BRITISH STANDARD

BS EN 15304:2010

Determination of the freeze-thaw resistance of autoclaved aerated concrete

ICS 91.100.30

BSI
British Standards

National foreword

This British Standard is the UK implementation of EN 15304:2010. It supersedes BS EN 15304:2007 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee B/523, Prefabricated components of reinforced autoclaved aerated concrete and lightweight aggregate concrete with open structure.

A list of organizations represented on this committee can be obtained on request to its secretary.

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Determination of the freeze-thaw resistance of autoclaved aerated concrete

Détermination de la résistance au gel/dégel du béton cellulaire autoclavé

Bestimmung des Frost-Tau-Widerstandes von dampfgehärtetem Porenbeton

This European Standard was approved by CEN on 23 January 2010.

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Foreword

This document (EN 15304:2010) has been prepared by Technical Committee CEN/TC 177 “Prefabricated reinforced components of autoclaved aerated concrete or lightweight aggregate concrete with open structure”, the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by September 2010, and conflicting national standards shall be withdrawn at the latest by September 2010.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 15304:2007.

The main changes with respect to EN 15304:2007 are listed below:

a) the clause "Definitions, symbols and abbreviations" has been added;

b) the normative references have been updated;

c) tolerances have been added to improve the ease of application;

d) the calculation of moisture content has been expanded;

e) the requirements for the test report have been expanded;

f) the determination of mass loss, calculation of dry density and calculation of moisture content have been clarified.

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1 Scope

This document specifies a method of determining the freeze-thaw resistance of autoclaved aerated concrete (AAC) manufactured according to EN 12602 or EN 771-4.

2 Normative references

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

EN 678, *Determination of the dry density of autoclaved aerated concrete*

EN 1353, *Determination of moisture content of autoclaved aerated concrete*

EN 12390-4, *Testing hardened concrete — Part 4: Compressive strength — Specification for testing machines*

3 Definitions, symbols and abbreviations

3.1 Superscripts and subscripts

m main test specimen (superscript)

r reference test specimen (superscript)

i identification number of the test specimen (subscript)

3.2 Symbols

3.2.1 Symbols used in the main body of the standard

$m_{i,0}^{r}$ measured initial moist mass of the reference test specimen i immediately after removal from polythene bag (or similar)

$m_{i,n}^{r}$ measured moist mass of the reference test specimen i representing the state immediately after completion of n freeze-thaw cycles (should be equal to $m_{i,0}^{r}$)

$m_{id,n}^{r}$ measured oven-dry mass of the reference test specimen i immediately after completion of n freeze-thaw cycles of the main test specimens

$m_{i,0}^{m}$ measured initial moist mass of the main test specimen i immediately after removal from polythene bag (or similar) prior to commencing the freeze-thaw cycles

$m_{i,n}^{m}$ moist mass of the main test specimen i immediately after completion of n freeze-thaw cycles

$m_{id,0}^{m}$ equivalent oven-dry mass of the main test specimen i immediately after removal from the polythene bag (or similar)

$m_{id,n}^{m}$ measured oven-dry mass of the main test specimen i immediately after completion of n freeze-thaw cycles

$\mu_{i,0}^{r}$ moisture content of the reference test specimen i immediately after removal from polythene bag (or similar)

$\mu_{i,0}^{m}$ moisture content of the main test specimen i immediately after removal from polythene bag or similar (assumed to be equal to $\mu_{i,0}^{r}$)

$\mu_{i,n}^{m}$ moisture content of the main test specimen i immediately after completion of n freeze-thaw cycles (at the end of the freeze-thaw test)

m_{iL} loss in oven-dry mass of the main test specimen i after completion of n freeze-thaw cycles

3.2.2 Symbols specific to Annex A

$m_{i,fa}^{r}$ measured moist mass of the fragments of the saturated (see A.3.2.2) reference test specimen i immediately after the compression test

$m_{i,fd}^{r}$ measured oven-dry mass of the fragments of the saturated (see A.3.2.2) reference test specimen i tested on compression

$m_{i,n2}^{m}$ measured moist mass of the saturated (see A.3.2.2) main test specimen i after finalisation of the n freeze-thaw cycles and after water immersion, immediately before testing of compressive strength (if grinding is needed, before that)

$m_{i,fa}^{m}$ measured moist mass of the fragments of the saturated (see A.3.2.2) main test specimen i immediately after the compression test

$m_{i,fd}^{m}$ measured oven-dry mass of the fragments of the saturated (see A.3.2.2) main test specimen i tested on compression

$\mu_{i,na}^{r}$ calculated moisture content of the saturated (see A.3.2.2) reference test specimen i immediately after compression test (assumed to be equal to the moisture content directly before compression test)

$\mu_{i,na}^{m}$ calculated moisture content of the saturated (see A.3.2.2) main test specimen i after finalisation of the n freeze-thaw cycles, immediately after compression test

$f_{ci,n}^{m}$ individual value of the compressive strength of the main test specimen i after the specified number of cycles (n) and subsequent conditioning according to A.3.2.1 or A.3.2.2, in megapascals

$f_{ci,n}^{r}$ individual value of the compressive strength of the appropriate reference test specimen i , conditioned in the same manner (according to A.3.2.1 or A.3.2.2) and tested at the same time as the corresponding main test specimen, in megapascals

$f_{ci,rel}$ relative decrease of compressive strength of the main test specimen i as a percentage of the initial compressive strength

4 Principle

Cubic test specimens (two equal groups consisting of main test specimens and reference test specimens) are cut from products sampled from normal production, saturated in water for (48 ± 1) h, removed and then placed in polythene bags or similar protecting against drying for (24 ± 1) h to equilibrate.

The main test specimens are subjected to repeated freezing at (–15 ± 2) °C for at least 8 h followed by thawing in an environment of > 95 % relative humidity and (20 ± 2) °C for at least 8 h. The reference test specimens are stored in a climatic chamber at (20 ± 5) °C in conditions that prevent drying of the AAC during storage.

After the specified number of freeze-thaw cycles (not less than 15), the mass loss of the main test specimens is determined. The dry density and moisture content is also determined on the reference test specimens. If the loss in compressive strength is also required to be determined, then Annex A should be followed.

NOTE Depending on the conditions at the place of use, the number of freeze-thaw cycles and requirements for limit values of loss in mass and compressive strength can be specified by national provisions.

5 Apparatus

5.1 Saw with rotating carborundum or diamond blade or similar equipment for cutting test specimens.

5.2 Balance, capable of determining the mass of the test specimens to an accuracy of 0,1 %.

5.3 Callipers, capable of reading the dimensions of the test specimens to an accuracy of 0,1 mm.

5.4 Container, to store the test specimens under water at (20 ± 2) °C.

5.5 Feeler gauge, capable of measuring 0,1 mm, (if required) 0,5 mm and 1 mm.

5.6 Room or cabinet for thawing of the main test specimens able to maintain a relative humidity > 95 % at (20 ± 2) °C.

5.7 Storage room for reference test specimens able to maintain a relative humidity > 95 % at (20 ± 5) °C.

5.8 Freezing chamber with internal air circulation capable of maintaining a uniformly distributed temperature of (–15 ± 2) °C.

5.9 Ventilated drying oven, capable of maintaining a temperature of (105 ± 5) °C.

5.10 Straight edge, at least 200 mm long, and a square.

5.11 Compression testing machine, preferably hydraulically operated, which meets the requirements of EN 12390-4.

NOTE The room according to 5.6 needs not necessarily be humidity-controlled. Alternatively it is possible to substitute moisture losses by 2 h prior to the end of the thawing period placing the main test specimens in underwater storage for 1 h at (20 ± 5) °C and subsequently leaving the test specimens to equilibrate in air for 1 h at (20 ± 5) °C before freezing. This procedure is especially appropriate in combination with automatic systems. It should be ensured that the starting moisture content is not exceeded.

6 Test specimens

6.1 Sample

The sample for the preparation of the test specimens shall be taken in such a manner that it is representative of the product to be investigated, and the test specimens shall be cut from the sample as illustrated in Figure 1.

6.2 Shape and size of the test specimens

The test specimens shall be cubes with an edge length of (100 ± 2) mm.

6.3 Number of test specimens

A test set shall consist of 12 test specimens: 6 main test specimens and 6 reference test specimens.

The main test specimens are exposed to a specified number of freeze-thaw cycles in accordance with 7.1, and their loss in mass (see 8.3) and, if required, their loss in compressive strength due to this exposure is determined (see A.3 and A.4).

The reference test specimens are used for determination of the moisture content of the AAC prior to the freeze-thaw test and of the dry density and, if required, for the determination of the (control) compressive strength.

NOTE Prior to the test a control specimen is needed for each AAC type to evaluate the freeze-thaw temperature-time relationship of the test equipment, see 7.1.

6.4 Preparation of test specimens

The test specimens shall be cut by means of a rotating diamond or carborundum blade or similar equipment. Their surfaces shall not deviate from planeness by more than 0,5 mm. Planeness shall be checked across the two diagonals using a straight edge and, if necessary, a 0,5 mm feeler gauge.

Where test specimens are used for the determination of the compressive strength, their loadbearing surfaces shall not deviate from planeness by more than 0,1 mm and the angle between the loadbearing surfaces and adjacent surfaces shall not deviate from a right angle by more than 1 mm/100 mm. If necessary, the latter shall be checked along both orthogonal middle axes of the loadbearing surfaces by means of a square and a 1 mm feeler gauge or similar instrument.

NOTE If the loadbearing surfaces of the main test specimens determined for the compression test are pitted after completion of freeze-thaw cycles, they should be ground to a flatness of 0,1 mm.

The position of the test specimens in the material relative to the rise of the mass shall be shown by the numbering, and the direction of rise shall be marked on the test specimens.

Equal numbers of test specimens shall be prepared from the upper third of the sample, from the middle and from the lower third in the direction of rise of the mass during manufacture (see Figure 1). The test specimens shall be cut in pairs (main test specimens and reference test specimens) from adjacent areas of the sample to ensure a good comparison.

Test specimens shall be suitably referenced and indicated either as main (m) or reference (r). In addition, the position of the test specimens in the unit and the number of the unit shall be marked.

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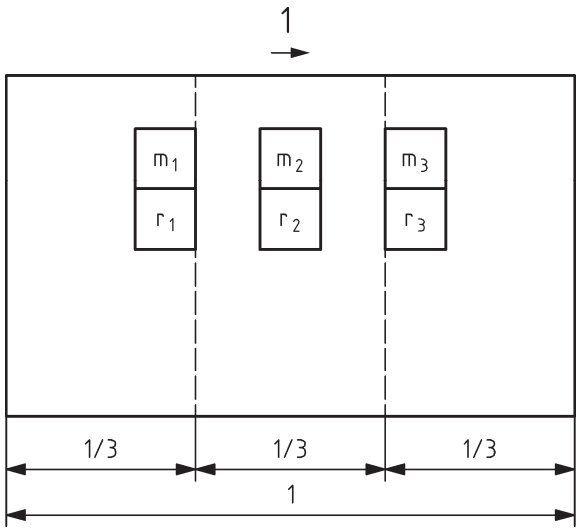

Key

1 Direction of rise
m Main test specimen
r Reference test specimen

Figure 1 – Cutting scheme

6.5 Measurement of test specimens and determination of their volume

The dimensions of the test specimens shall be measured to an accuracy of 0,1 mm, using callipers. Length, height and width shall be measured in mid height at two opposite sides, and the volume V of the test specimens shall be calculated by multiplying the mean values.

6.6 Conditioning of test specimens

After their preparation, the main test specimens and the reference test specimens shall be saturated in water for 48 h at (20 ± 2) °C. For this purpose they shall be stored for (24 ± 1) h with half of their thickness ((50 ± 2) mm) in water and for 24 h totally under water. Then they shall be removed from the water and placed in a polythene bag or similar protecting against drying for (24 ± 1) h to allow the specimens to equilibrate.

7 Testing procedure

7.1 Freeze-thaw test

The main test specimens shall be frozen in air at a temperature of (–15 ± 2) °C, preferably placed on wooden bearers or on mesh shelves. The distance between the main test specimens among each other as well as to the lateral chamber walls and to the upper shelves shall be at least 50 mm. The temperature at the centre of the test specimens shall fall to 0 °C within 2 h to 4 h and shall be checked on a control specimen prior to commencing the test. The freezing period is the time taken for the centre of the test specimens to reach a temperature of (–15 ± 2) °C and shall be a minimum of 8 h.

NOTE 1 The initial air temperature in the freezing chamber (when test specimens are loaded into the freezing chamber) can be (–15 ± 2) °C or can be decreased gradually from (20 ± 2) °C to that temperature for automatic systems.

Thawing of the main test specimens after the freezing cycle can take place either in the same freezing chamber, for automatic systems, or in a separate thawing chamber. The main test specimens should be positioned preferably on wooden bearers, and the distance between each other as well as to the lateral container walls and to the upper shelves shall be at least 50 mm. During the thawing period a relative humidity of above 95 % shall be maintained to prevent moisture loss. The final air temperature shall be maintained at (20 ± 2) °C. The temperature at the centre of the test specimens shall rise to 0 °C within 4 h to 6 h and shall

be checked on a control specimen prior to commencing the test. The thawing period is the time taken for the centre of the test specimens to reach a temperature of (20 ± 2) °C and shall be a minimum of 8 h.

NOTE 2 At the initial stage of thawing a lower humidity is permitted for a short period.

NOTE 3 The required rate of temperature rise or fall in the centre of the main test specimens can be obtained by variation in the volume loading and air circulation of the chamber or by an automatic control system.

This completes one freeze-thaw cycle.

In case of a forced interruption of testing, the main test specimens shall be kept in the thawed condition, in a storage room at a temperature of (20 ± 5) ºC and a relative humidity of > 95 %, so that drying is excluded.

The reference test specimens shall be kept during the period of freeze-thaw cycles of the main test specimens in a storage room at a temperature of (20 ± 5) ºC and a relative humidity of > 95 % or alternatively sealed in polythene bags at the same temperature so that they do not lose moisture.

NOTE 4 If not automated, the freeze-thaw cycles are best programmed such that the placing of the main test specimens in the freezing chamber is undertaken at 17:00 and in the thawing chamber at 09:00 of the following day to fit into the working day. If the test is interrupted at weekends, then the main test specimens should be kept in frozen condition over this period.

After 15 freeze-thaw cycles and at the completion of the test any visual damage to the main test specimens shall be noted.

NOTE 5 Splitting of a main test specimen during the freeze-thaw test should not be considered as frost damage. This test specimen should be disregarded in the test result.

7.2 Determination of actual moisture content and dry density of AAC

7.2.1 The mass $m_{i,0}^{m}$ of the main test specimens and $m_{i,0}^{r}$ of the reference test specimens shall be determined immediately after removal from the polythene bags (or similar) prior to commencing the freeze-thaw test.

7.2.2 The moist mass $m_{i,n}^{m}$ of the main test specimens and $m_{i,n}^{r}$ of the reference test specimens shall be determined immediately after completion of the n freeze-thaw cycles.

7.2.3 After the specified number n of freeze-thaw cycles, both the reference and the main test specimens shall be dried at (105 ± 5) °C until constant mass to determine $m_{id,n}^{m}$ and $m_{id,n}^{r}$, respectively. The oven-dry mass of the reference specimens is used to determine the moisture content of the AAC prior to freeze-thaw tests in accordance with EN 1353 and to calculate the dry density in accordance with EN 678.

7.2.4 If required, the loss of compressive strength shall be determined in accordance with Annex A.

8 Test results

8.1 Calculation of dry density

This calculation shall be done in accordance with EN 678.

The dry density of each main and reference test specimen is calculated by dividing its oven-dry mass $m_{id,n}^{m}$ or $m_{id,n}^{r}$ by its volume V_i (see 6.5) and is rounded to the nearest 5 kg/m^3. The mean value is expressed as the average and is rounded to the nearest 10 kg/m^3.

8.2 Calculation of moisture content

This calculation shall be done in accordance with EN 1353.

The moisture content prior to commencement of the freeze-thaw test $\mu^{r}_{i,0}$ of the reference test specimens immediately after removal from polythene bag (or similar) can be calculated in percent according to Equation (1):

$$\mu^{r}_{i,0} = 100 \cdot (m^{r}_{i,0} / m^{r}_{id,n} - 1) \quad (1)$$

where

$m^{r}_{i,0}$ is the measured initial moist mass of the reference test specimen i immediately after removal from polythene bag (or similar);

$m^{r}_{id,n}$ is the measured[1)] oven-dry mass of the reference test specimen i immediately after completion of n freeze-thaw cycles of the main test specimens.

NOTE It is assumed that the moisture content $\mu^{m}_{i,0}$ of the main test specimen i is equal to the moisture content $\mu^{r}_{i,0}$ of the adjacent reference test specimen i.

If required, for the control of the loss of moisture during the freeze-thaw test, the moisture content $\mu^{m}_{i,n}$ of the main test specimens at the end of the freeze-thaw test can be calculated in percent according to Equation (2):

$$\mu^{m}_{i,n} = 100 \cdot (m^{m}_{i,n} / m^{m}_{id,n} - 1) \quad (2)$$

where

$m^{m}_{i,n}$ is the measured moist mass of the main test specimen i immediately after completion of n freeze-thaw cycles;

$m^{m}_{id,n}$ is the measured[1)] oven-dry mass of the main test specimen i immediately after completion of n freeze-thaw cycles.

Results of each test specimen shall be expressed to the nearest 0,1 %. The mean values are expressed as the average to the nearest 1 %.

8.3 Calculation of mass loss

This calculation is based on the loss in the oven-dry mass of the main test specimens. This is determined from the difference between the initial oven-dry mass (calculated by assuming that the main test specimens have the same initial moisture content as the adjacent reference test specimens) and the final oven-dry mass determined directly on the main test specimens.

NOTE This assumption is correct when the main test specimens and the reference test specimens are taken in pairs from adjacent areas of the same AAC component or masonry unit as required in 6.4.

The equivalent oven-dry mass $m^{m}_{id,0}$ of the main test specimen i immediately after removal from the polythene bag (or similar) is calculated according to Equation (3):

1) Or calculated, see A.4.2.2.

$$m_{\mathrm{id,0}}^{\mathrm{m}} = m_{\mathrm{i,0}}^{\mathrm{m}} \cdot \left(\frac{m_{\mathrm{id,n}}^{\mathrm{r}}}{m_{\mathrm{i,0}}^{\mathrm{r}}} \right) \tag{3}$$

where

$m_{\mathrm{i,0}}^{\mathrm{m}}$ is the measured initial moist mass of the main test specimen i immediately after removal from polythene bag (or similar) prior to commencing the freeze-thaw cycles;

$m_{\mathrm{id,n}}^{\mathrm{r}}$ is the measured[1)] oven-dry mass of the reference test specimen i after completion of n freeze-thaw cycles;

$m_{\mathrm{i,0}}^{\mathrm{r}}$ is the measured initial moist mass of the reference test specimen i immediately after removal from the polythene bag (or similar).

The loss in oven-dry mass m_{iL} of the main test specimen i after number n of freeze-thaw cycles is calculated in percent according to Equation (4):

$$m_{\mathrm{iL}} = 100 \cdot \left(1 - \frac{m_{\mathrm{id,n}}^{\mathrm{m}}}{m_{\mathrm{id,0}}^{\mathrm{m}}} \right) \tag{4}$$

where

$m_{\mathrm{id,0}}^{\mathrm{m}}$ is the equivalent dry mass of the considered main test specimen i immediately after removal from the polythene bag prior to commencing the freeze-thaw cycles according to Equation (3);

$m_{\mathrm{id,n}}^{\mathrm{m}}$ is the measured oven-dry mass of the considered main test specimen i after number n of freeze-thaw cycles.

The mean loss in mass $\overline{m}_{\mathrm{L}}$ is defined as the mean value of the loss in mass for the 6 main test specimens.

9 Test report

The test report shall include the following:

a) Identification of the product;

b) Date of manufacture or other code;

c) Place of testing, testing institute and person responsible for testing;

d) Number and date of issue of this European Standard;

e) Size and relative position of the test specimens as cut from the product sampled;

f) Date of first and last measurement;

g) Number n of freeze-thaw cycles used in the test;

h) Dry density of the individual main and reference test specimens and mean value;

i) Moisture content $\mu_{\mathrm{i,0}}^{\mathrm{r}}$ of the individual reference test specimens and the mean value $\overline{\mu}_{0}^{\mathrm{r}}$ before commencing the freeze-thaw test;

j) Information on testing (automatic system or manual), method of humidity control during thawing, method of conditioning test specimens prior to compressive strength testing (if required);

k) Moisture content $\mu_{i,n}^{m}$ of the individual main test specimens and the mean value $\overline{\mu}_{n}^{m}$ on completion of the freeze-thaw tests (if required);

l) Moist mass $m_{i,0}^{r}$ of the reference test specimens immediately after removal from the polythene bags (or similar) prior to commencing the freeze-thaw test and moist mass $m_{i,n}^{r}$ of the reference test specimens representing the state immediately after completion of the n freeze-thaw cycles (if required);

m) Loss in mass m_{iL} of the individual main test specimens i and the mean value $\overline{m}_{L}$;

n) Observations on the appearance of the main test specimens before and after the test;

o) Method used to condition the test specimens for compression test after freeze-thaw cycles (if required according to Annex A);

p) Compressive strength of the tested main test specimens and reference test specimens (if required according to Annex A);

q) Moisture content of the tested main test specimens and reference test specimens immediately after compression test when compression test is made in saturated state, calculated individual values $\mu_{i,na}^{m}$ and $\mu_{i,na}^{r}$ and mean values $\overline{\mu}_{na}^{m}$ and $\overline{\mu}_{na}^{r}$ (if required according to Annex A);

r) Loss in compressive strength $f_{ci,rel}$ of the individual main test specimens i and the mean value $\overline{f}_{c,rel}$ (if required according to Annex A);

s) (If appropriate) deviations from the standard method of testing;

t) A declaration that the testing has been carried out in accordance with this European Standard, except as detailed in 9 s).

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Annex A
(informative)

Determination of the loss in compressive strength in addition to the loss in mass

A.1 General

This procedure should be used where the loss in compressive strength is also required to be determined in conjunction with the loss in mass. The procedure in the main clause of this standard should be followed with attention to particular clauses and additional requirements, as below.

The compressive strength may be determined either in the oven-dry state (reference method in cases of dispute) or in the saturated state.

A.2 Test specimens

A.2.1 Number of test specimens

See 6.3.

A.2.2 Preparation of test specimens

See 6.4.

A.3 Testing procedure

A.3.1 Freeze-thaw tests

See Clause 7.

A.3.2 Conditioning of the test specimens for compression test after the freeze-thaw cycles

A.3.2.1 Conditioning for the compression test in oven-dry state

After completion of the required number n of freeze-thaw cycles (see 7.1) the main test specimens should be weighed in the moist state (mass $m_{i,n}^{m}$, see 7.2.2). Subsequently, both main and reference specimens should be dried to constant mass at (105 ± 5) °C and weighed again (mass $m_{id,n}^{m}$ and $m_{id,n}^{r}$, see 7.2.3).

If the loadbearing surfaces of the main test specimens are pitted, they should be ground to a flatness of 0,1 mm before determining the compressive strength. After this procedure, the main test specimens should be dried again to constant mass at (105 ± 5) °C.

Before the compression test all test specimens should be allowed to cool at room temperature for at least 5 h. During this period they should be sealed in polythylene bags (or similar) to avoid absorption of moisture.

A.3.2.2 Conditioning for compression test in saturated state

After completion of the required number n of freeze-thaw cycles (see 7.1) the main test specimens should be weighed in the moist state (mass $m_{i,n}^{m}$).

Subsequently the main test specimens for the compression test should be conditioned by fully immersing in water at (20 ± 2) °C for (24 ± 1) h. After removing from immersion the superficial moisture is eliminated from

the main test specimens by wiping the surfaces with a sponge or an absorbent cloth and the main test specimens are placed into a polythene bag (or similar) for (24 ± 1) h to equilibrate before compression testing.

If the loadbearing surfaces of the main test specimens determined for the compression test are pitted, they should be ground to a flatness of 0,1 mm soon after removal from polythene bag (or similar) just before compression testing.

A.3.3 Compression test

A.3.3.1 Compressive strength determined on oven-dried test specimens

The compressive strength should be determined during the same period on all main and reference test specimens in accordance with EN 679:2005, Clauses 6 and 7.

The cross-sectional area of the main test specimens should be calculated from the initial dimensions measured before the freeze-thaw test in accordance with 6.5.

A.3.3.2 Compressive strength determined on saturated test specimens

The compressive strength should be determined in accordance with EN 679:2005, Clauses 6 and 7.

The cross-sectional area of the main test specimens should be calculated from the initial dimensions measured before the freeze-thaw test in accordance with 6.5.

In addition, the moist mass $m^{\mathrm{m}}_{\mathrm{i,n2}}$ of the main test specimens (after water immersion and equilibration) should be determined immediately before the compression test. If grinding is needed for main test specimens, moist mass $m^{\mathrm{m}}_{\mathrm{i,n2}}$ should be determined before grinding.

It is important that all main and reference test specimens are tested during the same period, soon after removal from polythene bag (or similar) or storage. The mass $m^{\mathrm{r}}_{\mathrm{i,n}}$ (see 7.2.2) should be measured just after removal from storage before the compression test. Directly after the compression test all loose material should be removed from the bigger fragments of the crushed test specimen, e.g. by using a steel brush. Subsequently these bigger fragments shall be weighed immediately after the compression test (measured moist mass $m^{\mathrm{m}}_{\mathrm{i,fa}}$ of fragments from main test specimen i and measured moist mass $m^{\mathrm{r}}_{\mathrm{i,fa}}$ of fragments from reference test specimen i), dried at (105 ± 5) °C to constant mass and then weighed again (measured oven-dry mass $m^{\mathrm{m}}_{\mathrm{i,fd}}$ of fragments from main test specimen i and measured oven-dry mass $m^{\mathrm{r}}_{\mathrm{i,fd}}$ of fragments from reference test specimen i).

To be representative for the considered test specimen, the total moist mass of the bigger fragments should be at least 80 % of the moist mass of the test specimen before the compression test.

A.4 Test results

A.4.1 Calculation of loss of compressive strength of main test specimens

The relative decrease of compressive strength of the main test specimen i as a percentage of the initial compressive strength is calculated to the nearest 0,1 % using Equation (A.1):

$$f_{\mathrm{ci,\,rel}} = \left(1 - \frac{f^{\mathrm{m}}_{\mathrm{ci,n}}}{f^{\mathrm{r}}_{\mathrm{ci,n}}}\right) \cdot 100 \qquad \text{(A.1)}$$

where

$f_{ci,n}^{m}$ is the individual value of the compressive strength of the main test specimen i after the specified number n of cycles and subsequent conditioning according to A.3.2.1 or A.3.2.2, in megapascals;

$f_{ci,n}^{r}$ is the individual value of the compressive strength of the appropriate reference test specimen i, conditioned in the same manner (according to A.3.2.1 or A.3.2.2) and tested at the same period as the corresponding main test specimen, in megapascals.

NOTE As explained in 6.4 the test specimens should be cut in pairs (main test specimens and reference test specimens) from adjacent areas of the sample to ensure a good comparison. In addition, as such the resulting test data is used to compare between them.

The mean loss in compressive strength $\bar{f}_{c,rel}$ is defined as the mean value of the loss in compressive strengths $f_{ci,rel}$ for the main test specimens. It is calculated to the nearest 1 %.

A.4.2 Determination of mass loss

A.4.2.1 If the compressive strength is determined on oven-dried test specimens

The procedure according to 8.3 applies.

A.4.2.2 If the compressive strength is determined on saturated test specimens

The procedure according to 8.3 applies.

The oven-dry mass $m_{id,n}^{m}$ of the main test specimen i after finalisation of the n freeze-thaw cycles is calculated using Equation (A.2):

$$m_{id,n}^{m} = \frac{m_{i,n2}^{m}}{1 + \frac{\mu_{i,na}^{m}}{100}} \quad \text{(A.2)}$$

where

$m_{i,n2}^{m}$ is the measured moist mass of the main test specimen i after finalisation of the n freeze-thaw cycles and after water immersion, immediately before testing of compressive strength (if grinding is needed, before that);

$\mu_{i,na}^{m}$ is the moisture content of the main test specimen i after finalisation of the n freeze-thaw cycles, immediately after compression test calculated as explained in A.4.4, in percent.

The oven-dry mass $m_{id,n}^{r}$ of the reference test specimen i after finalisation of the n freeze-thaw-cycles is calculated using Equation (A.3):

$$m_{id,n}^{r} = \frac{m_{i,n}^{r}}{1 + \frac{\mu_{i,na}^{r}}{100}} \quad \text{(A.3)}$$

where

$m^{r}_{i,n}$ is the measured moist mass of the reference test specimen i representing the state immediately after completion of n freeze-thaw cycles;

$\mu^{r}_{i,na}$ is the moisture content of the reference test specimen i immediately after compression test calculated as explained in A.4.4, in percent.

NOTE It is assumed that the moisture content immediately after compression test is equal to the moisture content directly before compression test.

A.4.3 Calculation of dry density

See 7.1.

When determining the dry density of AAC using saturated compressed test specimens (see A.3.2.2), the volume of the fragments is calculated by multiplying the original volume V_i of the test specimen by the ratio of the moist mass of the fragments determined directly after the compression test and the moist mass of the test specimen determined immediately before the compression test. The dry density of the AAC is calculated by dividing the dry mass of the fragments by their volume.

A.4.4 Calculation of moisture content

See 7.2.

In addition when conditioning is performed using saturated compressed test specimens (see A.3.2.2) the moisture content $\mu^{m}_{i,na}$ of the main test specimen i after finalisation of the n freeze-thaw cycles immediately after compression test in percent is calculated using Equation (A.4):

$$\mu^{m}_{i,na} = 100 \times \left(\frac{m^{m}_{i,fa}}{m^{m}_{i,fd}} - 1 \right) \quad \text{(A.4)}$$

where

$m^{m}_{i,fa}$ is the measured moist mass of the fragments of main test specimen i immediately after the compression test;

$m^{m}_{i,fd}$ is the measured oven-dry mass of the fragments of main test specimen i tested on compression.

The moisture content $\mu^{r}_{i,na}$ of the reference test specimen i immediately after compression test in percent is calculated using Equation (A.5):

$$\mu^{r}_{i,na} = 100 \times \left(\frac{m^{r}_{i,fa}}{m^{r}_{i,fd}} - 1 \right) \quad \text{(A.5)}$$

where

$m^{r}_{i,fa}$ is the measured moist mass of the fragments of reference test specimen i immediately after the compression test;

$m^{r}_{i,fd}$ is the measured oven-dry mass of the fragments of reference test specimen i tested on compression.

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Annex B
(informative)

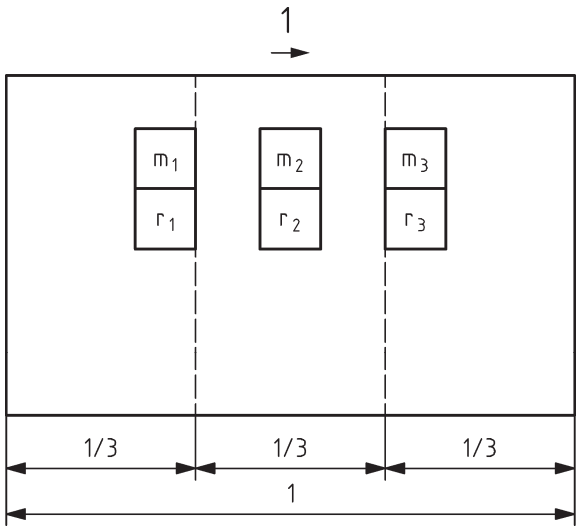
Flow chart of freeze-thaw test

Step by step guide for overview of test method with reference to the detailed procedure contained in the main text

Sampling and preparation of test specimens – Clause 5

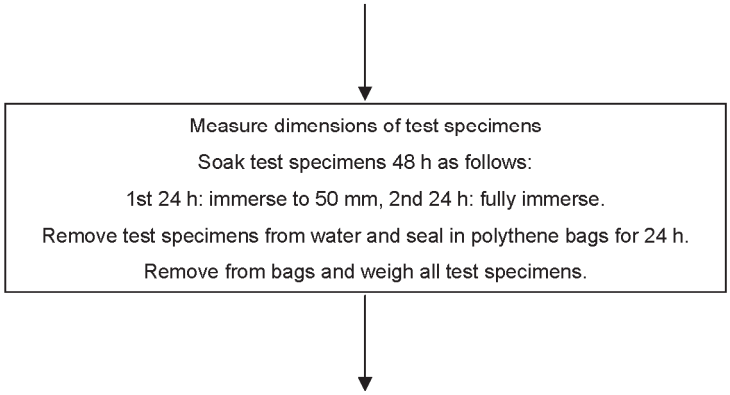
Use a prefabricated AAC-component or large masonry unit of sufficient size to cut all test specimens or cut test specimens from adjacent units from a batch that is representative of material to be tested.

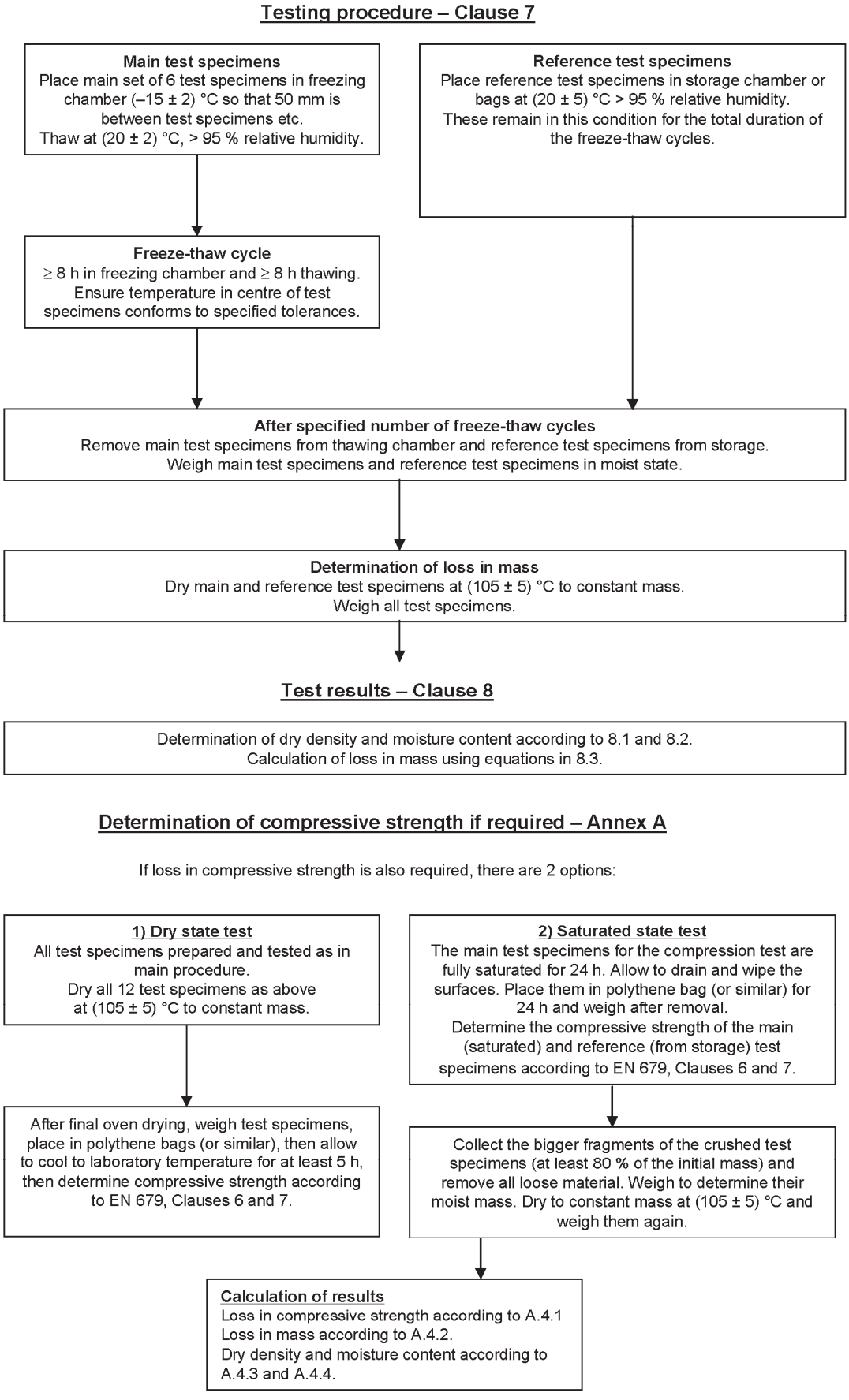
Cut and surface grind 12 test specimens as illustrated in Figure B.1. Take equal numbers from upper, middle and lower third relative to direction of rise, mark position of test specimens, direction of rise etc. Divide into main and reference test specimens, 6 test specimens per set.



Key
1 Direction of rise
m Main test specimen
r Reference test specimen

Figure B.1– Cutting scheme





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