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Določanje obstojnosti avtoklaviranega celičastega betona proti zamrzovanju-tajanju

Determination of the freeze-thaw resistance of autoclaved aerated concrete

Bestimmung des Frost-Tau-Widerstandes von dampfgehärtetem Porenbeton

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

Ta slovenski standard je istoveten z: EN 15304:2010

ICS:

91.100.30	Beton in betonski izdelki	Concrete and concrete products

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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of an identical text or by endorsement, at the latest by September 2010, and conflicting national standards shall be withdrawn at the latest by September 2010.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.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

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

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

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

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

$m^{m}_{i,0}$ 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

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

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

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

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

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

$\mu^{m}_{i,n}$ 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

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

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

$m^{m}_{i,n2}$ 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)

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

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

$\mu^{r}_{i,na}$ 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)

$\mu^{m}_{i,na}$ 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

$f^{m}_{ci,n}$ 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

$f^{r}_{ci,n}$ 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.

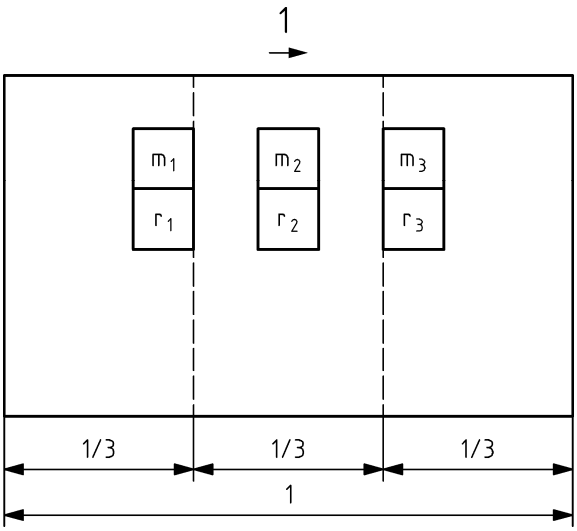
Where test specimens are used for the determination of the compressive strength, their loadbearing surfaces shall not deviate from planeness by more than 0,1 mm and the angle between the loadbearing surfaces and adjacent surfaces shall not deviate from a right angle by more than 1 mm/100 mm. If necessary, 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.



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.