

Testing aggregates —

Part 123: Method for determination of alkali-silica reactivity — Concrete prism method

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- British Civil Engineering Test Equipment Manufacturers Association
- British Geological Survey
- County Surveyors' Society
- Department of the Environment, Transport and the Regions — Represented by the Building Research Establishment
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Foreword

This British Standard has been prepared under the direction of Technical Committee B/502. It specifies a method for the measurement of expansion of concrete produced by alkali-silica reaction involving specific aggregate combinations, and is based on the measurement of the length change of concrete prisms containing a high level of alkali that are made from the aggregate under test.

| This test method was originally published as DD 218:1995, which is withdrawn.

Annex A is informative, annex B is normative and annex C is informative.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 11, a blank page, an inside back cover and a back cover.

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1 Scope

This British Standard specifies a method of measuring the expansion of concrete produced by alkali-silica reaction involving specific combinations of aggregates. The method is designed as an accelerated laboratory test for a specific combination of aggregates and is not considered to be a performance test for concrete.

NOTE Aggregates are usually tested in the same combination as when they are actually used. When the aggregate combination to be used is not decided, however, the test sample of aggregate is tested in combination with both an inert aggregate and an aggregate geologically similar to itself in proportions specified in the method. This procedure provides a generally satisfactory assessment of the aggregate by accommodating any pessimum value which it may possess.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of this British Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. For undated references, the latest edition of the cited publication referred to applies.

BS 12, *Specification for Portland cement*.

BS 410, *Specification for test sieves*.

BS 812-2, *Testing aggregates — Part 2: Methods for the determination of density*.

BS 812-100, *Testing aggregates — Part 100: General requirements for apparatus and calibration*.

BS 812-101, *Testing aggregates — Part 101: Guide to sampling and testing aggregates*.

BS 812-102:1989, *Testing aggregates — Part 102: Methods for sampling*.

BS 812-117, *Testing aggregates — Part 117: Method for determination of water-soluble chloride salts*.

BS 882, *Specification for aggregates from natural sources for concrete*.

BS 1881-108:1983, *Testing concrete — Part 108: Method for making test cubes from fresh concrete*.

BS 1881-131, *Testing concrete — Part 131: Methods for testing cement in a reference concrete*.

BS EN 196-6, *Methods of testing cement — Part 6: Determination of fineness*.

BS EN 196-21:1992, *Methods of testing cement — Part 21: Determination of chloride, carbon dioxide and alkali content of cement*.

3 Terms and definitions

For the purposes of this part of BS 812, the terms and definitions given in BS 812-100, BS 812-101 and BS 812-102 apply.

4 Principle

Concrete test prisms are prepared from the aggregate combination under test, and stored for a period of 52 weeks in conditions which would promote any potential alkali-silica reaction. During this time measurements are made at intervals to determine whether any expansion has occurred.

In order to promote the development of any expansive forces and to ensure that slowly reacting aggregates are detected in the 52-week period, the test is accelerated by:

- formulating the concrete to possess a higher than average cement and alkali content;
- storing the prisms at high humidity and a comparatively high temperature (38 °C) to increase the rate of the chemical reaction.

NOTE If expansion exceeding an agreed or specified limit is recorded in the test, or atypical expansion is obtained in routine monitoring of an aggregate source, the individual test specimen exhibiting the highest expansion may be examined to confirm that alkali-silica reaction is the main cause of that expansion. Suitable procedures are to be found in *The Diagnosis of Alkali-Silica Reaction* [1].

5 Sampling

The samples of coarse and fine aggregates used for the test (the laboratory samples) shall be taken in accordance with the procedure specified in BS 812-102:1989, clause 5.

NOTE The recommendations given in BS 812-102 are primarily intended for sampling from a stockpile of aggregate. Where aggregate is being sampled from a quarry it is important to ensure that the samples obtained for use in the test are satisfactorily representative of the sources concerned.

6 Apparatus

6.1 General

All apparatus shall conform to the general requirements of BS 812-100.

6.2 Sample divider, of size appropriate to the maximum particle size to be handled, or alternatively, a flat shovel and a clean, flat, hard surface (e.g. a metal tray), for use in quartering.

NOTE A suitable divider is the riffle box illustrated in BS 812-102:1989, Figure 2.

6.3 Test sieves, conforming to BS 410, of the size and apertures appropriate to the nominal size of aggregates to be tested.

6.4 Balance, of minimum capacity 5 kg, readable to 1 g.

6.5 Balance, of minimum capacity 100 g, readable to 0.01 g.

6.6 Four steel moulds, with cavities suitable for casting concrete prisms of lengths (250 ± 50) mm. No two cavities shall differ in length by more than 5 mm and the cross-sections shall be (75 ± 2) mm by (75 ± 2) mm. The moulds shall have the facility for casting stainless steel reference studs into the mid-points of the end faces of the prisms.

The reference studs shall be mounted inside the mould before casting the prisms. The studs shall either have smooth conical recesses into which a 6 mm ball may be located, as shown in Figure 1, or shall provide a 3 mm radius hemispherical bearing, as shown in Figure 2.

NOTE The use of stainless steel grade 316 S11, as specified in BS 970-1:1991, or a grade of similar quality, is recommended for the manufacture of reference studs.

6.7 Length comparator, incorporating a measuring device with graduations not greater than 0.002 mm and having a maximum error of ± 0.002 mm. The arrangement of the comparator and the range of displacement of the gauge shall be such that specimens can be inserted and removed without damage or undue pressure to the prisms, reference studs or measuring device.

NOTE 1 To allow for typical variations of the prisms and the reference rod, a minimum range of displacement of the measuring device of 15 mm is recommended.

The gauge shall be mounted rigidly in a vertical orientation in a stoutly constructed measuring frame.

NOTE 2 An example of a measuring frame incorporating a mechanical gauge is shown in Figure 3. Similar devices utilizing digital or electronic gauges may be used.

Each stud locator of the comparator shall have a stainless steel hemisphere which can be placed into the reference studs in the test prisms. Alternatively, if reference studs which provide hemispherical bearings are used, the comparator shall have recessed conical cups which can be located onto the studs.

NOTE 3 Attention is drawn to the need to ensure the long term stability and accuracy of comparators. In particular, mechanical gauges should be checked for evidence of wear, and electrical gauges for drift.

6.8 Reference length gauge rod, with ends machined to match the shape of the reference studs in the prisms. For example, for use with the recessed studs, the rod shall have smooth conical recesses; for studs with the hemispherical bearing, the rod shall have hemispherical ends of 3 mm radius.

The rod shall be made from material which has a coefficient of linear thermal expansion, in the range 0 °C to 100 °C, of not more than 2×10^{-4} % per °C.

NOTE 1 The material known as "Invar" which is a nickel-iron alloy containing about 36 % nickel, has been found to be satisfactory.

NOTE 2 The gauge length of the rod slowly diminishes with time as the contact surfaces wear. It is therefore recommended that a second similar rod be stored for use as a primary standard for periodically checking the regular rod, or for use as a spare if necessary.

The gauge length of the rod shall not differ from the mean gauge length of the four prisms by more than 5 mm.

6.9 Concrete mixing equipment, as specified in BS 1881-131.

6.10 Vibrating table, as specified in BS 1881-108:1983, **3.3**.

6.11 Containers, for maintaining a high relative humidity around the wrapped prisms during storage.

NOTE A suitable design of container is shown in Figure 4.

6.12 Twill-weave cotton cloth, (240 ± 30) g/m² dry, at least 10 mm wider, but not more than 20 mm wider, than the length of the prisms.

6.13 Polyethylene lay flat tubing, 500 gauge, 180 mm wide.

6.14 Polyethylene bags, 500 gauge, approximately 500 mm $\times$ 250 mm.

6.15 Temperature-controlled room or cabinet, capable of being maintained at a temperature of (38 ± 2) °C throughout its storage space.

6.16 Temperature-recording equipment, capable of keeping a record of the temperature at one point within the storage facility (see **6.14**).

6.17 Temperature-controlled room, capable of being maintained at a temperature of (20 ± 2) °C and at a relative humidity of not less than 50 %.

6.18 Ventilated oven, thermostatically controlled at a temperature of (110 ± 5) °C, for drying the aggregate.

6.19 Nine maximum/minimum thermometers.

6.20 Steel rule, graduated in millimetres.

7 Materials

7.1 Potassium sulfate, of analytical reagent quality.

7.2 High-alkali Portland cement, with a certified alkali content¹⁾.

NOTE For testing other than reference and referee testing, cement to the following specification may be used as an alternative to the certified reference cement. Portland cement conforming to BS 12, having a total alkali content, expressed as equivalent sodium oxide (the sum of the contents of Na₂O and 0.658 K₂O), of not less than 0.8 % and not more than 1.0 % as determined in accordance with BS EN 196-21:1992, clause 7 (see **9.3**).

WARNING Safety precautions should be taken when preparing and handling test prisms made from mixes prepared from Portland cement. In particular, eyes should be protected during all mixing operations and gloves worn during mixing and whenever the test prisms are handled.

7.3 Deionized water.

7.4 Mixing water, of potable quality.

¹⁾ A reference cement with a certified alkali content can be obtained from Building Research Establishment, Garston, Watford.