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Prezraļ evanje stavb - Raļ unske metode za doloļ itev zraļ nega toka v stanovanjih

Ventilation for buildings - Calculation methods for the determination of air flow rates in dwellings

Lüftung von Gebäuden - Berechnungsverfahren zur Bestimmung von Luftvolumenströmen in Wohnungen

Ventilation des bâtiments - Méthodes de calcul pour la détermination des débits d'air dans les logements

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Ventilation for buildings - Calculation methods for the determination of air flow rates in dwellings

Ventilation des bâtiments - Méthodes de calcul pour la détermination des débits d'air dans les logements

Lüftung von Gebäuden - Berechnungsverfahren zur Bestimmung von Luftvolumenströmen in Wohnungen

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Foreword

This document (EN 13465:2004) has been prepared by Technical Committee CEN/TC 156 "Ventilation for buildings", the secretariat of which is held by BSI.

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of an identical text or by endorsement, at the latest by July 2004, and conflicting national standards shall be withdrawn at the latest by July 2004.

The annexes A and B are informative.

This document includes a bibliography.

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

Introduction

The general approach for the methods presented in this document, together with some background information, is described in this introduction and references on which the presented methods are based are given in the Bibliography.

This European Standard covers air flows for dwellings and this information may be needed for different applications, such as:

— calculation of energy losses due to ventilation;

— determination of design or maximum heating load due to ventilation;

— evaluation of indoor air quality.

Depending on the application and the building type, either outdoor air flow rates or both outdoor and internal flows are considered. In addition different applications may require varying levels of simplification.

This is not allowed for directly in the methods, but through the degree of detail required for the input parameters, and the number of sets of parameters to be used. Default values and advice on the selection of appropriate input data should be given in the standards dealing with specific applications.

This European Standard is based on volume flows, with reference to indoor air temperature. A mass flow based approach is more correct, and may be applied if necessary.

This method is based on a single zone model using a simple flow balance equation that is solved alternatively for the unknown internal pressure. This process normally requires a computer. The advantage of this method is that the interactions between the wind induced flow, the stack induced flow and the flows from any mechanical system are considered correctly.

Nevertheless, the methods and equations outlined give flow rate values for a specific state of the ventilation system components, namely the ducts and vents (open or closed), the fan and the combustion appliance (on or off), and for a specific set of internal temperature and outside climate data. For the determination of the evolution in time of these air flows, the calculation procedure has to be repeated for each state of the system (and for each set of temperature and wind data, if applicable). The average flow values have to be calculated according to the opening and running time fractions of the specific components.

NOTE The methods presented are in principle applicable to other types of buildings, however, the basic assumptions as well as all quantitative aspects given herein are adjusted to the situation normally encountered in dwellings.

1 Scope

This European Standard specifies methods to calculate basic whole house air flow rates for single family houses and individual apartments up to the size of approximately 1 000 m^3. This European Standard may be used for applications such as energy loss calculations, heat load calculations and indoor air quality evaluations.

The same basic method apply for these different applications, the input parameter values being selected according to the requirements of the specific application.

This standard covers natural, mechanical extract and balanced ventilation systems. Flows due to window opening are also considered, but only as a single sided effect (i.e. no cross ventilation). Therefore, the application is limited mainly to the heating season.

2 Normative references

This European 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 European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

EN 12792, *Ventilation for buildings – Symbols, terminology and graphical symbols.*

CR 1749, *European scheme for the classification of gas appliances according to the method of evacuation of the products of combustion (Types).*

prEN ISO 15927-1, *Hygrothermal performance of buildings - Calculation and presentation of climatic data - Part 1: Montly and annual means of single meteorological elements (ISO/FDIS 15927:2002).*

3 Terms and definitions

For the purposes of this European Standard, the terms and definitions given in EN 12792 together with the following apply.

3.1
building height
height of the building from the entrance ground level to the roof top level

3.2
building type
classification of building in respect of type of house or apartment, building height and staircase configuration (see 5.1)

3.3
vertical duct
duct or shaft, including flue or chimney, which is mainly vertical and not closed

3.4
dwelling
building or part of a building where people normally live

3.5
dwelling leakage
overall leakage airflow for a given test pressure difference across building

3.6
dwelling volume
volume within internal outdoor walls of the purposely conditioned space of the building (or part of the building). This generally includes neither the attic, nor the basement, nor any additional structural annex of the building

3.7
dwelling air temperature
average air temperature of the rooms in the dwelling

3.8
vent
opening intended to act as an air transfer device

3.9
reference wind speed at site
wind speed at site, at a height of 10 m, in undisturbed shielding conditions

NOTE 1 Shielding is accounted for in the wind pressure coefficients.

NOTE 2 In some countries, the reference wind speed is taken as equal to the meteo data available for the site. If not, an appropriate method to extrapolate from the meteo wind speed to the reference wind speed at site has to be used (see annex A.5).

3.10
shielding
effect classified according to the relative height, width and distance of relevant obstacle(s) in relation to the building (see 5.3)

3.11
natural ventilation system
ventilation system where the air is moved by natural forces into the building through leakages (infiltration) and openings (ventilation), and leaves the building through leakages, openings, cowls or roof outlets including vertical ducts used for extraction

3.12
mechanical extract ventilation system
ventilation system where the air is extracted from the dwelling by a fan and using exhaust air terminal devices, ducts and roof /wall outlets, the air having entered the dwelling through externally mounted air transfer devices, windows and leakages

3.13
mechanical balanced ventilation system
ventilation system where the air is supplied to the building by a fan, ducts and supply air terminal devices, and air is extracted from the building by another fan, ducts, exhaust air terminal devices, cowls or roof/wall outlets

3.14
airing
natural ventilation by window opening

NOTE In this standard, only single sided ventilation effects are considered which means the ventilation effect due to this window opening is considered to be independent of other open windows or additional ventilation system flows

4 Symbols and abbreviations

Symbol	Description	Unit
A_{eff}	Effective area of an air terminal device	m^2
C	Flow coefficient of leakage or vent	dm^3/s at 1 Pa
C_D	Discharge coefficient of an opening	
C_k	ratio of flow through a bottom hung window and the totally opened window	
C_{inf}	Leakage coefficient of dwelling envelope leakage	dm^3/s at 1Pa
C_{int}	Leakage coefficient of internal leakages	dm^3/s at 1Pa
Cp	Wind pressure coefficient	-
F_d	Time proportion of duct open	-
F_{fan}	Time proportion of fan running	-
F_V	Time proportion of vents open	-
Hb	Building height	m
Hd	Distance from ground level to duct top end	m
Hf	Height of dominating facade	m
H	Stack height	m
H_{WD}	Average height from bottom to top of window openings	m
I_p	specific leakage proportion	
n	Flow exponent	-
n_{50}	Overall leakage value of the dwelling	air changes per hour (ach) at 50 Pa
P	Nominal power of combustion appliance	kW
p	Pressure (relative to barometric pressure)	Pa
$\Delta\theta$	Difference of temperature indoor - outdoor	°C
Δp	Pressure difference	Pa
Q_V	Air volume flow rate	dm^3/s
V	Volume of the dwelling	m^3
v	Reference wind speed	m/s
θ	Air temperature	°C
ρ	Air density	kg/m^3
α	angle of window opening	°
W_{WD}	Average width of the window opening	m

Subscripts:

Av	Average value		
R	Room related parameter	in	Related to flow into the room or dwelling
Int	Related to adjacent internal room	nat	Related to natural ventilation
Out	Related to outside	supply	Related to nominal supply air flow
St	Related to stack effects	syst	Related to the ventilation system
W	Related to wind effects	tot	Related to total air flow rate
Airing	Related to window opening	transfer	Related to transfer air flow
Comb	Related to combustion	vent	Related to vents
Extr	Related to nominal extract flow rate	s	Related to a specific state of the system
Inf	Related to infiltration	t	Related to temperature effects
Leak	Related to an individual leak	wo	Related to window opening

5 Classification

5.1 Building types

Building types are classified in accordance with Table 1 and Figure 1.

Table 1 — Building types

Building type	Label	Subtype	Ceiling level of upmost floor	Label
Single family house	SFH			
Apartment	APT	Low rise	below 15m	APTL
Apartment	APT	Medium rise	15 to 50 m	APTM
Apartment	APT	High rise	> 50m*	APTH

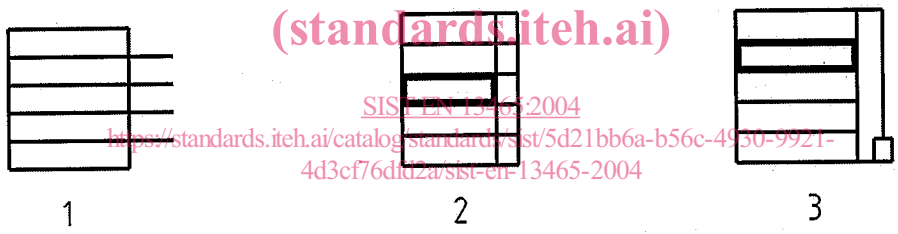
Furthermore, three APT building types 1 to 3 are classified by the staircase configuration as shown in Figure 1:

APT Type 1-No vertical connection between floors, no corridor, outdoor staircase

APT Type 2-Corridor and staircase or Type 1 with internal vertical leaks

APT Type 3-Vertically open staircase, hall

* NOTE For tall buildings, special design is recommended. The method may be applied but in rough approximation only.



Key
1 Apt Type1
2 Apt Type 2
3 Apt Type 3

Figure 1 — Apartment types in respect to staircase configuration

5.2 Shielding class

Different shielding classes may be specified for different wind directions.(see Figure 2 and Table 2).

An obstacle is defined as any building structure or object for which $H_{obst}/H_b > 0{,}3$ and $B_{obst}/H_b > 0{,}3$

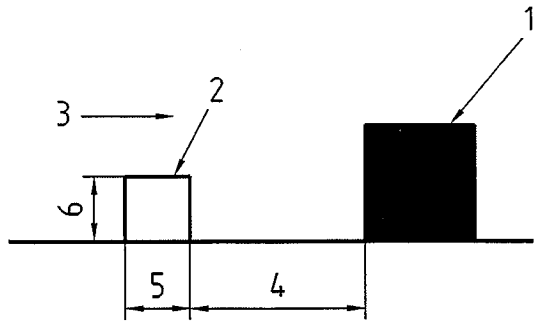
where

$H_{b:}$ = Height of the building

H_{obst} = Height of the nearest obstacle (upstream, if wind direction is considered)

B_{obst} = Width of the nearest obstacle

D = Distance between the nearest obstacle and the building



Key

1 Building, height H_b
2 Obstacle
3 Wind
4 Distance, D
5 Width, B_{obst}
6 Height, H_{obst}

Figure 2 — Obstacle and building

Table 2 — Shielding classes depending on the obstacle height and relative distance

Shielding class	Relative distance D/H_{obst}
Open	> 4
Normal	1,5 to 4
Shielded	< 1,5

6 Input data

6.1 Climatic data

6.1.1 General

The following climatic data shall be specified according to the application and the time period considered:

— outside temperature, θ_{out} ;

— reference wind speed at site at 10m, undisturbed.

6.1.2 Outdoor air condition

Humidity and other pollutants to be considered for the control of the vents and/or the fans shall be considered in the time proportion factors at which the vents are open and the fans running but need not be defined explicitly.

6.2 Building and dwelling related data

6.2.1 General

The following data shall be recorded:

6.2.2 Building height

The height of the building in accordance with 3.1.

6.2.3 Building type

The building type as specified in accordance with 5.1.

6.2.4 Overall leakage value and leakage exponent for the dwelling

The envelope leakages shall be considered for the individual building types as follows:

— for SFH : the whole house leakage;

— for APT : the facade leakage and the internal leakage to the adjacent apartment(s) and the corridor.

The leakage is characterized by a powerlaw relation between the total air flow rate and the pressure difference across the envelope given by the following formula:

$$q_V = C\,(\Delta p)^n \qquad (1)$$

where C is the flow coefficient, normalized to 1 Pa pressure difference and n is the flow exponent.

NOTE The leakage characteristic can be measured as specified in EN 13829.

Leakage can also be expressed in terms of equivalent leakage area.

The n_{50}-value is specified as the flow rate at 50 Pa pressure difference across the envelope divided by the dwelling or apartment volume.

To convert between n_{50} and C values see A.2. The n_{50}-value of the dwelling and the flow exponent shall be determined by measurement, or specified on the basis of either the overall leakage of the dwelling or building or values determined from measured or estimated values for the individual leaks.

Typical n_{50}-values for different building construction types are given in A.1.

6.2.5 Leakage distribution

The ratio of the facade leakage to the overall dwelling leakage.

NOTE A surface area weighted ratio can be used as a default value. Roof may be considered or not as a facade depending on construction type (terrace, roof with slope...).

6.2.6 Dwelling volume

The volume of the dwelling as specified for the n_{50} value (see 6.2.4).

6.2.7 Building wind shielding

The shielding class specified in accordance with 5.3.

6.2.8 Wind pressure coefficients

Wind pressure coefficients for the selected envelope parts (normally the windward and leeward facades, and the roof, see A.4)

6.2.9 Dwelling air temperature

Average air temperature of the rooms in the dwelling under investigation, θ_R.