SLOVENSKI STANDARD
# oSIST prEN 12390-14:2016

**01-april-2016**

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**Preskušanje strjenega betona - 14. del: Semiadiabatska metoda za ugotavljanje toplote, ki se sprosti med procesom strjevanja betona**

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

Prüfung von Festbeton -Teil 14: Teiladiabatisches Verfahren zur Bestimmung der Wärme, die während des Erhärtungsprozesses von Beton freigesetzt wird



Essai pour béton durci - Partie 14: Méthode semi-adiabatique de détermination de la chaleur dégagée par le béton au cours son processus de durcissement

**Ta slovenski standard je istoveten z:** **prEN 12390-14**



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**ICS:**

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|---|---|---|
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# Testing hardened concrete - Part 14: Semi-adiabatic method for the determination of heat released by concrete during its hardening process

Essai pour béton durci - Partie 14

Prüfung von Festbeton -Teil 14: Teiladiabatisches Verfahren zur Bestimmung der Wärme, die während des Erhärtungsprozesses von Beton freigesetzt wird

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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# European Foreword

This document (prEN 12390-14:2016) has been prepared by Technical Committee CEN/TC 104 “Concrete and related products”, the secretariat of which is held by DIN.

This document is currently submitted to the CEN Enquiry.

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 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 xx: Determination of shrinkage (in preparation)*

— *Part xy: Determination of creep (in preparation)*

# 1 Scope

This European Standard specifies the procedure for the determination of heat released by concrete during its hardening process in semi-adiabatic condition in a laboratory. Annex B specifies the procedure when the test is performed on site. 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, in whole or in part, are normatively referenced in this document and are indispensable for its application. 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, units and scripts

## 3.1 Terms and definitions

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

**3.1.1**
**semi-adiabatic equipment**
equipment containing a calorimeter cell where the maximum heat losses are less than 100 J/(h·K)



**3.1.2**
**adiabatism error**
**($\alpha$)**
rate of decrease in temperature (°C /h) of a fully hydrated reference concrete sample



**3.1.3**
**semi-adiabatic heat release**
**($q$)**
calculated value of heat released by concrete during its hydration in semi-adiabatic conditions

**3.1.4**
**calorimeter cell**
cell containing the sample container (mould) or control specimen and having an external insulated enclosure with a sealable removable cover

## 3.2 Symbols, units and scripts

**Table 1 — Symbols, units and explanation**

| Symbol | Units | Explanation |
|---|---|---|
| $C_{cal}$ | J/°C | heat capacity of the calorimeter, obtained from the calibration |
| $C_{con}$ | J/°C | total heat capacity of the concrete specimen alone (product of mass times specific heat capacity) |
| $C_{tot}$ | J/°C | total heat capacity = $C_{con}$ + $C_{cal}$ |
| $\alpha$ | °C /h | adiabatism error |
| $\theta(t)$ | °C | deviation in temperature between the concrete specimen and the control specimen at time $t$ = $T_{con}(t) - T_{ctl}(t)$, |
| $\Delta T_c^*$ | °C | intrinsic temperature rise |
| $q(t)$ | J/g | heat release at time $t$ |
| $T_{ext}$ | °C | exterior temperature |
| $T_{con,0}$ | °C | initial temperature of fresh concrete |
| $T_{con}(t)$ | °C | temperature of the concrete specimen at time $t$ |
| $T_{cal}(t)$ | °C | temperature of the calorimeter cell at time $t$ |
| $T_{ctl}(t)$ | °C | temperature of the hardened concrete control specimen at time $t$ |
| $\Delta T_m$ | °C | measured temperature rise |
| $\Delta T_c$ | °C | corrected temperature rise |
| $t$ | min | Duration test = age of concrete = time elapsed since the first contact of cement with water |
| $t_0$ | — | initial time of test |
| $\Delta t$ | min | time interval between readings not greater than 5 min |
| $c_c$ | J°C$^{-1}$ kg$^{-1}$ | specific heat of cement |
| $c_a$ | J°C$^{-1}$ kg$^{-1}$ | specific heat of aggregate and additions |
| $c_w$ | J°C$^{-1}$ kg$^{-1}$ | specific heat of water in sample |
| $\mu_w$ | J°C$^{-1}$ kg$^{-1}$ | average specific heat for the water equal to 3760 J°C$^{-1}$ kg$^{-1}$. |
| $\mu_s$ | J°C$^{-1}$ kg$^{-1}$ | specific heat for solids in the mix (cement, additions and aggregates) and equals approximately 800 J °C$^{-1}$ kg$^{-1}$. |
| $m_{con}$ | kg | mass of concrete sample |
| $m_c$ | kg | mass of cement in sample |
| $m_{ad}$ | kg | mass of additions in sample |
| $m_a$ | kg | mass of aggregate in sample |

| | | |
|---|---|---|
| $m_{\text{w}}$ | kg | nominal mass of water in sample |
| $m_{\text{mould}}$ | kg | mass of empty mould |
| $Q$ | J | Heat applied to mass of distilled water |
| $R^2$ | — | Regression coefficient |
| $I$ | A | Intensity of direct current |
| $C_{\text{T}}$ | J | Total heat capacity of the system equipment and distilled water |
| $C_{\text{dw}}$ | J | Heat capacity of distilled water |
| $a$, $b$ | — | Calibration coefficients |
| $m_{\text{c}}(Q_{\text{i}})_{\text{t}}$ | Jg | hydration heat developed in $m_{\text{con}}$ grams of concrete |

NOTE If needed, more accurate values of specific heat of the concrete constituent materials may be used (see Annex C).

## 4 Principle

The test determines the quantity of heat released over time of a concrete specimen placed into a semi-adiabatic calorimeter designed for concrete.

The quantity of heat produced, measured in Joules, is determined at regular intervals from just after casting of the specimen.

The test is carried out using two calorimeters which have been constructed to minimize the heat loss from the concrete sample to the surrounding environment and have identical heat loss coefficients and heat capacities.

A sample of fresh concrete is placed in a container which is then introduced into the calorimeter and the internal temperature of the hardening concrete and quantity of heat released is measured. At any given time, the heat released by hydration equals the heat accumulated into both the calorimeter and specimen plus the cumulative heat that has dissipated to the outside since the initial time.

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

## 5 Apparatus

### 5.1 Thermometers

To measure the temperature of the fresh concrete specimen ($T_{\text{con}}$) and the temperature ($T_{\text{ctl}}$) of the hardened concrete control specimen with a maximum permissible error of 0,1 °C in the working range of the test. Only platinum resistance thermometers shall be used in the calibration of the equipment.

Other methods of temperature measurement may be used in the test but with the acceptance that the accuracy of the results produced will be less accurate. If used, it shall be declared in the test report.

### 5.2 Balance

To measure the mass of the concrete to a maximum permissible error of 0,02 %.

### 5.3 Temperature monitoring and control system

A digital multimeter, used to measure both the calibration cylinder resistance and test voltages having a maximum permissible error of 0,1 % in the operating range 0-200 V.

One calibration cylinder, containing an aluminium specimen with an identical shape to the test specimen and a heating resistance of 2,500 ohms minimum with a resistivity having a low thermal coefficient e.g. constantan or manganin wire. The resistance connection wires are designed with a maximum cross-section of 0,05 mm$^2$ to avoid heat leaks.

Another calorimeter used as a control device, equipped with an inert specimen of an identical design to the calibration cylinder, yet without a heating resistance;

A temperature measurement instrumentation with a maximum permissible error of 0,1 °C in the operating range of 10 – 100 °C.

## 5.4 Semi- adiabatic equipment (schematic example shown in Figure 1)

To perform the test, two calorimeters having identical heat loss coefficients ($\alpha$) at 20 °C and heat capacities ($C_{\mathrm{cal}}$) to within 15 % are required [3]. One contains the control specimen, the other for the test specimen.

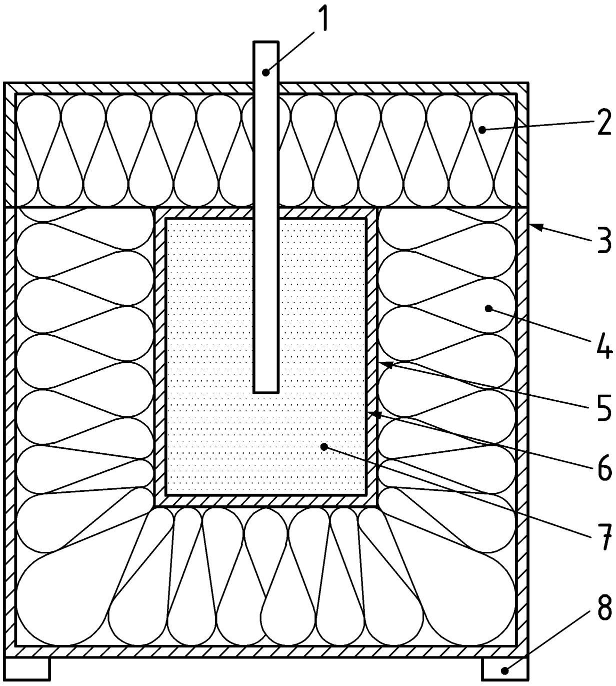
Each calorimeter typically consists of a calorimeter cell with a removable insulated cover and an external enclosure made with a high heat conductivity material, e.g. steel or other suitable material. The calorimeter cell is surrounded by an external insulating layer encased in a rigid caisson.

A cubic or cylindrical shaped sample container (mould with cover) made from steel with a wall thickness of approximately 0,1 – 0,2 mm or from cardboard with a wall thickness of approximately 1,9 mm having a volume of at least 5 l.

The sample container shall allow the positioning of a probe tube made from a high heat conductivity material not readily attacked by cement paste in the centre of the sample to house a thermometer. The tube is filled with diathermal fluid in order to provide the best possible heat contact between the thermometer and the concrete sample.

The apparatus shall be supported in a way to ensure that the temperature of the base is determined by the ambient air.

The calorimeters shall be calibrated according to the procedure specified in Annex A.1 or alternatively Annex A.2 every 4 years or any time the calorimeter has been modified or refurbished.




**Key**

Equipment items:

1 Probe tube for thermometer in diathermal fluid

2 Cover (with similar heat insulation as rest of equipment)

3 External caisson

4 Thermal insulation

5 Steel shell

6 Sample container (mould)

7 Sample under test or control sample

8 Base



**Figure 1 — Schematic arrangement of the equipment**

## 5.5 Control specimen

A control specimen (thermally inert) cast using the same procedure as the test specimen is required.

NOTE Concrete specimens of similar density are assumed to have similar heat capacity.

Concrete specimen of at least three months old is assumed to be thermally inert. Special attention should be taken for hydraulic binders with slow heat release.

# 6 Procedure

The test shall be carried out in a conditioned room with a temperature of (20 ± 2) °C.

The open calorimeters, control specimen and constituent materials shall be stored in the conditioned room for at least 24 h. Sufficient materials are required to produce a concrete sample of at least 20 l.

A control specimen is placed inside a calorimeter located in the conditioned room.