Australian Standard®

Methods of testing portland and blended cements

Method 13: Determination of drying shrinkage of portland and blended cement mortars

PREFACE

Background

Since 1988, and during the development of AS 3972, *Portland and blended cements* as a performance-based Standard, the cement industry has carried out work to develop a suitable test method for shrinkage. At the time of publication of AS 3972 (1991), this work was still continuing.

The work was completed in late 1992 and the results were submitted to BD/10 Committee and considered by that Committee at its meeting on 24 March 1993. Based on the submission and the deliberations of the Committee it was agreed that AS 3972 be amended to incorporate Type SL shrinkage-limited cement, and to include the proposed test method for drying shrinkage as Method 13 in AS 2350, *Methods of testing portland and blended cements*.

In addition to these documents, a brief summary of the work undertaken by the cement industry to develop the test method and specification for Type SL cement is given below.

Test method development

The test method investigated was based on the French Standard Method NF15-433. An initial investigation examined the influences of constant water-cement ratio, constant flow and various curing regimes, i.e. 24-h, 3-d and 7-d curing before exposure to drying. Seven different cements were used in the initial investigation, including flyash and slag blended cements. Parallel concrete shrinkage testing was also carried out using the seven cements, one aggregate and one mix design to investigate possible correlation with the proposed test method.

It was concluded from the initial investigation that a drying shrinkage test based on the ISO/CEN mortar and prism is feasible. The correlation with concrete shrinkage was highly significant at all ages. Also, it was concluded that the use of 24 h curing in the mould, followed by 27 d exposure to the drying conditions was capable of distinguishing between cement types. The determination of drying shrinkage at 28 d is in parallel with the assessment of compressive strength at 28 d.

Based on these conclusions and recommendations, work continued to the second part of the investigation to develop the test method further and to determine its precision. In the course of this work a number of cement samples were distributed to seven participating laboratories to carry out 20 repeat tests (under conditions of repeatability and reproducibility) to determine the precision of the test method.

Principal features of the method

The method uses the mortar and the mould used for the standard strength test AS 2350.11. The mould is adjusted/modified to accept the studs required to measure the change in the length of the prismatic specimen.

The specimens in the mould are stored in a moist atmosphere for 24 h. The demoulded specimens are stored under drying conditions of 50 ±5% RH and 23 ±2°C. Measurement of the specimen's length is carried out, initially on demoulding and subsequently at age of 7 d, 14 d, 21 d and 28 d.

Shrinkage limits

Once the test method had been developed and its precision established, it was possible to proceed with the necessary work to establish appropriate limits for shrinkage-limited cement, Type SL.

It was recognized from the outset that before shrinkage criteria be suggested or recommended it was important to set some principles for setting such limits. The principles adopted were as follows:

(a) The test method should stand on its own merits and no attempt should be made to pass all cements as 'low shrinkage' cements.

(b) The criteria to be set should not be a world-wide absolute lower value but a value in the lower range for world cement which is technically defensible and internationally competitive.

(c) The limits set should reflect the performance of cements which have been considered acceptable in low shrinkage applications (including those meeting N.S.W. 'ACSE' specifications).

Based on these principles a database was established to provide the background for setting the limits. The database included various cement types produced in Australia and a number of cements obtained from overseas, of known shrinkage performance.

Testing of overseas cements served to verify the test method and to assist in placing the shrinkage values of Australian cements in an international context.

All cements were coded and laboratories had no knowledge of expected shrinkage performance, particularly of the overseas cements. The results reported by all laboratories were consistent with the performance reported by the suppliers of the cements. This has further increased confidence in the test method.

METHOD

1 SCOPE This Standard sets out the method for the determination of the drying shrinkage of portland and blended cement mortars of defined composition.

NOTE: The test results indicate the potential performances of cement in mortar and concrete mixtures. It should be recognized, however, that drying shrinkage of mortar and concrete is affected by many factors other than cement.

2 REFERENCED DOCUMENTS The following documents are referred to in this Standard:

AS
2350 Methods of testing portland and blended cements
2350.12 Method 12: Preparation of a standard mortar and moulding of specimens

3 PRINCIPLE The method comprises the determination of drying shrinkage of prismatic test specimens 40 mm × 40 mm × 150 mm in size.

The mortar is prepared and the specimens are moulded in accordance with AS 2350.12.

The specimens in the mould are stored in a moist atmosphere for 24 h and then the demoulded specimens are stored under drying conditions of 50 ±5% RH and 23 ±2 °C. Measurement of the specimen length is carried out on demoulding and at the age of 7 d, 14 d, 21 d, and 28 d from casting.

4 APPARATUS The apparatus specified in AS 2350.12 and that below is required.

4.1 Reference drying chamber The drying chamber for the storage of specimens shall provide a suitably controlled environment in accordance with the following requirements:

NOTE: The drying chamber model no. CSTC 9-6-4.5\TH\23-50\J3317 manufactured by Thermoline Pty Ltd is considered to comply with the requirements of this Clause.

(a) The temperature in the drying chamber shall be maintained at 23 ±1°C for 95% of each 24 h period, remaining in the range 23 ±2°C.

(b) The relative humidity in the drying chamber shall be maintained at 50 ±5%.

NOTE: Humidity and temperature may deviate from specification when specimens are being placed in, or removed from the drying chamber. These deviations should not be taken to indicate noncompliance with the specification, provided that they do not exceed 1% of the total test period.

(c) The rate of evaporation, determined using the method given in Appendix A, shall be within the range of 15 g to 50 g per 24 h. Checks on the evaporation rate shall be carried out at least monthly.

NOTE: It is recommended to vary the location of the containers within the drying chamber on a monthly basis or where conditions have changed.

(d) The drying chamber shall be fitted with suitable shelving to provide a substantially unidirectional air flow from the back to the front of the chamber.

(e) Supporting racks shall be constructed of nominal 100 mm square stainless steel mesh. The wire used in the mesh shall be a nominal 5 mm diameter. The mesh shall have 'legs' fashioned from the free ends of the mesh so that the specimens will be supported at not less than 12 mm above the plate of the shelf. Clearance of not less than 25 mm shall be provided between the specimens. A means of correct relocation of this rack on the shelf shall be provided. See Figure 1.

(f) Storage positions shall always be kept occupied (with dummy specimens if necessary).

NOTE: It is recommended that the dummy specimens be prisms of the same dimensions as the test specimens.

4.2 Alternative drying chamber An alternative drying chamber may be used provided that it is demonstrated that the drying shrinkage results at the specified age(s) have a 95% probability of not differing from that attained by the reference drying chamber.

4.3 Mould The mould design and assembly procedure shall, in principle, comply with the standard mould specified in AS 2350.12 but incorporating the modifications that will enable the requirements of this Standard to be met.

The mould used in determining the drying shrinkage shall provide for three specimens of 40 mm width and 40 mm depth incorporating a gauge length of 130 mm, and shall be constructed according to Figure 2.