Institut luxembourgeois de la normalisation
de l'accréditation, de la sécurité et qualité
des produits et services

ILNAS-EN 12390-15:2019

Testing hardened concrete - Part 15: Adiabatic method for the determination of heat released by concrete during its hardening process

Essais pour béton durci - Partie 15 : Méthode adiabatique de détermination de la chaleur dégagée par le béton en cours de durcissement

Prüfung von Festbeton - Teil 15: Adiabatisches Verfahren zur Bestimmung der Wärme, die während des Erhärtungsprozesses von Beton

07/2019

National Foreword

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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 12390-15

July 2019

ICS 91.100.30

English Version

Testing hardened concrete - Part 15: Adiabatic method for the determination of heat released by concrete during its hardening process

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Prüfung von Festbeton - Teil 15: Adiabatisches Verfahren zur Bestimmung der Wärme, die während des Erhärtungsprozesses von Beton freigesetzt wird

This European Standard was approved by CEN on 17 June 2019.

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Ref. No. EN 12390-15:2019 E

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European foreword

This document (EN 12390-15:2019) has been prepared by Technical Committee CEN/TC 104 "Concrete and related products", the secretariat of which is held by SN.

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of an identical text or by endorsement, at the latest by January 2020, and conflicting national standards shall be withdrawn at the latest by January 2020.

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

This standard is one of a series on testing concrete.

EN 12390, *Testing hardened concrete*, consists of the following parts:

— *Part 1: Shape, dimensions and other requirements of specimens and moulds*

— *Part 2: Making and curing specimens for strength tests*

— *Part 3: Compressive strength of test specimens*

— *Part 4: Compressive strength - Specification for testing machines*

— *Part 5: Flexural strength of test specimens*

— *Part 6: Tensile splitting strength of test specimens*

— *Part 7: Density of hardened concrete*

— *Part 8: Depth of penetration of water under pressure*

— *Part 10: Determination of the carbonation resistance of concrete at atmospheric levels of carbon dioxide*

— *Part 11: Testing hardened concrete. Determination of the chloride resistance of concrete, unidirectional diffusion*

— *Part 12: Determination of the potential carbonation resistance of concrete: Accelerated carbonation method (in preparation)*

— *Part 13: Determination of secant modulus of elasticity*

— *Part 14: Semi-adiabatic method for the determination of heat released by concrete during its hardening process*

— *Part 15: Adiabatic method for the determination of heat released by concrete during its hardening process*

— *Part 16: Determination of shrinkage of concrete (in preparation)*

— *Part 17: Determination of creep of concrete in compression (in preparation)*

According to the CEN-CENELEC Internal Regulations, the national standards organisations 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, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

1 Scope

This document specifies the procedure for the determination of heat released by concrete during its hardening process in adiabatic condition.

The test is suitable for specimens having a declared value of D of the coarsest fraction of aggregates actually used in the concrete (D_{max}) not greater than 32 mm.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 12350-1, *Testing fresh concrete — Part 1: Sampling*

EN 12390-2, *Testing hardened concrete — Part 2: Making and curing specimens for strength tests*

3 Terms, definitions, symbols and scripts

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at http://www.iso.org/obp

3.1.1
adiabatic equipment
equipment whose error of adiabatism, as defined in 3.1.2, is less than 0,05 K/h at least in the temperature range 20 °C to 70 °C, and the ratio between the heat capacity of calorimeter and the heat capacity of the sample $\frac{C_{cal}}{C_{con}}$ is less or equal than 0,1

3.1.2
adiabatism error
α
rate of decrease in temperature (K/h) of a fully hydrated reference concrete sample

Note 1 to entry: A concrete sample can be considered to be fully hydrated when cured for 12 months in accordance with EN 12390-2.

3.1.3
intrinsic temperature rise
ΔT_c^*
temperature rise in concrete in the absence of heat transfer from the concrete sample to the surrounding environment

3.1.4
adiabatic heat release
q
heat released by concrete during its hydration in adiabatic conditions as a function of time

3.1.5
calorimeter cell
element containing the sample container (mould) and having the external enclosure with uniform temperature distribution which is provided by a controlled conditioning system

Note 1 to entry: As a consequence of uniform temperature distribution in the region defined by the sample mould and the external envelope, adiabatic conditions should be ensured.

3.2 Symbols and scripts

Table 1 — Symbols, units and explanation

Symbol	Units	Explanation
C_{cal}	J/K	heat capacity of the calorimeter
C_{con}	J/K	total heat capacity of the concrete specimen alone
α	K/h	adiabatism error
ΔT_c^*	K	intrinsic temperature rise
$q(t)$	J/kg	heat release at time t
$T_{\text{con,0}}$	°C	initial temperature of fresh concrete
$T_{\text{con}}(t)$	°C	temperature of the concrete specimen at time t
$T_{\text{cal}}(t)$	°C	temperature of the calorimeter cell at time t
ΔT_{m}	K	measured temperature rise
ΔT_{c}	K	corrected temperature rise
t	h	time elapsed since start of test t_0
t_0	—	initial time of test (first contact of cement with water)
Δt	min	time interval between two measures of temperature
c_{c}	J/(kg·K)	specific heat of cement
c_{a}	J/(kg·K)	specific heat of aggregate
c_{ad}	J/(kg·K)	specific heat of additions
c_{w}	J/(kg·K)	specific heat of water in sample
m_{con}	kg	mass of concrete sample
m_{c}	kg	nominal mass of cement in the mix design per cubic metre
m_{ad}	kg	nominal mass of additions in the mix design per cubic metre
m_{a}	kg	nominal mass of aggregate in the mix design per cubic metre

Symbol	Units	Explanation
m_w	kg	nominal mass of water in the mix design per cubic metre
m_{mould}	kg	sum of the masses of empty mould, probe tube and mould cover
Q	J	heat applied to mass of distilled water
R^2	—	regression coefficient
I	A	intensity of direct current
C_T	J/K	total heat capacity of the system equipment containing calibration sample, a reference sample or the calibration medium
C_{dw}	J/K	heat capacity of distilled water
$m_c(Q_i)_t$	J/g	hydration heat developed in m_{con} grams of concrete

If needed, more accurate values of specific heat of the concrete constituent materials may be used (see Annex C of EN 12390-14:2018 semi-adiabatic method).

4 Principle

The test determines the quantity of heat released from the concrete during its hardening process in an adiabatic condition at regular intervals from just after casting of the specimen.

The test is carried out using an adiabatic calorimeter which has been constructed to minimize the heat loss from the concrete sample.

A sample of freshly mixed concrete is placed in a mould which is then introduced into the adiabatic calorimeter and the internal temperature of the hardening concrete is measured.

The test is suitable for concrete containing all types of cement referred to in EN 206, with the exception of quick-setting cements.

5 Apparatus

5.1 Thermometers

To measure the temperature of the concrete sample (T_{con}) and the temperature of the calorimeter cell (T_{cal}) with a maximum permissible error of 0,3 K in the working range of the test (10 °C to 100 °C).

NOTE Platinum resistance thermometers are the preferred thermometers when calibrating the equipment.

5.2 Balance

To measure the mass of the concrete to a maximum permissible error of 0,1 %.

5.3 Temperature monitoring and control system

A closed loop control system capable of providing a uniform temperature distribution over all the external enclosure of the calorimeter cell and able to automatically adjust the temperature of the calorimeter cell such that the difference between the temperature of the sample and the calorimeter cell is not negative and not greater than 0,5 K in order to ensure adiabatic conditions.