

Australian Standard®

AS 1141.60.1:2014

Methods for sampling and testing aggregates
Method 60.1: Potential alkali-silica reactivity—
Accelerated mortar bar method

PREFACE

This Standard was prepared by Standards Australia Committee CE-012, Aggregates and Rock for Engineering Purposes.

This Standard incorporates Amendment No. 1 (February 2019). The changes required by the Amendment are indicated in the text by a marginal bar and amendment number against the clause, note, table, figure or part thereof affected.

This test method for alkali silica reaction is based on international methods, including ASTM C1260 *Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)*. However, the classification limits for the test have been drawn from local methods based on Australian experience of alkali-silica reaction. The method has been modified to include procedures, based on Australian and international research, intended to improve repeatability and reproducibility.

If a blended cement is used in this test method, the classification limits given in this method may not be applicable.

The term ‘informative’ has been used in this Standard to define the application of the appendix to which it applies. An ‘informative’ appendix is only for information and guidance.

WARNING: SOME OF THE CHEMICALS OR PROCEDURES SPECIFIED IN THIS STANDARD COULD LEAD TO A HAZARDOUS SITUATION IF CORRECT SAFETY MEASURES ARE NOT FOLLOWED. PERSONS USING THIS AUSTRALIAN STANDARD MUST BE FAMILIAR WITH NORMAL LABORATORY PRACTICE. THIS STANDARD DOES NOT ADDRESS THE SAFETY PROBLEMS, IF ANY, ASSOCIATED WITH ITS USE. IT IS THE RESPONSIBILITY OF THE LEGAL ENTITY USING THIS STANDARD TO ESTABLISH APPROPRIATE SAFETY AND HEALTH PRACTICES, TO ENSURE COMPLIANCE WITH ANY NATIONAL, STATE OR LOCAL REGULATORY REQUIREMENTS, AND TO INSTRUCT IN, AND ENFORCE COMPLIANCE OF, THE SAFETY AND HEALTH PRACTICES.

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- (a) Paragraph 4 of Clause 1, *Scope*.
- (b) Clause 4.5, *Containers* (modified).
- (c) Clause 4.8, *Mixer, paddle and mixing bowl* (modified).
- (d) Note to Item (b) of Clause 6.5.2, *Preparation of moulds*.
- (e) Clause 6.5.7, *Moulding of test specimens* (modified).
- (f) Items (b) to (e) of Clause 7.1, *Initial storage and reading* (modified).
- (g) Items (b) to (e) of Clause 7.2, *Zero readings* (modified).

METHOD

1 SCOPE

This Standard sets out the procedure to classify aggregate according to its susceptibility to alkali attack leading to expansive reactions in concrete. This expansion-inducing reaction is known as alkali-silica reaction (ASR) (see Note). The classification is determined from the measured increase in length of mortar bars prepared using the aggregate under consideration, during storage of the bars under the prescribed test conditions.

NOTE: The test is suitable for alkali-silica reactivity. It is not suitable for alkali-carbonate reactivity.

This test method permits detection of the potential for deleterious alkali-silica reaction of aggregate using mortar bars exposed to a solution of sodium hydroxide over a period of 21 days.

Certain rock types, such as deformed granites, granitic gneisses and some metabasalts, fail to react to this procedure and yet are deleteriously expansive in the field. By contrast, some glassy basalt aggregates, which are not reactive in concrete when used as coarse aggregate, may cause excessive expansion when used in fine aggregate in this test. With such aggregates, prior field experience and concrete prism test results should be considered in determining the potential for alkali-silica reactivity (see SA HB 79 for further information).

This method does not purport to address the safety concerns, if any, associated with its use. It is the responsibility of the user of this Standard to establish appropriate health and safety practices and determine the applicability of regulatory limitations prior to use.

NOTES:

- 1 See Preface for copyright information about this Clause.
- 2 Appendix A provides guidance on alkali-silica reaction.

2 REFERENCED DOCUMENTS

The following documents are referred to in this Standard:

AS

- | | |
|-----------|---|
| 1012 | Methods of testing concrete |
| 1012.13 | Method 13: Determination of the drying shrinkage of concrete for samples prepared in the field or in the laboratory |
| 1141 | Methods for sampling and testing aggregates |
| 1141.3.1 | Method 3.1: Sampling—Aggregates |
| 1141.3.2 | Method 3.2: Sampling—Rock spalls and boulders |
| 1141.60.2 | Method 60.2: Potential alkali-silica reactivity—Concrete prism test |

AS

A1 | [Text deleted]

- 2350 Methods of testing portland, blended and masonry cements
- 2350.12 Method 12: Preparation of standard mortar and moulding of specimens
- 2350.13 Method 13: Determination of drying shrinkage of cement mortars
- 2701 Methods of sampling and testing mortar for masonry construction
- 2758 Aggregates and rock for engineering purposes
- 2758.1 Part 1: Concrete aggregates
- 3972 General purpose and blended cements
- SA HB
- 79 Alkali aggregate reaction—Guidelines on minimising the risk of damage to concrete structures in Australia

3 DEFINITIONS

For the purpose of this Standard, the definitions in AS 1141.1 apply.

4 APPARATUS

A1 | 4.0 General

The apparatus specified in Clauses 4.1 to 4.14, conforming to the relevant provisions of AS 1141.2 and the requirements given below, is required.

4.1 Standard mortar and mould

Mortar and moulding of specimens in accordance with AS 2350.12.

4.2 Laboratory mixing area and humidity controlled storage area

The air within the laboratory where preparation of the specimens takes place shall be maintained within a temperature range of 20°C to 27.5°C and the relative humidity of the air shall not be less than 50%. The specimen humidity controlled storage area shall be maintained at 23 ±2°C and at a relative humidity not less than 95%.

4.3 Balance

Of sufficient capacity, readable to 1.0 g with a limit of performance of 0.5 g.

4.4 Comparator

4.4.1 General

A vertical, horizontal or inclined comparator, as specified below, may be used.

NOTE: Prior to performing measurements using any comparator, the comparator anvils should be checked to ensure that they are parallel using the procedure given in AS 2350.13—2006, Appendix B.

4.4.2 Vertical comparator

A vertical comparator equipped with a measuring device, such as a digital micrometer, capable of measuring length change over a range of 290 mm to 300 mm. The comparator shall be of rigid construction with a rigid, plane base. Means shall be provided to ensure that specimens are placed vertical in the comparator. The base anvil of the comparator shall be flat but may be fitted with a cup at the centre point to assist with placement of the specimen. It shall be ensured that the base cup remains free of debris and always allows the base gauge stud to contact the base anvil.

The measuring device shall be capable of reading to 0.001 mm. The stem anvil shall be flat but may be fitted with a cup at the centre point to assist with placement of the specimen. It shall be ensured that the gauge stud is in contact with the anvil of the measuring device.

4.4.3 *Horizontal or inclined comparator*

A horizontal or inclined comparator equipped with a device, such as a digital micrometer, capable of measuring length change over a range of 290 mm to 300 mm. The comparator shall be of rigid construction and shall consist of a frame for supporting the specimen during the measurement in such a way that minimal weight is carried by the gauge studs (see Note).

The measuring device shall be readable to 0.001 mm. The stem of the measuring device and the end rest for the specimen shall be fitted with flat anvils.

NOTE: Ideally, the specimen will fit the comparator in a horizontal position so that the gauge studs do not support the mass of the specimen. However, practice with comparators of this type has found that a more practical design is to incline the frame.

4.4.4 *Reference bar*

A reference bar shall be used with the comparator and shall consist of material characterized by an extremely low coefficient of thermal expansion, such as invar. The reference bar shall be not less than 6 mm in diameter and shall have an overall length of 295 ± 1.5 mm.

Each end shall be reduced in diameter and the end 5 mm shall be approximately the same diameter and have the same end radius as the projecting end of the gauge stud used in the specimen. Each end of the reference bar shall be polished. The central section of the reference bar shall be covered by a rubber tube or equivalent of length approximately 100 mm and a wall thickness of at least 3 mm to minimize the effect of temperature change during handling. The reference bar shall be provided with a positioning mark and shall always be placed in the comparator in the same orientation.

4.4.5 *Operator precision check*

The precision of the length measurement by a single operator shall be checked by reporting the length of a specimen prepared following this method, 20 times within a 15 min period, replacing the specimen in the comparator for each reading. The specimen used shall be undamaged and older than 48 h since casting. The standard deviation of these 20 length measurements shall not exceed 0.001 mm. This check shall be performed by each new operator and by each operator at least each six months. Records of the checks shall be maintained in the laboratory.

4.5 Containers

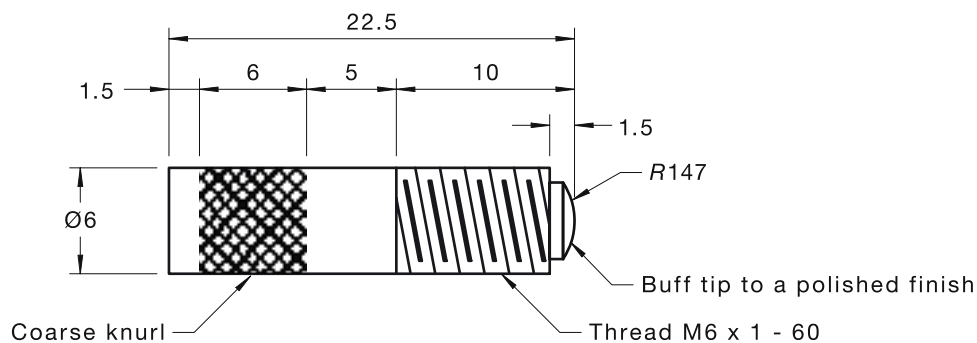
The containers shall be of such a nature that the bars can be totally immersed in either the water or 1 mol/L sodium hydroxide (NaOH) solution. The containers shall be made of a material that can withstand prolonged exposure to 80°C and shall be inert to a 1 mol/L NaOH solution (see Note 1). The containers shall be so constructed that when used for storing specimens, the loss or gain of moisture is prevented by tight-fitting covers, by sealing, or both (see Note 2). The bars in the solution shall be placed and supported so that the solution has access to the whole of the bar; therefore, it shall be ensured that the specimens do not touch the sides of the container or each other. The volume of the containers shall be adequate to allow for the requirement of volume of fluid to volume of specimens (see Clause 5.2). The specimens, if stood upright in the solution, shall not be supported by the metal gauge stud.

NOTES:

- 1 The NaOH solution will corrode glass or metal containers.
- 2 Some microwave-proof food storage containers made of polypropylene or high-density polyethylene have been found to be acceptable.
- 3 See Preface for copyright information about this Clause.

4.6 Gauge studs

Gauge studs shall be of stainless steel and shall comply with the dimensional requirements for studs for horizontal comparators in AS 1012.13 but for this method they may be used with either comparator, the vertical comparator being fitted with flat anvils. A typical gauge stud is illustrated in Figure 1.



DIMENSIONS IN MILLIMETRES

FIGURE 1 TYPICAL GAUGE STUD

4.7 Length gauge

A length gauge shall be provided for checking the nominal length between gauge studs. The length gauge shall be made of metal and shall have a diameter of at least 6 mm and a length of 250 ± 0.2 mm. The ends of the bar shall be flat and perpendicular to its length.

4.8 Mixer, paddle, and mixing bowl

Mixer, paddle, and mixing bowl shall conform to the requirements of AS 2350.12, except that the clearance between the lower end of the paddle and the bottom of the bowl shall be 5.1 ± 0.3 mm.

NOTE: See Preface for copyright information about this Clause.

4.9 Moulds

Moulds shall be made of a non-absorbent material which does not react with cement paste and their internal surfaces shall have a smooth finish. Each mould shall be provided with a baseplate that is either integral or separate. Moulds with separate baseplates shall be provided with lugs or suitable means for their attachment. The moulds shall be substantial enough to hold their form without distortion and shall be substantially leakproof. The moulds shall be 25 mm × 25 mm × 285 mm with a gauge length of 250 mm.

4.10 Oven or water bath

A convection oven or water bath with a temperature control capable of maintaining $80 \pm 2^\circ\text{C}$ and with a temperature monitoring apparatus that complies with the requirements of Clause 4.14 following.

4.11 Sieves

A1 | As required for preparing the grading given in Table 1.

4.12 Sodium hydroxide bath

As an alternative to using containers of sodium hydroxide solution, which are then placed in an oven or water bath, it is permissible to store the mortar bars in a specially designed bath containing the sodium hydroxide solution. All exposed components of the bath shall be resistant to the corrosive effects of a 1 mol/L sodium hydroxide solution at 80°C . The bath

shall be capable of maintaining the solution at $80 \pm 2^\circ\text{C}$. The bath shall be equipped with a temperature monitoring apparatus that complies with the requirements of Clause 4.14 following. The bath shall be equipped with a tight fitting lid to minimize solution evaporation and for safety.

4.13 Tamper and trowel

The tamper shall consist of seasoned hardwood, which shall be rendered non-absorptive by immersion for 15 min in paraffin wax at approximately 200°C .

The tamper shall be approximately 10 mm $\times$ 10 mm in cross section, and shall have a flat face at right angles to the axis of the rod. A convenient length is 125 mm to 150 mm.

The trowel shall have a steel blade 100 mm to 150 mm long with straight edges.

4.14 Temperature recording apparatus

The temperature of the sodium hydroxide solution shall be monitored, and adjusted if required, for the duration of the test. The temperature shall be measured continuously and recorded at intervals not greater than 15 min on a chart recorder or with a data logger, with a tolerance of 1°C .

The following monitoring and temperature storage conditions shall be met:

- (a) The recording shall show when temperature was adjusted and the duration and extent to which the temperature may have departed from the $80 \pm 2^\circ\text{C}$ requirement.
- (b) Slight departures from the temperature range are allowable during solution concentration adjustment or length measurements, provided that no single temperature departure exceeds 4 hours.
- (c) The sum total of all temperature departures during the total period of the test shall not exceed 8 hours.

NOTES:

- 1 If it can be demonstrated that the temperature of the oven (if used) or the water in the water bath (if used) is equal to the temperature of the solution, then a recording of the oven temperature or water temperature over time may be used.
- 2 Both Australian and overseas research has demonstrated that solution temperature is a critical variable in this test procedure. For this reason, temperature monitoring requirements have been expanded in this Australian Standard and temperature departures have been restricted.

5 REAGENTS

5.1 General

Unless otherwise specified, all reagents shall be of technical grade.

Unless otherwise indicated, references to water shall mean domestic potable water. Distilled water shall not be used for storage of specimens.

5.2 Sodium hydroxide solution

Each litre of solution shall contain 40.0 g of NaOH dissolved in 900 mL of distilled or deionized water, and shall be diluted with additional distilled or deionized water to obtain 1.0 L of solution. A fresh solution of sodium hydroxide shall be prepared for each series of tests conducted at the same time. The OH^- ion concentration shall be measured and recorded at the time of preparation. Sufficient solution shall be prepared so that the volume proportion of sodium hydroxide solution to mortar bars in a storage container is at least 4. The volume of a mortar bar may be taken as 184 mL.