

Thermal performance of buildings — Determination of thermal resistance by hot box method using heat flow meter — Masonry

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ICS 91.120.10

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Summary of pages

This document comprises a front cover, an inside front cover, the EN title page, pages 2 to 17 and a back cover.

Amendments issued since publication

Amd. No.	Date	Text affected

This British Standard, having been prepared under the direction of the Engineering Sector Board, was published under the authority of the Standards Board and comes into effect on 15 July 1998

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ICS 91.060.10; 91.080.30; 91.120.10

Descriptors: Buildings, walls, laboratory tests, measurements, thermal properties, thermal resistance, heat transfer, fidelity calibration

English version

Thermal performance of buildings — Determination of thermal resistance by hot box method using heat flow meter — Masonry

Performance thermique des bâtiments —
Détermination de la résistance thermique selon la
méthode de la boîte chaude avec fluxmètre —
Maçonnerie

Wärmetechnisches Verhalten von Gebäuden —
Messung des Wärmedurchlaßwiderstandes
Heizkastenverfahren mit dem
Wärmestrommesser — Mauerwerk

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Comité Européen de Normalisation
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Foreword

This European Standard has been prepared by Technical Committee CEN/TC 89, Thermal performance of buildings and building components, the Secretariat of which is held by SIS.

This European Standard is one of a package on measurements with hot box apparatus. The basic principles of the method and the guarded and calibrated implementations are described in EN ISO 8990.

In this European Standard the basic principles of the method and the implementation of a heat flow meter in a hot box for measurements on masonry is described, keeping the style and structure as similar as possible to EN ISO 8990:1996. The numbering of clauses in this European Standard follows the clause numbering in EN ISO 8990:1996.

In the same package of European Standards the procedure to test window panes, window frames, complete windows and doors in a hot box are described.

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 1998, and conflicting national standards shall be withdrawn at the latest by September 1998.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

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Introduction

Many masonry elements are such that in practice the heat transfer through them is a complex combination of conduction, convection, radiation and mass transfer. The method described in this standard determines the total amount of heat transferred from one side of the specimen to the other for a given temperature difference in defined testing conditions. However, the heat transfer properties often depend on the specimen itself and on the boundary conditions, specimen dimensions, direction of heat transfer, temperatures, temperature differences, air velocities and relative humidity. In consequence the test conditions either replicate those of the intended application or are convertible to them. For ease of intercomparison of results, conventional testing conditions are adopted during the tests. Tested values are the base used in conversion procedures to get the appropriate design values.

The results obtained from a single specimen are not necessarily representative or applicable to all samples of a masonry wall and product standards should be consulted for appropriate sampling.

The design and operation of the heat flow meter hot box is a very complex subject. It is essential that the designer and user of such apparatus has a thorough background knowledge of heat transfer, and has experience of precision measurement techniques.

For a particular specimen it should be decided whether the method is applicable or whether other measurement methods or calculations are more suitable. For homogeneous specimens the guarded hot plate apparatus (see ISO 8302) or the heat flow meter apparatus (see ISO 8301) should be preferred. For specimens not meeting the homogeneity criteria of 6.2.1 of this standard, or with a possibility of convection within internal cavities, the metering section of a heat flow meter might not cover a representative portion of the specimen: for such specimens the use of a guarded or calibrated hot box apparatus of suitable size should be considered (see EN ISO 8990).

1 Scope

This standard establishes the principles and criteria to be complied with for the determination of the laboratory steady-state heat transfer properties of masonry walls in a hot box by means of a heat flow meter mounted on one face of the masonry wall to be tested (i.e. the test specimen). It describes the apparatus, measurement technique and necessary data reporting. It does not, however, specify a particular apparatus design since requirements vary particularly in terms of size, and also to a lesser extent, in terms of operating conditions.

The property that is measured is the surface-to-surface thermal resistance of the specimen, provided that the metering section of the heat flow meter covers a representative portion of the specimen, and the homogeneity criteria of 6.2.1 are met. From these measurements the thermal resistance for application in buildings is derived. The thermal transmittance of a masonry wall can then be calculated from this value with standardized surface coefficients.

This standard is applicable to measurements on both dry and moist specimens, provided that the conditions indicated in 5.3.3 are met. The influence of moisture content on the thermal properties of masonry can be taken into account by measurements at different moisture contents of the specimen in the range of the practical moisture content including the dry state, which corresponds to the most frequent testing condition.

The method is also suitable for horizontal elements such as ceilings and floors.

2 Normative references

This standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred applies.

EN ISO 6946, *Building components and building elements — Thermal resistance and thermal transmittance — Calculation method* (ISO 6946:1996).

EN ISO 7345, *Thermal insulation — Physical quantities and definitions* (ISO 7345:1987).

EN ISO 8990:1996, *Thermal insulation — Determination of steady-state thermal transmission properties — Calibrated and guarded hot box* (ISO 8990:1994).

ISO 8301:1991, *Thermal insulation — Determination of steady-state thermal resistance and related properties — Heat flow meter apparatus*.

ISO 8302:1991, *Thermal insulation — Determination of steady-state thermal resistance and related properties — Guarded hot plate apparatus*.

3 Definitions, symbols and units

3.1

Definitions

For the purposes of this standard, the definitions in EN ISO 7345 and EN ISO 8990:1996 and the following definitions apply.

3.1.1

mean radiant temperature¹⁾

appropriate weighting of the temperatures of surfaces “seen” by the specimen for the purpose of determining the radiant heat flow rate to or from the surface of the specimen

3.1.2

environmental temperature¹⁾

appropriate weighting of air and radiant temperatures, for the purpose of determining the heat flow rate to the surface of the specimen

3.1.3

moderately inhomogeneous specimen

specimen which, when tested, meets temperature uniformity criteria as stated in 5.3.2

3.2 Symbols and units

Symbol	Quantity	Unit
A	area perpendicular to the density of heat flow rate	m^2
R_s	surface thermal resistance	$\text{m}^2\cdot\text{K}/\text{W}$
R_t	specimen thermal resistance (surface-to-surface)	$\text{m}^2\cdot\text{K}/\text{W}$
R_T	total thermal resistance (environment to environment)	$\text{m}^2\cdot\text{K}/\text{W}$
T_a	air temperature	K
T_n	environmental temperature	K
T_r	mean radiant temperature	K
T_s	surface temperature	K
U	thermal transmittance ($1/R_T$)	$\text{W}/(\text{m}^2\cdot\text{K})$
d	specimen thickness	m
f	calibration factor of the heat flow meter	$\text{W}/(\text{mV}\cdot\text{m}^2)$
g	guard width	m
h	surface coefficient of heat transfer ($1/R_{si}$ or $1/R_{se}$)	$\text{W}/(\text{m}^2\cdot\text{K})$
l	half-side of the metering section	m
p	metering section perimeter	m
q	density of heat flow rate	W/m^2
ΔT_g	temperature difference between metering and guard section	K

Symbol	Quantity	Unit
Φ_1	heat flow rate through the metering section of the specimen	W
Φ_2	imbalance heat flow rate between guard section and metering section in the specimen	W
Φ_2'	portion of the imbalance heat flow rate Φ_2 credited to the average temperature imbalance ΔT_g	W
Φ_2''	portion of the imbalance heat flow rate Φ_2 credited to temperature non-uniformity on guard section and metering section	W
Φ_5	heat flow rate at the edge of the specimen	W
λ_f	thermal conductivity of the heat flow meter	$\text{W}/(\text{m}\cdot\text{K})$
λ_s	thermal conductivity of the material of the specimen in contact with the heat flow meter	$\text{W}/(\text{m}\cdot\text{K})$

Subscripts

For the purposes of this standard, the following subscripts apply,

i	internal, usually hot side
e	external, usually cold side
*	moist specimen

4 Principle of the method

4.1 Principle of the apparatus

The heat flow meter hot box apparatus is intended to reproduce the boundary conditions of a specimen in steady state conditions between two environments, each at uniform temperature. A specimen is then placed between a hot and a cold chamber in which environmental temperatures are imposed. Heat exchanged at the surfaces of the test specimen involves both convective and radiative contributions. The former depends upon air temperatures and air velocity, and the latter depends upon the temperatures and the total hemispherical emissivities of the specimen surfaces and of surfaces “seen” by the test specimen surfaces. The effect of the heat transfer by convection and radiation are conventionally combined in the concept of an “environmental temperature” and a surface heat transfer coefficient.

For this method it is important to limit non-uniformities of temperature on the surface of the specimen and it is not necessary to reproduce exactly end use surface coefficients of heat transfer and environmental temperatures.

¹⁾ For more information see EN ISO 8990:1996, annex A.