard to BS EN 206 – Specification for constituent materials and concrete*

BS EN 196-1:2005, *Methods of testing cement – Determination of strength*

BS EN 196-2, *Methods of testing cement – Chemical analysis of cement*

BS EN 196-3:2005+A1:2008, *Methods of testing cement – Determination of setting times and soundness*

BS EN 196-9:2010, *Methods of testing cement – Heat of hydration – Semi-adiabatic method*

BS EN 197-1:2011, *Cement – Composition, specifications and conformity criteria for* common cements