This Australian/New Zealand Standard was prepared by Joint Technical Committee BD-026, Masonry and Paving Units. It was approved on behalf of the Council of Standards Australia on 6 June 2003 and on behalf of the Council of Standards New Zealand on 9 September 2003 and published on 25 September 2003.

The following are represented on Committee BD-026:

Association of Consulting Engineers Australia
Association of Consulting Structural Engineers of NSW
Australian Building Codes Board
Australian Chamber of Commerce and Industry
Australian Institute of Building Surveyors
CSIRO Manufacturing and Infrastructure Technology
Calcium Silicate Brick Manufacturers
Clay Brick and Paver Institute
Clay Brick Manufacturers Association WA
Clay Brick and Paver Association of New South Wales
Concrete Masonry Association of Australia
Department of Infrastructure (Victoria)
Engineering and Construction Laboratories Association
Institution of Engineers Australia
Institute of Municipal Engineering Australia NSW Division
National Association of Testing Authorities Australia
New Zealand Concrete Masonry Association
Standards New Zealand
Stone Industry Association
University of Newcastle

Additional interest participating in the preparation of this Standard:

Master Builders Australia

Keeping Standards up-to-date

Standards are living documents which reflect progress in science, technology and systems. To maintain their currency, all Standards are periodically reviewed, and new editions are published. Between editions, amendments may be issued. Standards may also be withdrawn. It is important that readers assure themselves they are using a current Standard, which should include any amendments which may have been published since the Standard was purchased.

Detailed information about joint Australian/New Zealand Standards can be found by visiting the Standards Australia web site at www.standards.com.au or Standards New Zealand web site at www.standard.co.nz and looking up the relevant Standard in the on-line catalogue.

Alternatively, both organizations publish an annual printed Catalogue with full details of all current Standards. For more frequent listings or notification of revisions, amendments and withdrawals, Standards Australia and Standards New Zealand offer a number of update options. For information about these services, users should contact their respective national Standards organization.

We also welcome suggestions for the improvement in our Standards, and especially encourage readers to notify us immediately of any apparent inaccuracies or ambiguities. Please address your comments to the Chief Executive of either Standards Australia International or Standards New Zealand at the address shown on the back cover.

Originated as part of AS 1226.5—1984.
Previous edition AS/NZS 4456.11:1997.
Second edition 2003.

This Standard was issued in draft form for comment as DR 02582.

Jointly published by Standards Australia International Ltd, GPO Box 5420, Sydney, NSW 2001 and Standards New Zealand, Private Bag 2439, Wellington 6020

ISBN 0 7337 5417 1 Printed in Australia

Australian/New Zealand Standard™

Masonry units, segmental pavers and flags—Methods of test

Method 12: Determining coefficients of contraction

1 SCOPE

This Standard sets out the methods for determining the coefficients of contraction of masonry units, pavers and flags. The coefficient of residual curing contraction is an indication of the potential shrinkage undergone by a masonry unit during its secondary curing process. The coefficient of drying contraction is an indication of the potential contraction undergone by a saturated masonry unit when it is allowed to dry over a long period at ambient conditions.

NOTE: For ease of use, the methods of determining residual curing contraction and drying contraction have been separated in this Standard, even though masonry units would most likely be tested for both properties consecutively.

2 REFERENCED DOCUMENTS

The following document is referred to in this Standard:

AS/NZS		
4456	Masonry units, segmental pavers and flags—Methods of test	
4456.0	Part 0:	General introduction and list of methods
4456.1	Method 1:	Sampling for testing
4456.2	Method 2:	Assessment of mean and standard deviation

3 DEFINITIONS

For the purpose of this Standard, the definitions given in AS/NZS 4456.0 apply.

4 NOTATION

The following notation is used in this Standard:

L	=	overall length of unit, in millimetres
Z_i	=	initial gauge reading of reference bar (average of two readings), in millimetres
	=	$(Z_1 + Z_2)/2$
Z_f	=	final gauge reading of reference bar (average of two readings), in millimetres
	=	$(Z_3 + Z_4)/2$
dZ	=	difference between final and initial gauge readings ($Z_f - Z_i$) of the reference bar, in millimetres
Y_i	=	initial gauge reading of specimen, in millimetres
Y_f	=	final gauge reading of specimen, in millimetres
dl	=	change in length of the specimen, in millimetres

e_{cc} = the coefficient of residual curing contraction of the specimen, in millimetres per metre

$\bar{e}_{cc}$ = mean coefficient of residual curing contraction of the sample, in millimetres per metre

e_{dc} = the coefficient of drying contraction of the specimen, in millimetres per metre

$\bar{e}_{dc}$ = mean coefficient of drying contraction of the sample, in millimetres per metre

5 APPARATUS

The following is required:

(a) A temperature-controlled space whose temperature is controlled to 22 ±3°C.

(b) A measuring frame fitted with a micrometer or dial gauge that is capable of being read to the nearest 0.002 mm or better (see Figure 1).

(c) A flat-ended reference bar of invar steel rod fitted with an insulated grip and approximately equal in length to the test specimens.

(d) Two steel balls of 6.5 mm diameter.

(e) Two steel-ball adaptors that can be attached to the reference bar (see Figure 2).

(f) A calliper capable of being read to 0.5 mm over the length of the units being tested.

(g) A tungsten carbide drill of 6.5 mm diameter.

(h) An immersion tank capable of immersing all specimens on a grid without them touching each other.

(i) For AAC unit, a humidity chamber or container in which the specimens can be placed on racks to dry at 22 ±3°C and 43 ±2% relative humidity. This humidity corresponds to the equilibrium condition over a saturated solution of potassium carbonate in water. The trays containing the saturated solution shall contain sufficient solid salt that can be stirred thoroughly at least every 7 days to prevent the formation of lumps or a crust.

(j) A well-ventilated drying oven with a cubic capacity not less than 3 times the total volume of the specimens being dried, and capable of maintaining a temperature of 110 ±8°C.

6 COEFFICIENT OF RESIDUAL CURING CONTRACTION

6.1 Principle

A sample of 5 units is taken, each at 7 d of age or greater. The units are initially saturated then measured for length. They are then placed in water at laboratory temperature for 7 d, surface dried, and remeasured.

NOTE: Specimens tested at ages greater than 7 d are unlikely to give coefficients of curing contraction as great as those tested at age 7 d.

6.2 Preparation of test specimens

Specimens accumulated from continuous sampling shall be deemed to meet the requirements of this method, provided that the number of specimens accumulated is at least 5. For assessment of an individual lot, 5 units shall be selected in accordance with AS/NZS 4456.1.

Specimens may be cut from units. Where specimens are cut from units, they shall be taken in such a manner that they are representative of the lot under investigation and of the units used in practice. For autoclaved aerated concrete, cut specimens shall be taken so that they represent a uniform distribution across the sample in the direction of rise or compaction of the mass during manufacture. The specimens may be split or dry cut. They shall not contain any reinforcement, and the cut surfaces shall be clean and planar. The length axis of the prisms shall be parallel to the length of the unit. Cut test specimens shall be prisms with a length to suit the length of the measuring frame, but not less than 150 mm. The position of the specimen in the production unit shall be shown by a letter designation in the specimen number, i.e. U (upper), MU (middle upper), M (middle), ML (middle lower) or L (lower).

NOTE: Wet-sawn specimens should not be used because the introduction of water will invalidate the test.

By means of the tungsten carbide drill, a conical depression shall be formed in the centre of each end of each unit to provide reference point seats for the steel balls. All dust from the drilling shall be brushed from the conical depressions.

Where difficulty is encountered in making smooth conical depressions in coarse-textured or friable units, it shall be permissible, after initial drilling, to fill the depression with a moisture-stable, epoxy-based filler, for which the dimensional stability has been checked under the test conditions before it is adopted for used.

When the filler is cured, it shall be redrilled to re-expose the unit surface.

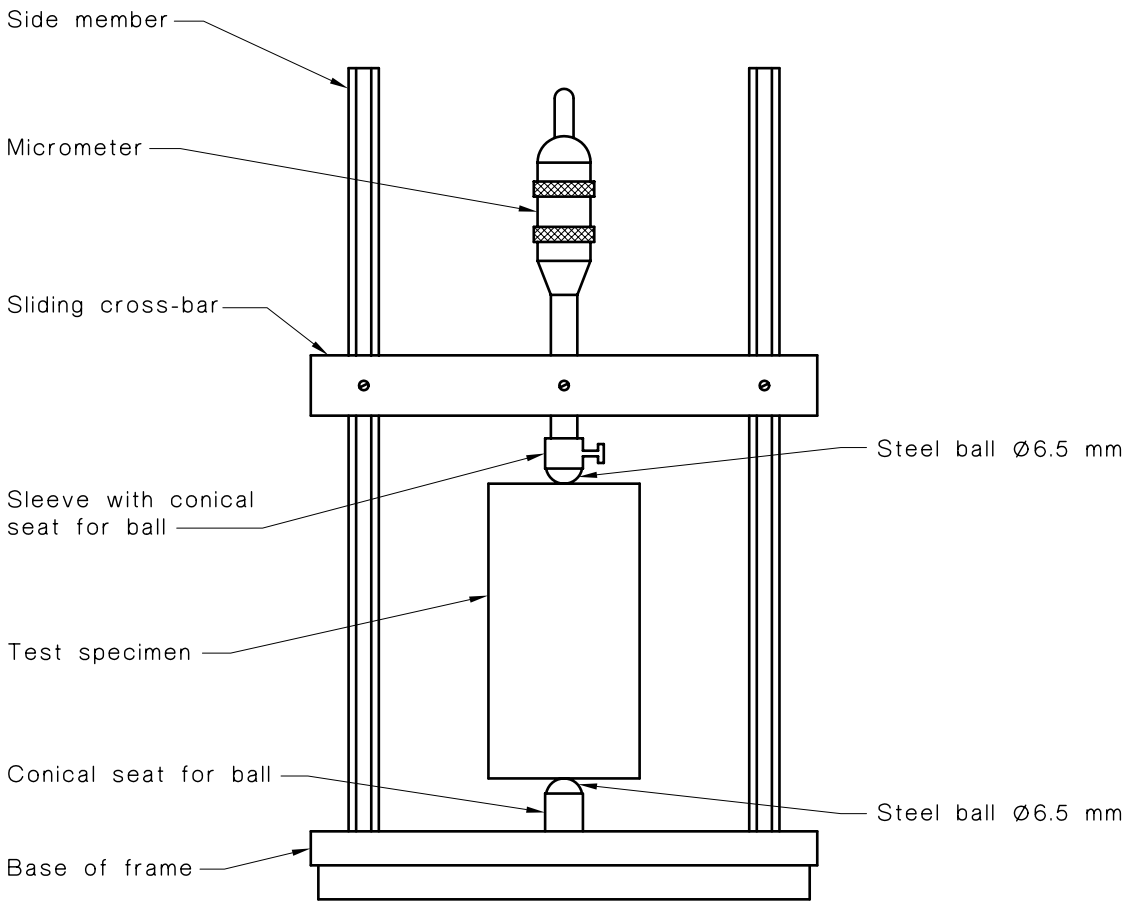

FIGURE 1 TYPICAL MEASURING FRAME

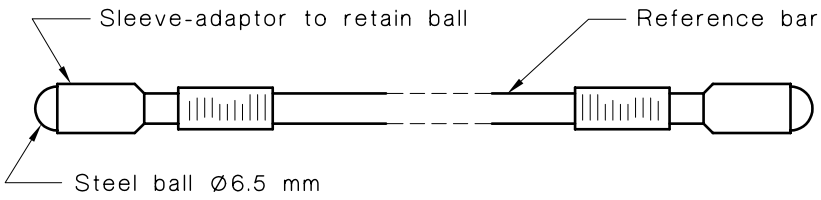

FIGURE 2 TYPICAL REFERENCE BAR WITH STEEL-BALL ADAPTORS

6.3 Procedure

The procedure shall be as follows:

(a) Immerse the specimens in potable water, at laboratory temperature, for 2 h.

(b) Using the calliper, measure the overall length of each specimen to the nearest 1 mm and record as L.

(c) Attach one steel ball adaptor to each end of the reference bar and with the balls in position measure the length of the reference bar supported vertically in the measuring frame with the micrometer to the nearest 0.002 mm. Record the result as Z_1.

(d) Support the test specimen between the steel balls in the measuring frame. Take care that the unit is properly seated on the steel balls and read the micrometer to the nearest 0.002 mm. Record the result as Y_i. Repeat this procedure for all other test specimens.

(e) Remeasure the length of the reference bar as in Step (c) and record the result as Z_2.

(f) Place the specimens in the immersion tank, inside the controlled temperature space, and leave them to soak for 7 days.

(g) Remove the specimens from the tank and surface dry them. Remeasure the reference bar and the specimens as in Steps (c) to (e) and record these results as Z_3, Y_f and Z_4.

6.4 Calculation of curing contraction

The following calculations shall be made:

(a) $Z_i = \dfrac{Z_1 + Z_2}{2}$ and $Z_f = \dfrac{Z_3 + Z_4}{2}$

(b) $dZ = Z_f - Z_i$

(c) $dL = Y_i - (Y_f + dZ)$

(d) $e_{cc} = \dfrac{dL}{L} \times 1000 \text{ mm/m}$

(e) Calculate mean coefficient of residual curing contraction in accordance with AS/NZS 4456.2 to one decimal place.

6.5 Recording

The following information shall be recorded:

(a) Reference to this test method, i.e., AS/NZS 4456.12.

(b) Description of the marking, location and identification of the lot.

(c) Sample and specimen identification.

(d) Date of sample and test.

(e) Work sizes for the lot.

(f) Age of the specimens at commencement of test.

(g) If cut from units, the position of the specimen in the production unit.

(h) Dates and times of the initial and final gauge readings.

(i) All measurements taken.

(j) Coefficient of residual curing contraction to one decimal place.

(k) Mean coefficient of residual curing contraction.

6.6 Report

If a report is prepared, it shall include the following information:

(a) Reference to this test method, i.e., AS/NZS 4456.12.

(b) Description of the marking and identification of the lot, of each specimen.

(c) Sample and specimen identification.

(d) Date of sample and test.

(e) Work sizes for the lot.

(f) Identification of manufacturer.

(g) Age of sample at test.

(h) If cut from units, the position of the specimen in the production unit.

(i) Initial length of each specimen.

(j) Coefficient of residual curing contraction for each specimen, to one decimal place, in millimetres per metre.

(k) Mean coefficient of residual curing contraction, to one decimal place, in millimetres per metre.

7 COEFFICIENT OF DRYING CONTRACTION

7.1 Principle

A sample of 5 units, each at least 14 days of age, is immersed in water for 72 h and measured for length. (This immersion can be deleted if the specimens have just been tested for residual curing contraction.) Autoclaved aerated concrete samples are then dried at 22 ±3°C and 43 ±2% relative humidity and remeasured every 7 days. Once constant length is achieved, the coefficient of drying contraction is calculated from the difference in wet and dry lengths. Other types of masonry units are dried in a ventilated oven set at 110 ±8°C and remeasured every 2 d. For materials adversely affected by temperatures of 110 ±8°C, lower temperatures may be used and are reported. For dimension stone, a temperature of 65 ±3°C is appropriate.

7.2 Preparation of test specimens

Five units, of age 14 days or greater, selected in accordance with AS/NZS 4456.1, shall be used as the test specimens. The test specimens may be those that have been used for testing the coefficient of residual curing contraction (see Clause 6).

Specimens may be cut from units. Where specimens are cut from units, they shall be cut in such a manner that they are representative of the lot under investigation and of the units used in practice. For autoclaved aerated concrete, cut specimens shall be taken so that they represent a uniform distribution across the sample in the direction of rise or compaction of the mass during manufacture. The specimens shall be cut by means of a carborundum or diamond saw. They shall not contain any reinforcement, and the cut surfaces shall be clean and planar. The length axis of the prisms shall be parallel to the length of the unit. Cut test specimens shall be prisms with a length to suit the length of the measuring frame, but not less than 150 mm. The position of the specimen in the production unit shall be shown by a letter designation in the specimen number, i.e., U (upper), MU (middle upper), M (middle), ML (middle lower) or L (lower).

By means of the tungsten carbide drill, a conical depression shall be formed in the centre of each end of each unit to provide reference point seats for the steel balls.

All dust shall be brushed from the drilling of the conical depressions.

Where difficulty is encountered in making smooth conical depressions in coarse-textured or friable units, it shall be permissible, after initial drilling, to fill the depression with a moisture-stable, epoxy-based filler, for which the dimensional stability has been checked under the test conditions before it is adopted for use.

When the filler is cured, it shall be redrilled to re-expose the unit surface.

7.3 Procedure

The procedure shall be as follows:

(a) Place the specimens in the immersion tank, inside the controlled temperature space, and leave them to soak for 72 h. Specimens may need to be weighed down until negatively buoyant. Specimens that have just been tested for residual curing contraction do not need further immersion.

(b) Remove the specimens from the tank and surface-dry them.

(c) As soon as possible, but not later than half an hour after removing the specimens from the water, measure the reference bar and the specimens as follows:

(i) Using the calliper, measure the overall length of each specimen to the nearest 1 mm and record as L.

(ii) Attach one steel ball adaptor to each end of the reference bar and with the balls in position measure the length of the reference bar supported vertically in the measuring frame with the micrometer to the nearest 0.002 mm. Record the result as Z_1.

(iii) Support the test specimen between the steel balls in the measuring frame. Take care that the unit is properly seated on the steel balls and read the micrometer to the nearest 0.002 mm. Record the result as Y_i. Repeat this procedure for all other test specimens.

(iv) Remeasure the length of the reference bar as in Step (ii) and record the result as Z_2.

(v) For autoclaved aerated concrete (AAC) specimens, place them in the humidity chamber. For other types of masonry units, place them in the ventilated drying oven, and dry them at 110 ±8°C. (For dimensioned stone, a temperature of 65 ±3°C is appropriate.) Take the specimens out of the oven and allow them to cool in air to room temperature and measure within 1 h of reaching room temperature.

(vi) Remeasure the reference bar and the cooled specimens as in Steps (iii) and (iv), and return the specimens to the drying chamber.

(vii) Repeat Step (vi) until the difference between two consecutive readings of specimen length are within 0.002 mm of the specimen length.

(viii) Record this length and the reference bar lengths as Z_3, Y_f and Z_4.

7.4 Calculations of drying contraction

The following calculations shall be made:

(a) $Z_i = \frac{Z_1 + Z_2}{2}$ and $Z_f \frac{Z_3 + Z_4}{2}$

(b) $dZ = Z_f - Z_i$

(c) $dL = Y_i - (Y_f + dZ)$

(d) $e_{dc} = \frac{dL}{L} \times 1000$

(e) Calculate mean coefficient of drying contraction in accordance with AS/NZS 4456.2 to one decimal place.

7.5 Recording

The following information shall be recorded:

(a) Reference to this test method, i.e., AS/NZS 4456.12.

(b) Description of the marking, location and identification of the lot.

(c) Sample and specimen identification.

(d) Date of sample and test.

(e) Work sizes for the lot.

(f) If cut from units, the position of the specimen in the production unit.

(g) Dates and times of the initial and final gauge readings.

(h) All measurements taken.

(i) Coefficient of drying contraction (e_{dc}) of each specimen to one decimal place, in millimetres per metre.

(j) Mean coefficient of drying contraction, to one decimal place, in millimetres per metre.

7.6 Report

If a report is prepared, it shall include the following information:

(a) Reference to this test method, i.e., AS/NZS 4456.12.

(b) Description of the marking and identification of the lot, of each specimen.

(c) Sample and specimen identification.

(d) Date of sample and test.

(e) Work sizes for the lot.

(f) Age of sample at test, if known.

(g) If cut from units, the position of the specimen in the production unit.

(h) Initial length of each specimen, to the nearest millimetre.

(i) Coefficient of drying contraction (e_{dc}) of each specimen to one decimal place, in millimetres per metre.

(j) Mean coefficient of drying contraction $(\bar{e}_{dc})$ of the sample to one decimal place, in millimetres per metre.

This Australian/New Zealand Standard was prepared by Joint Technical Committee BD-026, Masonry and Paving Units. It was approved on behalf of the Council of Standards Australia on 6 June 2003 and on behalf of the Council of Standards New Zealand on 9 September 2003 and published on 25 September 2003.

The following are represented on Committee BD-026:

Association of Consulting Engineers Australia
Association of Consulting Structural Engineers of NSW
Australian Building Codes Board
Australian Chamber of Commerce and Industry
Australian Institute of Building Surveyors
CSIRO Manufacturing and Infrastructure Technology
Calcium Silicate Brick Manufacturers
Clay Brick and Paver Institute
Clay Brick Manufacturers Association WA
Clay Brick and Paver Association of New South Wales
Concrete Masonry Association of Australia
Department of Infrastructure (Victoria)
Engineering and Construction Laboratories Association
Institution of Engineers Australia
Institute of Municipal Engineering Australia NSW Division
National Association of Testing Authorities Australia
New Zealand Concrete Masonry Association
Standards New Zealand
Stone Industry Association
University of Newcastle

Additional interest participating in the preparation of this Standard:

Master Builders Australia

Keeping Standards up-to-date

Standards are living documents which reflect progress in science, technology and systems. To maintain their currency, all Standards are periodically reviewed, and new editions are published. Between editions, amendments may be issued. Standards may also be withdrawn. It is important that readers assure themselves they are using a current Standard, which should include any amendments which may have been published since the Standard was purchased.

Detailed information about joint Australian/New Zealand Standards can be found by visiting the Standards Australia web site at www.standards.com.au or Standards New Zealand web site at www.standard.co.nz and looking up the relevant Standard in the on-line catalogue.

Alternatively, both organizations publish an annual printed Catalogue with full details of all current Standards. For more frequent listings or notification of revisions, amendments and withdrawals, Standards Australia and Standards New Zealand offer a number of update options. For information about these services, users should contact their respective national Standards organization.

We also welcome suggestions for the improvement in our Standards, and especially encourage readers to notify us immediately of any apparent inaccuracies or ambiguities. Please address your comments to the Chief Executive of either Standards Australia International or Standards New Zealand at the address shown on the back cover.

Originated as Part of AS Int 306—1948.
Previous edition AS/NZS 4456.12:1997.
Second edition 2003.

This Standard was issued in draft form for comment as DR 02583.

Jointly published by Standards Australia International Ltd, GPO Box 5420, Sydney, NSW 2001 and Standards New Zealand, Private Bag 2439, Wellington 6020

ISBN 0 7337 5418 X

Printed in Australia

Australian/New Zealand Standard™

Masonry units, segmental pavers and flags—Methods of test

Method 13: Determining pitting due to lime particles

1 SCOPE

This Standard sets out the method of examination for pitting, due to lime particles, of masonry units, segmental pavers and flags.

2 REFERENCED DOCUMENTS

The following documents are referred to in this Standard:

AS/NZS		
4456	Masonry units, segmental pavers and flags—Methods of test	
4456.0	Part 0:	General introduction and list of methods
4456.1	Method 1:	Sampling for testing
4456.6	Method 6:	Determining potential to effloresce
4456.11	Method 11:	Determining coefficients of expansion

3 DEFINITIONS

For the purpose of this Standard, the definitions given in AS/NZS 4456.0 apply.

4 PRINCIPLE

Units are exposed to a moist environment and then inspected for the presence of pits caused by the expansion of lime particles.

5 APPARATUS

A moist cupboard is required, capable of maintaining a relative humidity exceeding 95% at room temperature.

6 PREPARATION OF TEST SPECIMENS

Where specimens have been tested for coefficient of expansion or for potential to effloresce in accordance with AS/NZS 4456.11 or AS/NZS 4456.6 as appropriate, the 5 specimens so tested shall be examined for signs of pitting due to lime according to the procedure given in Clause 7, immediately after the completion of those tests.

Where a test for efflorescence or for coefficient of expansion has not been carried out, specimens accumulated from continuous sampling shall be deemed to meet the requirements of this method, provided that the number of specimens accumulated is at least five. For assessment of an individual lot, select 5 units in accordance with AS/NZS 4456.1. The 5 specimens shall be placed in a moist cupboard at room temperature for 48 h.