Air Infiltration Review

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Pressure Coefficient Simulation Program

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Synopsis

A computer program named "Cp Generator", has been developed to predict the wind pressure coefficients, Cp, on the facades and roofs of block shaped buildings.

The program is based on fits of measured data, including wind shielding by obstacles and terrain roughness.

The main advantages of the program are:

- it needs no expertise in wind pressures;
- the input is simple. It exists of building and obstacle coordinates and orientations;
- generating Cp values for ventilation model calculations needs no separate action. By linking the pressure simulation program and the ventilation calculation program as well as their input, wider application of ventilation programs for non-experts becomes possible.

The accuracy of the predicted wind pressures in the first version of the pressure simulation program is promising. Some development is still needed, however, in particular complex building shapes and surroundings have to be dealt with more carefully, as well as increasing wind velocities in small passages. Detailed improvements are also necessary, for example, to account for sloped roofs and the position of ventilation provisions above roof level.

Consequently, generation and implementation of additional wind tunnel data is planned, to improve the present version of the program.

1. Introduction

A good prediction of wind pressure coefficients, Cp, on facades and roofs with ventilation provision, is vital for natural ventilation calculations. The accuracy of the ventilation calculations can highly depend on it, if wind is the dominant driving force.

The use of wind tunnel experiments to predict Cp values is a proven, but expensive method. The use of Cp estimations from data bases is a cheaper, but less accurate alternative and in the case of surrounding obstacles almost impossible.

In both methods, generating Cp-values is an expert job, to be performed separately, before the actual ventilation calculations. This is found to be a disadvantage for

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operating applications with ventilation models by non-expert users.

The organisation for applied scientific research TNO is developing an automatic control system for natural ventilation of industrial buildings for the Dutch ventilation company BRAKEL-ATMOS. The control system calculates and sets optimum grill positions, depending on meteo conditions, inside temperature, required ventilation flow and allowable draught.

For this application the need for implicit prediction of wind pressure coefficients became urgent. Due to the knowledge of most of its users, the input needs to be simple data of the building to be ventilated and its surroundings.

The lack of such a tool led to the development of the first version of a wind pressure simulation program, described in this paper.

The pressure simulation program is a computer program, written in Pascal and running under MS-DOS.

The pressure simulation program may be applied for:

- simple building structures (to be simplified to rectangular shaped facades with flat roofs);
- with ventilation provisions on variable position within the facades and roof;
- in different surroundings per orientation;
- with common terrain roughnesses (z0 = 0.35 to 7 m);
- and several local obstacles (also more or less block shaped).

2. Basics Of The Program

The pressure simulation program is based on measured data {1,2}. It concerns wind tunnel experiments:

- on typical block shaped buildings,
- in different terrain roughnesses,
- with and without obstacles on systematically varying distances.

Because of the systematic set-up of these measurements, it was possible to fit the data to a set of mathematical expressions. For parameters describing the data additional references {3,4 and 5} are applied.

The start of the fits is a formula, describing the general relation of wind pressure and wind direction for an unshielded object. The relation is presented by different researchers (Phaff [1]. Walker and Wilson [4] and ASHRAE).

With a set of additional formulas, containing the building dimensions and the terrain roughness as relevant parameters, the wind pressures on different spots of the roof and each facade are predicted.

The next stage was to add the influence of nearby obstacles.

For the main orientation of each obstacle to the building, a correction on the unshielded Cp was determined, using both the distance between obstacle and building and the leeward side Cp of the obstacle itself. The obstacle leeward Cp was calculated using the same procedure as used for the unshielded building, but now using of course the obstacle dimensions.

After calculating the Cp correction for the main obstacle direction, the correction for surrounding directions is determined, using the "shielding angle" of the obstacle to the building.

To ease the use of the program, a set of formulas has been added, calculating input parameters like dimensions and angles from a minimum of building and obstacle coordinates, to be entered by the user.

3. Program Input

To allow the program to be used by non-experts, the input is restricted to measurable dimensions of the building, nearby obstacles and their positions.

To prevent a time consuming, over-detailed input, a simple instruction points out what kind of details are relevant. An example is the criteria for obstacles further away than 5 x their height. These are not considered

Air Infiltration Review

Editor: Janet Blacknell

Air Infiltration Review has a quarterly circulation of 3,500 copies and is currently distributed to organisations in 40 countries. Short articles or correspondence of a general technical nature related to the subject of air infiltration and ventilation are welcome for possible inclusion in AIR. Articles intended for publication must be written in English and should not exceed 1,500 words in length. If you wish to contribute to AIR, please contact the Air Infiltration and Ventilation Centre. Please note that all submitted papers should use SI units.

Conclusions and opinions expressed in contributions to Air Infiltration Review represent the author(s)' own views and not necessarily those of the Air Infiltration and Ventilation Centre.

to be of importance for the local shielding but may contribute to the terrain roughness.

An example of a part of the input is given in the text block and the building lay-out (Figure 1).

obstacles (position in m (=meter)
terrain level above sea :0 roof height of the building: 8.2 name: HOUSE x, y: 0, 0 azimut: 270 l, b, z: 22.6 8.5 8 (actual gutter height=5.4) name: x, y: 20, -10 l, b, z: 0.1, 0.1, 10 name: x, y: 14.6, 0 azimut: 270 l. b, z: 22.6, 2.15, 3 name: x, y: 18.3, 0 azimut: 270 l, b, z: 8.5 34.2 8.5

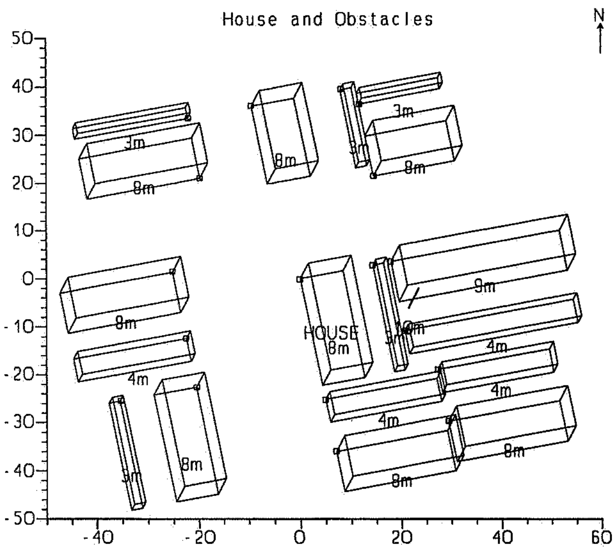


Figure 1: Input lay-out with a marked edge on floor level of each building. Turning left first defines dimension x and secondly y. Azimuth is given for the first facade.

4. Program Output

The output of the pressure simulation program is an array of pressure data. The pressure data files may be linked directly to a ventilation calculation program.

The output may also be expressed graphically. An example of a graphical output is given in Figure 2.

The upper figures show the Cp -values per wind direction in the unshielded situation (imaginary), the local shielding correction (black filling) and their combined result, presenting the actual Cp -values. In the lower figures Cp is plotted polar on a map with the building lay-out. From this plot the influence of each obstacle on Cp may be seen directly.

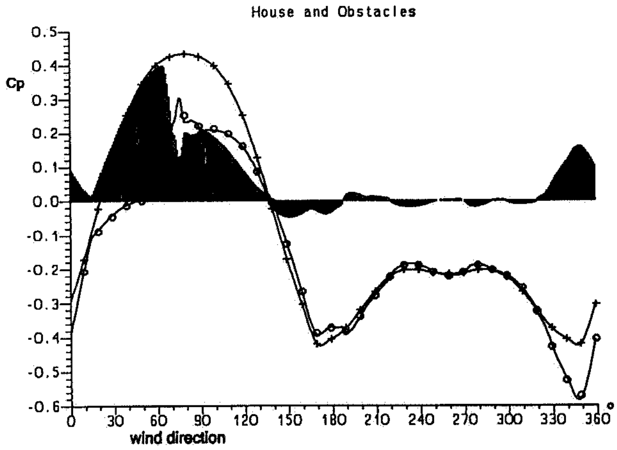
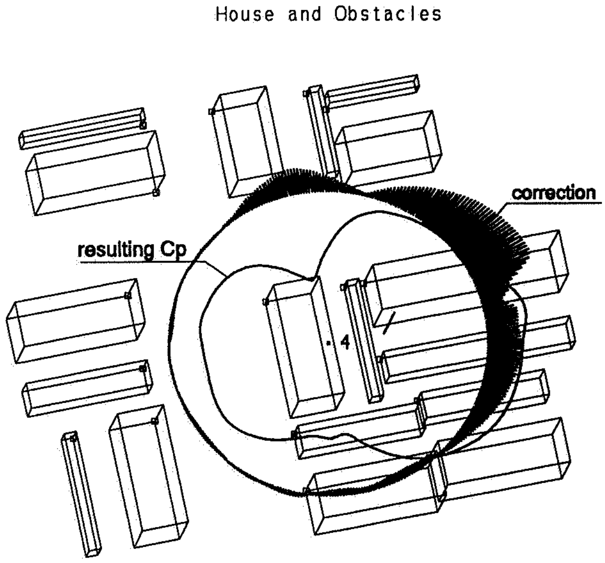


Figure 2: Output graph for the rear facade. '+'= unshielded, Bar=obstacle correction'o'=resulting Cp. Below given as a polar diagram.



5. First Evaluation

For the output example shown, a data set of wind-tunnel Cp values is available. The data set has proved to fit well with actual on-site measurements.

A comparison of these data and the Cp-values calculated with the pressure simulation program is presented in Figures 3,4 and 5.

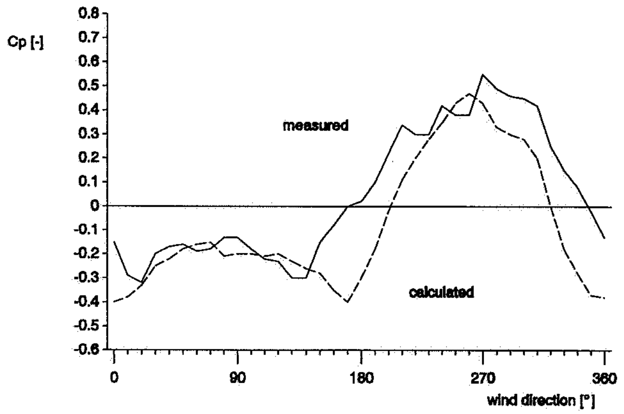


Figure 4: Comparison measured and calculated Cp for the front facade.

The comparison shows a rather good agreement for both facades. Most remarkable in these characteristics is the change of calculated windward into leeward pressures happening too fast. An over-estimation of the contraction effect (under-estimation of the velocity increase) in the case of small passages is held responsible for this.

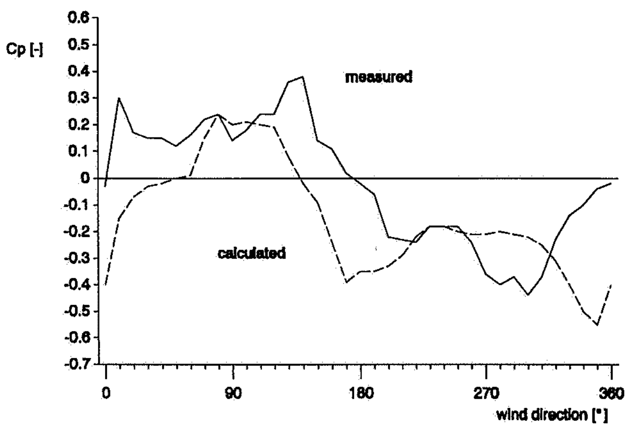


Figure 5: Comparison measured and calculated Cp for the rear facade

The comparison for the roof pressure shows a worse agreement, especially for wind directions between 180° and 330°. The slope of the roof and the position of the ventilation duct within the roof is held responsible for this difference. The pressure simulation program doesn't account for sloped roofs yet.

One should realise that a rather preliminary tool is used and that a rather complex configuration of obstacles is concerned.

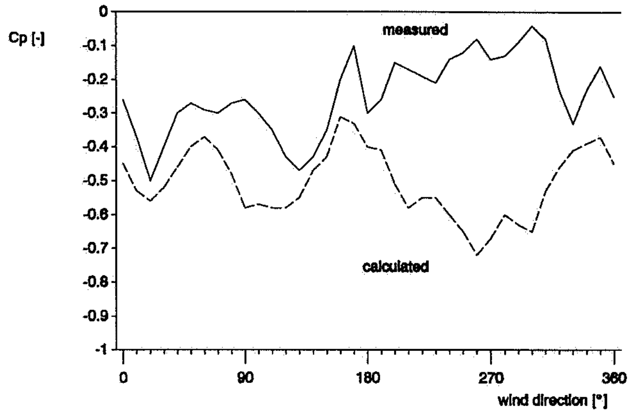


Figure 6: Comparison measured and calculated Cp for the roof pitch

Also, one should realise that minor differences in Cp, especially over a wind direction sector, and at steep changes, will have less effect in reality. This is due to normal fluctuations of the actual wind direction. Therefore the results of the comparison are considered to be hopeful. If some essential corrections are added, the pressure simulation program is expected to be a useful tool. Hence, further development of the tool is recommended.

6. Future Improvements

To end up with a useful and sufficiently accurate pressure simulation program, improvements are recommended on:

- complex building shapes (non-block shaped, like sloped roofs, building extensions or combined obstacles, sloped surfaces, seasonal corrections for vegetation);
- contraction effects depending on passage width.

Apart from this, extracting a version for correction of local meteo data is recommended. When local meteo data is used to control ventilation, the correction for local effects is often poor. This badly affects ventilation control. The obstacle corrections of the pressure simulation program may also be utilised to correct these data.

Orders and Requests for Additional Information

Two new tools are available from TNO; the "Cp Generator" and the "Grill Optimiser".

To place an order for calculations with the "Cp Generator" or the "Grill Optimiser", or to request a special order in this field or other information, send enquiries to:

TNO Building and Construction Research,
Department of Indoor Environment,
Building Physics and Systems,
PO Box 49, 2600 AA Delft, The Netherlands

Contact B Knoll or J C Phaff

Tel: +31 15 2608470 or +31 15 2608462
Fax: +31 15 2608432

email b.knoll@bouw.tno.nl or j.phaff@bouw.tno.nl

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[3 Bottema M. Wind Climate and Urban Geometry. TU Eindhoven (NL), 1993.

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This article first appeared in the 16th AIVC Conference Proceedings, September 1995.

Thermal Comfort: A Primer

by Martin W Liddament, Head of AIVC

Thermal sensation plays a key role in the perception of comfort and ,as with other comfort parameters, is highly subjective. A comprehensive review of thermal comfort is published in Chapter 8 of the ASHRAE Fundamentals (1993) and in Section A1 of the CIBSE Guide (1988). Air is the primary transport mechanism for thermal comfort while air speed and turbulence influences the sensation of cooling and draughts. High infiltration or unnecessary air change rates result in the loss of conditioned air and may prevent comfort conditions from being attained. A good background knowledge of thermal requirements is therefore essential to any ventilation design. Factors influencing thermal comfort include:

Temperature and radiation (dry bulb, mean radiant): Thermal sensation is dominated by the surrounding 'temperature'. However, the standard dry bulb or ambient air temperature measurement is often an insufficient indicator for establishing comfort criteria, since it ignores the influence of radiant energy. A more complex approach to the description of temperature is therefore needed. Commonly this incorporates the 'mean radiant temperature'. This is a measure of the average radiation exchange between the occupant and the surrounding surfaces and is conventionally measured using a black globe thermometer to represent the occupant. Radiation exchange can be highly asymmetric, for example factors such as cold windows may cause local discomfort, by increased radiant cooling.

Relative humidity: In a sedentary environment, about 25% of the body's heat is emitted by transpiration. As ambient air temperature and metabolic activity increases, transpiration losses increase to between 50 and 80% of total body heat emission. Transpiration heat loss is inhibited by high relative humidities, thus creating thermal discomfort. On the other hand dry air at low to normal temperature induces transpiration losses resulting in dehydration. Therefore, there is a preferred minimum relative humidity level of typically 30%. In dry cold climates, humidification of the air to acceptable relative humidity levels can be costly.

Air speed and turbulence: The sensation of thermal comfort is influenced by air speed and the scale of turbulence. Where cooling is needed, increased air speed can be used to advantage as, for example, with convective chilled ceiling (see Chapter 7) or with air circulation fans. At other times, draughts cause discomfort by localised cooling. Fanger et al (1985) showed that the number of people dissatisfied with their environment increased substantially as air velocity was increased from 0.1 to 0.5m/s. In a further study, Fanger et al (1987) demonstrated the impact on thermal comfort of turbulent intensity. Again, discomfort could be caused as turbulent intensity increased.

Clothing: Clothing provides thermal insulation and, as such, has an important influence on acceptable temperature. Choice of clothing can alter comfort preference by as much as 2 to 3k. The unit used to express the thermal conductivity of clothing is the 'clo', where 1 clo is equivalent to 0.155 $m^2.K/W$.

PMV value	Thermal sensation
+3	hot
+2	warm
+1	slightly warm
0	neutral
-1	slightly cool
-2	cool
-3	cold

Table 1: Defining Predicted Mean Vote (PMV) (Fanger 1982)

Other parameters: Other parameters such as state of health, level of physical activity, gender, working environment and individual preferences influence perception of thermal comfort.

Perception of thermal comfort: Early test chamber studies conducted in the United States resulted in the development of a thermal sensation scale and the concept of 'predicted mean vote' (PMV). The PMV awarded a numerical value to represent an individual's perceived level of thermal sensation, varying from +3 for hot to -3 for cold. This approach was subsequently used by Fanger (1982) to measure the response of groups of occupants exposed to identical thermal conditions (see Table 1). Those not scoring +1, -1 or 0 are deemed to be dissatisfied, from which the predicted percent dissatisfied (PPD) of occupants could be determined. The immediate conclusion of this work was that it was not possible to define a set of thermal conditions that would satisfy everyone. Even when the average of the predicted mean vote was zero, i.e. a neutral thermal environment, 5% of the test occupants were dissatisfied.

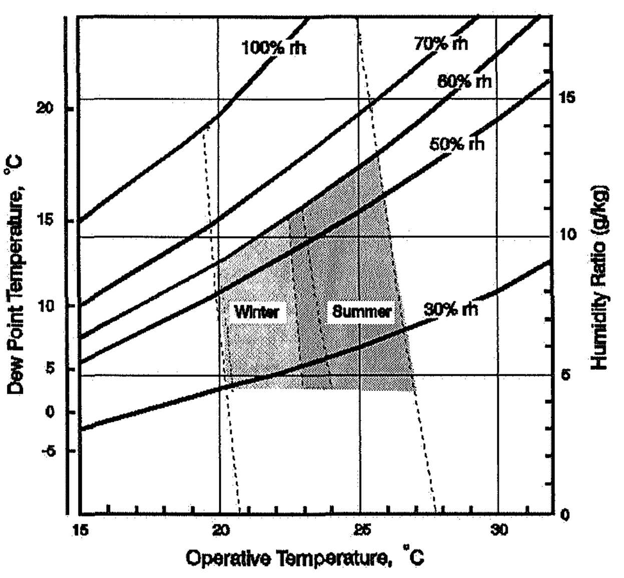

Figure 1: Acceptable Thermal Comfort.

Operative and resultant temperatures: Defining optimum comfort conditions in the home and office has concentrated on combining dry bulb temperature, mean radiant temperature, air speed and relative humidity into an acceptable comfort range. This has been accomplished by means of defining an 'operative' or mean resultant temperature that empirically combines dry bulb and mean radiant temperature with air speed. Equations for operative temperature as defined in ASHRAE Standard 55 (1992) on thermal comfort and the equivalent resultant temperature, as defined in Part A1 of the CIBSE Guide (1988) are summarised in Chapter 12. Essentially the operative and resultant temperatures are derived from the mean of the dry bulb and mean radiant temperature, with an added factor to represent the cooling effect of air speed. The ASHRAE comfort zone for 10% PPD, based on the combination of operative temperature with relative humidity is illustrated in Figure 1. Operative and resultant temperatures can be approximated by using a pink or grey 50 to 100mm diameter globe thermometer.

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News

Support for Energy Saving Measures in Germany

from Gunther Mertz, FGK, Germany

The German Government aims to reduce the energy consumption and subsequently the carbon dioxide emissions in the residential sector by giving financial incentives.

The following measures are to be supported:

a) The installation of solar systems, heat pumps and heat recovery systems in new buildings as well as in the building stock. The bonus will amount to two per cent of the basis assessment but not more than 500 Marks per year over a period of eight years. The bonus will be granted for measures that are completed by January 1st, 1999.

b) The construction of a low energy house with the heat energy requirements being less than 75 per cent of the requirements according to the 1995 Heat Transfer Barrier Act ("Waermeschutzverordnung", WSVO). Here, the bonus will amount to 400 Marks per year over a period of eight years and will be granted for houses to be finished by January 1st, 1999. In this way, clients fulfilling the conditions as mentioned above can be granted an additional bonus of up to 7200 Marks.

European Project on Natural Ventilation Inaugurated

A new natural ventilation project, "NATVENT" has been inaugurated with the aim of overcoming technical barriers to low-energy natural ventilation in office-type buildings in moderate and cold climates. The programme falls within the European Joule programme and will be coordinated by the UK Building Research Establishment.

The main objective of this proposal is to reduce primary energy consumption in buildings (and consequently CO_2 emissions) by encouraging the use of natural ventilation as the main design option for office type buildings in moderate and cold countries. It is intended for countries with low winter and moderate summer temperatures and where summer overheating from solar and internal gain can be significantly reduced by good natural ventilation. It also addresses the need to find good natural ventilation solutions to buildings in those urban areas where external air pollution and noise are problems.

Enquiries to Earle Perera at the Building Research Establishment, Garston, Watford, UK.

Participating countries are: Belgium, Denmark, Netherlands, Norway, Sweden, Switzerland, UK

Ventilation in Schools - An Annotated Bibliography

from Mark Limb, AIVC

The latest in this series of annotated bibliographies, focuses on Ventilation in Schools. The document is divided into seven sections outlined below:

Contents:

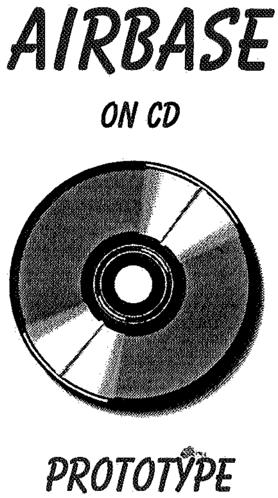
- Ventilation Standards for Schools
- Ventilation
  - Natural Ventilation
  - Mechanical ventilation
- Indoor Air Quality
  - Radon
  - Carbon Dioxide (CO_2) as a Source of Pollution
- Energy Efficiency in Schools
  - Green Energy Design/Passive Solar

The review contains an overview of ventilation standards that currently apply to ventilation in schools, and discusses the different types of ventilation strategies that are utilised to ensure that the recommended ventilation rates are met.

Both natural and mechanical ventilation strategies are discussed, including demand controlled ventilation (DCV). Indoor air quality is an important issue in school buildings, with good thermal and air quality being essential in establishing a quality learning environment. Radon and carbon dioxide ($CO2$) are the two main indoor pollutants that have caused concern in recent years; studies that investigate these are included, especially since the main strategy for the control of these pollutants is based on additional or correct ventilation. The final main section discusses the use of energy in schools, an important subject especially since most schools are in the control of local authorities who are constantly striving to achieve optimum energy efficiency. The review examines some passive solar and green design options that may see the face of many of our schools change in future years. All references quoted are available from the AIVC, and the completed review will be available from July 1996.

AIVC's AIRBASE Soon Available on CD

A prototype version of AIRBASE on CD has been produced and is currently being evaluated. Copies will be available from September 1996. Full details will appear in the next edition of Air Infiltration Review. For more information, please contact Mark Limb at the AIVC



New Format for AIVC Recent Additions Quarterly Abstracts

To facilitate a broader dissemination of information, the new edition of Recent Additions to Airbase is produced in twelve page format, with a full listing of documents available on the World Wide Web at the address below. A full format copy of Recent Additions is available on request from AIVC Library Services if you would prefer, at a charge of £25.00 inclusive of postage and packing. It is hoped that the new arrangement will prove a valuable and more economic improvement to AIVC services. We invite you to make full use of the AIVC Library Service, which is available to organisations in all participating countries, free of charge for essential items.

Airbase on the World WideWeb http://www.demon.co.uk/aivc/

Classification of Indoor Climate, Construction, and Finishing Materials

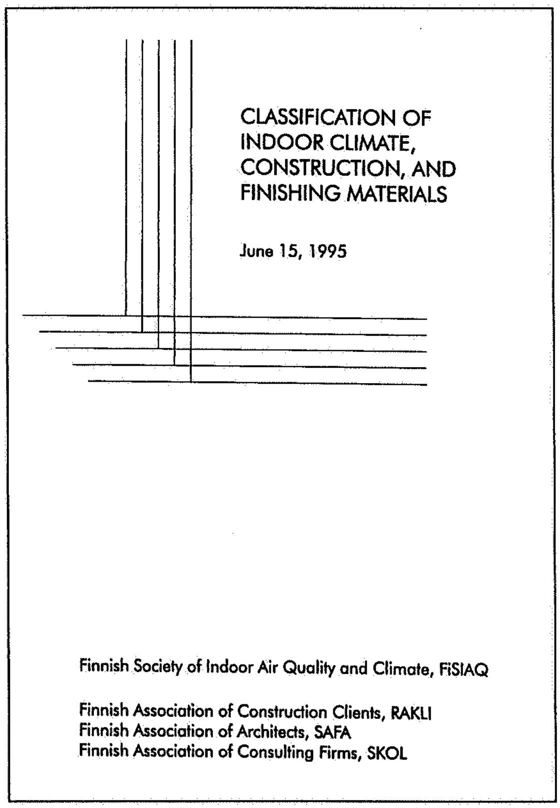
June 15, 1995

published by the Finnish Society of Indoor Air Quality and Climate, FiSIAQ

Indoor climate has become more important for health and comfort during recent years. As people spend approximately 90% of their time indoors, the quality of indoor air for the health is even more important than outdoor air. Good indoor climate reduces the number of illnesses and the symptoms of sick building syndrome. It also influences comfort and working efficiency. Good indoor climate is one of the most important goals when constructing a building. However, research and practice have shown that good indoor climate that satisfies the users of buildings is far too seldom achieved. The final quality of indoor climate is influenced simultaneously by heating, ventilation and air-conditioning systems and equipment, by ways of construction, performance of construction and materials used, and by the operation and maintenance of a building. To achieve good indoor climate provides that all matters presented in this Classification are taken into consideration in all the phases of design, construction and operation.

The Classification of Indoor Climate, Construction, and Finishing Materials has three parts. It is intended to be used in the design and construction of buildings and their mechanical systems to build healthier and more comfortable buildings. It also helps manufacturers of equipments and materials to produce less emittive building products. The Classification can be used both in new constructions and in evaluating old buildings, and also, when applicable, in renovations. The Classification is not an official building code, and it does not define liabilities of construction projects.

Contents



International Energy Agency Publications

Energy Conservation in Buildings and Community Systems, Annex 24

Heat, Air and Moisture Transfer in Highly Insulated, New and Retrofitted Envelope Parts (HAMTIE)

Final Report Volumes 1, 2 and 3 Now Available

Volume 1 Modelling £30.00, Volume 1 Addendum £50.00
Volume 2 Environmental Conditions £32.00
Volume 3 Material Properties £35.00

After the energy crisis of 1973, energy conservation became a major issue in all IEA countries. As the domestic sector uses 30 to 50% of the total energy and as low energy use in buildings is achievable without degradation of comfort, the building sector represents a preferential area for saving actions. One of the most effective measures to decrease energy use for heating and cooling is thermal insulation of the building envelope. Different countries, therefore, adopted strict insulation levels in the seventies.

In the second half of the eighties, feared environmental impact of an increasing global energy consumption became a dominant theme: greenhouse effect, acid rain, ozone depletion. This resulted in a further upgrading of insulation levels for the building envelope.

By the end of 1990 an enquiry was conducted in all IEA countries, questioning the way in which the effects of combined heat, air and moisture transport on energy and durability were handled in standards, codes of practice and consulting. The survey highlighted a lack of well balanced heat, air and moisture performance formulation and controls for building envelopes in many IEA countries. The outcome was a direct motivation to initiate Annex 24.

The two original objectives of the Annex were as follows:

1) to model and study the physical phenomena behind heat, air and moisture transport, and

2) to analyse the consequences for energy consumption, hygrothermal performance and durability.

The work, shared between twelve countries over four years, included model development, analysis of environmental conditions, compilation of material properties, fresh experimental work, common exercises and the drafting of interim and final reports. The five final reports, one per task, compile all results and give detailed information on (1) Common exercises, (2) Indoor climate data, indoor climate classes and MDRY-reference years for the outdoor climate, (3) Terminology and Catalogue of material properties, and (4) "National types" of construction.

Task 1: Modelling, by Hugo Hens,
KU Leuven, Belgium, 1996 ISBN 90 75741 02 2

Includes not only improvements in modelling but also testing of simplified models with a potential to predict the combined effects of heat, air and moisture transport on thermal performance, hygrothermal response and durability.

Task 1: Addendum,
KU Leuven, Belgium, 1996 ISBN 90 75741 02 2

Contains Common Exercises and Summary Reports.

Task 2: Environmental Conditions, by C Sanders,
KU Leuven, Belgium, 1996 ISBN 90 75741 03 0

Includes the choice of environmental parameters, a methodology of handling them and the development of sample sets of environmental conditions.

Task 3: Material Properties,by M Kumar Kumaran,
KU Leuven, Belgium, 1996, ISBN 90 75741 01 4

Contains terminology, symbols, data collection on thermal, hygric and air properties of materials and layers and substantial measuring work, especially on moisture properties.

Two further reports are soon to be available

Task 4: Experimental evaluation

This task included archival work on the state of the art in heat, air and moisture testing and performance formulation and an evaluation of laboratory and field tests on heat, air and moisture transport for the so called "National Types of Construction".

Task 5: Performances and practice

This task includes the translation of HAM knowledge into rules for energy impact and durability requirements.

To order, please contact AIVC.

Please add 10% for postage and packing.

International Energy Agency's

Air Infiltration and Ventilation Centre's

17th Annual Conference

Hotel 11, Gothenburg, Sweden

17-20 September, 1996

Conference Theme:
OPTIMUM VENTILATION AND AIR FLOW CONTROL IN BUILDINGS

Good indoor air quality and energy efficiency is critically dependent on well designed ventilation systems. The objective of this conference is to review current research and design approaches aimed at fulfilling ventilation needs. The conference is open to all member countries of the ECBCS Implementing Agreement* and also to authors of accepted papers from other non-member countries. A record number of abstracts from authors of more than twenty different countries has been received and accepted papers have been incorporated into a programme⁺which includes the following session titles:

- ***Optimum Air Distribution***
- ***Indoor Air Quality & Passive Cooling Design***
- ***Ventilation Strategies***
- ***Measurement, Modelling & Design Tools***
- ***Calculations and Measurements***
- ***Energy Efficient Ventilation***

⁺A full Conference programme of papers and authors can be found on the AIVC's World Wide Web Page.

Authors please note: The deadline for receipt of final papers for inclusion in the proceedings is July 31st, 1996

Conference Venue:

The venue for the Conference will be the Hotel 11 which is located in Eriksberg, a former shipyard in the heart of the Port of Gothenburg. This area of Gothenburg has been the subject of sympathetic renewal and development. It is easily accessible by road (via Lundbyleden, a major road network) or ferryboat (the hotel has its own quay). The 133 bedroom hotel has been tastefully converted and furnished with environmentally compatible materials to produce a spacious and comfortable hotel. An attractive conference package of £550 (discounted to £500 for early payment) is offered for the 3 day period which includes accommodation with selected meals, proceedings and attendance. Daily attendees and non-conference guests are also welcome. Allowance has been made for a free afternoon half way through the conference to allow visits to local points of interest.

For further information about this conference please contact:

Rhona Vickers, Conference Organiser,
Air Infiltration and Ventilation Centre,
Sovereign Court,
University of Warwick Science Park,
Coventry, CV4 7EZ, England.

Tel: +44 (0)1203 692050, Fax: +44 (0)1203 416306

* Australia, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Israel, Italy, Japan, Netherlands,New Zealand, Norway, Poland, Sweden, Switzerland, Turkey, UK, USA.

Forthcoming Conferences

World Renewable Energy Congress IV
15-21 June 1996
Denver, Colorado, USA
Contact: Prof Ali Sayigh, Director General of Wren, 147 Hilmanton, Lower Earley, Reading RG6 4HN, UK,
Tel: +44 (0)1734 611364, Fax: +44 (0)1734 611365

Roomvent '96
5th International Conference on Air Distribution in Rooms
July 17-19 1996
Yokohama, Japan
Contact: Conference Secretariat, Roomvent '96, Murakami and Kato Laboratory, Institute of Industrial Science,
University of Tokyo, 7-22-1 Roppongi, Minato-ku, Tokyo, 106 Japan
Tel: +81 3 3402 6231 x 2575
Fax: +81 3 3746 1449

PLEA 96 Louvain-la-neuve
The 13th International Conference on Passive and Low Energy Architecture
Building and Urban Renewal
July 16-18 1996
Louvain-la-neuve, Belgium
Contact: Professor A De Herde,
Architecture and Climate,
1 Place du Levant,
B-1348 Louvain la Neuve,
Belgium
Tel: +32 10 47 21 42
Fax: +35 10 47 45 44
email: deherde@arch.ud.ac.be

Indoor Air '96
7th International Conference on Indoor Air Quality and Climate
July 21-26 1996
Nagoya, Japan
Contact: Dr Koichi Ikeda, Indoor Air '96,
The Institute of Public Health, 6-1, Shirokanedai 4-chome,
Minato-ku, Tokyo 108, Japan
Tel: +81 3 3441 7111 x 275
Fax: +81 3 3446 4723
email: indair@kimura.arch.waseda.ac.jp

Profiting from Energy Efficiency
ACEEE 1996 Summer Study
August 25-31 1996
Asilomar Conference Center, Pacific Grove, California, USA
Contact: American Council for an Energy-Efficient Economy,
1001 Connecticut Avenue, NW, Suite 801, Washington, DC 20036, USA

ECCOMAS 96
Second ECCOMAS Conference on Numerical Methods in Engineering/ Third ECCOMAS Computational Fluid Dynamics Conference
9-13 September 1996
Paris, France
Contact: ECCOMAS 96, Universite de Paris VI, Laboratoire d'Analyse Numerique, Tour 55-65, 5eme etage, 4, Place Jussieu, 75252 Paris Cedex 05, France,
Tel: +33 1 44 27 11, Fax: +33 1 44 27 72 00,
email: eccomas96@ann.jussieu.fr

Optimum Ventilation and Air Flow Control in Buildings
17th Annual AIVC Conference
17-20 September 1996
Hotel 11, Gothenburg, Sweden
Contact: Rhona Vickers at the AIVC

ICCDR-3
Third International Conference on Carbon Dioxide Removal
September 9-1, 1996
Massachusetts Institute of Technology, Cambridge, Massachusetts, USA
Contact: ICCDR-3 Secretariat, c/o Anne Carbone, MIT Energy Laboratory, Room E40-469, 1 Amherst Street, Cambridge, MA 02139-4307, USA
Tel: +1 617 253 8296
Fax: +1 617 253 8013, email: hjherzog@mit.edu

13th International Symposium on Contamination Control
16-20 September 1996
"Nederlands Congresbouw", The Hague, The Netherlands
Contact: VCCN, Vereniging Contamination Control Nederland, PO Box 1269, 3800, BG Amersfoort, The Netherlands, Tel: +31 33 617496, Fax: +31 33 637050

Ab-Sorption '96
International Absorption Heat Pump Conference '96
September 17-20 1996
Le Centre Sheraton
Montreal, Quebec, Canada
Contact: Dr D Nikanpour/Dr S Hosatte, Organising Committee, CANMET-EDRL, 1615 Montee Ste Julie, PO Box 4800, Varennes, Quebec, Canada, J3X 1S6
Fax: +1 514 652 5177

Heat Pump '96
5th International Energy Agency Conference on Heat Pumping Technologies
September 22-26 1996
The Sheraton Centre Toronto, Ontario, Canada
Contact: c/o Dr Vincenza Galatone, Chairman, National Organising Committee, EDRL, 1615 Montee Ste-Julie, PO Box 4800, Varennes, Quebec, Canada, J3X 1S6
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* Starred items are available on loan (free), as a microfiche, or for £15.00 in hard copy. (The hard copy version will be sent unless otherwise stated.)

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Air Infiltration Review. Quarterly newsletter containing topical and informative articles on air infiltration research and application.
Recent Additions to AIRBASE. Quarterly bulletin of abstracts added to AIRBASE, AIVC's bibliographic database.

AIRBASE DATABASE

AIRBASE the AIVC's bibliographical database, containing over 9,000 records on air infiltration, ventilation and related areas, is available as a diskette package for your personal computer.

NUMERICAL DATABASE

Contains airtightness data which are particularly applicable to the evaluation of construction design, ventilation strategies, energy impact of ventilation, the performance of standards and recommendations, the influence of climate and calculation techniques.

WORLD WIDE WEB

The AIVC's home page holds Air Infiltration Review, publications and conference details and a searchable database based on the current edition of Recent Additions. The address is http://www.demon.co.uk/aivc/

TECHNICAL NOTES

(Unlisted technical notes have been superceded)
Applications Guide (1986) Air Infiltration Calculation Techniques
Handbook (1983) Air infiltration control in housing
TN 11 (1983) Validation and comparison of mathematical models
TN 13 (1984) Wind pressure data requirements
TN 13.1 (1984) 1984 Wind Pressure Workshop Proceedings
TN 16 (1985) Leakage Distribution in Buildings
TN 17 (1985) Ventilation Strategy - A Selected Bibliography
TN 20 (1987) 'Airborne moisture transfer: workshop proceedings
TN 21 (1987) Review and bibliography of ventilation effectiveness
TN 23 (1988) Inhabitants' behaviour with regard to ventilation
TN 24 (1988) AIVC Measurement Techniques Workshop
TN 25 (1989) Subject analysis of AIRBASE
TN 26 (1989) IEA Annex IX 'Minimum ventilation rates
TN 27 (1990) Infiltration and leakage paths in single family houses
TN 28 (1990) A guide to air change efficiency
TN 28.2 (1991) A guide to contaminant removal effectiveness
TN32 (1991) Reporting guidelines for airflows in buildings
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TN35 (1992) Knoll B 'Advanced ventilation systems - state of the art and trends.'
TN 36 (1992) Limb M J 'Airgloss Air Infiltration Glossary'.'
TN 37 (1992) Liddament M W, 'A Strategy for Future Ventilation Research and Applications',
TN 38 (1992) Limb M J 'AIRGUIDE: Guide to the AIVC's Bibliographic Database'.
TN 39 (1993) Liddament M W "A Review of Ventilation Effeciency".
TN 40 (1993) Kendrick J F, "An Overview of Combined Modelling of Heat Transport and Air Movement".
TN 41 (1993) Wilson D and Walker I, "Infiltration Data from the Alberta Home Heating Research Facility".
TN 42 (1994) Limb M J, "Current Ventilation and Air Conditioning Systems and Strategies".
TN 43 (1994) Limb M J "Ventilation and Building Airtightness: an International Comparison of Standards, Codes of Practice and Regulations".
TN 44 (1994) Orme M S, " An Analysis and Data Summary of the AIVC's Numerical Database".
TN45 (1994) Irving S, "Air-to-Air Heat Recovery in Ventilation".
TN 46 (1995) Limb M J, "1994 Survey of Current Research"
TN 47 (1995) Colliver D, "Energy Requirements for Conditioning of Ventilation Air".
Guide to Energy Efficient Ventilation (1996), Liddament M. W

ANNOTATED BIBLIOGRAPHIES

(Participants only - price see order form)
BIB1 (1993) Ventilation and infiltration characteristics of lift shafts and stair wells
BIB2 (1994) Garage Ventilation: Summarises research into the health, energy and design aspects of the various systems used in garage ventilation.
BIB3 (1994) Natural ventilation: Covers the main elements of natural ventilation research, the fundamental equations, driving forces and associated factors, as well as useful reports which focus on modelling and calculating natural ventilation air flows.
BIB4 (1995) "Air intake positioning to avoid contamination of ventilation air"
BIB5 (1996) "Heat pumps for ventilation exhaust air heat recovery"

AIVC CONFERENCE PROCEEDINGS

AIVC Conference Proceedings nos 1-9 are available as individual papers, or in microfiche form. Details of contents can be forwarded on request.
10th 'Progress and trends in air infiltration and ventilation research' Espoo, Finland, 1989;
11th 'Ventilation System Performance' Belgirate, Italy, 1990;
12th 'Air Movement and Ventilation Control within Buildings', Ottawa, Canada, 1991, 3 volumes.;
13th 'Ventilation for Energy Efficiency and Optimum Indoor Air Quality', France, 1992;
14th 'Energy Impact of Air Infiltration and Ventilation', Denmark, 1993
15th 'The role of ventilation', Buxton, UK, 1994
16th 'Implementing the results of ventilation research', Palm Springs, USA, 1995.

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