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Reports on Important Conferences on Energy Related Subjects

Rapports sur d'importantes conférences traitant des questions d'énergie

Berichte über wichtige Veranstaltungen zur Frage des Energiebedarfs

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SUMMARY
During the last years, several congresses and seminars took place in different countries dealing with questions of building physics, in particular of energy saving in buildings and in the built environment. Information on these questions is equally important for the civil engineer and for the architect. Therefore the IABSE Working Commission, «Building Physics», had short reports made on these events.

RÉSUMÉ
Ces dernières années il y a eu, dans différents pays, plusieurs congrès et séminaires s'occupant de la physique du bâtiment, notamment de l'économie d'énergie dans les bâtiments et dans l'environnement construit. Les informations sur ces questions sont également importantes pour l'ingénieur des constructions civiles et pour l'architecte. C'est pourquoi la Commission de Travail «Physique du bâtiment» de l'AIPC a fait préparer de courts rapports sur ces congrès et séminaires.

ZUSAMMENFASSUNG
In den letzten Jahren sind mehrere Veranstaltungen in verschiedenen Ländern abgehalten worden, die sich mit Fragen der Bauphysik, insbesondere der Energieeinsparung in Gebäuden und in der bebauten Umwelt befassten. Informationen über diese Fragen sind für den Bauingenieur und Architekten gleichermassen wichtig. Die IVBH-Arbeitskommission «Bauphysik» hat deshalb kurze Berichte über diese Veranstaltungen anfertigen lassen.

1. REPORT ON THREE AUSTRALIAN SEMINARS ON THE ENERGY-CONSERVING DESIGN OF BUILDINGS

by J. H. Cowan, Sydney (Australia)

1.1 Subject matter of the three seminars

The densely populated part of Australia lies in the subtropics, and most cities have long periods of sunshine both in winter and in summer. Passive solar energy can therefore be used to great advantage. The first volume deals with that aspect.

The second volume contains 6 papers on mathematical models and computer predictions.

The third volume contains another 8 papers on these topics, together with 5 papers on energy management.

1.2 Solar energy applications in the design of buildings, edited by H. J. Cowan. Applied Science Publishers, London 1980.

This volume contains the papers presented at a symposium organized by the University of Sydney:

1. Is there an energy problem in the design of buildings? By H. J. Cowan.
2. What makes people accept a thermal environment as comfortable? By R. K. Macpherson.
3. The design of sun shading devices. By A. M. Saleh.
4. Making the best use of daylight in buildings. By R. O. Phillips.
5. The thermal inertia of buildings and how to use it for energy conservation. By J. J. Greeland.
6. Available climatic data and how to use them. By R. M. Aynsley.
7. The use of computers for modelling the physical environment in buildings. By B. S. A. Forwood.
8. Computer programs for the design of the physical environment in buildings. By A. D. Radford.
9. Tradeoff diagrams for the integrated design of the physical environment in buildings. By A. D. Radford and J. S. Gero.
10. Report on energy conservation research. By J. A. Ballinger.
11. Thermal insulation of buildings. By L. F. O'Brien.
12. Solar energy systems in Australia and overseas. By P. R. Smith.
13. Sun shading devices. By E. L. Harkness.

1.3 Predictive methods for the energy-conserving design of buildings, edited by H. J. Cowan. Pergamon Press, Oxford 1983.

This volume contains the papers presented at a symposium organized by the Australian and New Zealand Association for the Advancement of Science:

1. A new mini-computer program to predict building energy use. By M. J. Wooldridge.
2. A thermal design tool for the sketch design stage. By S.V. Szokolay.
3. An evaluation of thermal performance computer programs. By T. J. Williamson.
4. Some aspects of thermocirculation heat transfer in Trombe-Michel walls. By W. W. S. Charters.

5. Computer simulation of the thermal performance of Western Australian housing compared with field measurement. By D. D. Carruthers.
6. An empirical study of problem heat flow paths in simulation models. By M. Smart and J. Ballinger.

1.4 Energy conservation in the design of multi-storey buildings, edited by H. J. Cowan. Pergamon Press, Oxford 1984.

This volume contains the papers presented at an international symposium organized under the auspices of the Institution of Engineers Australia, the Council for Tall Buildings, and the Commission on Building Physics of the IABSE:

Part I: Predictive methods for the energy-conservative design of multi-storey buildings.

1. Energy as a major architectural design issue. By L. Nield.
2. The Rocks Gateway Project, Sydney - A study in integrated energy design. By D. S. Thomas.
3. Contemporary energy conservation design considerations and methods. By R. T. Baum.
4. Simulation studies of building energy performance in warm and humid climates. By K. R. Rao, M. T. McCulley, C. O. Pedersen, and G. D. Ding.
5. The Application of BUNYIP to the design of multi-storey buildings. By A. M. Brown and S. K. Moller.
6. Energy-conservative design in context - The use of multi-criteria decision methods. By A. D. Radford, J. S. Gero, and N. D'Cruz.
7. New tools for analyzing the thermal and day-lighting performance of fenestration in multi-storey buildings. By S. Selkowitz.
8. The application of computers to energy conservation in H.V.A.C. plants. By H. D. B. Norman.

Part II: Energy management in multi-storey buildings.

9. Survey of energy management of office buildings in Sydney. By A. H. Van Ocken and R. J. Bennett.
10. Energy conservation in New South Wales hospitals. By J. W. Ellis.
11. Energy audits, their evaluation, and conservation measures. By J. S. B. Iffland.
12. Computer control of building energy systems. By D. Busch.
13. An integrated approach to environmental comfort with low energy. By B. P. Lim and K. R. Rao.

2. REPORT ON THE CONGRESS "ENERGY EFFICIENT ENCLOSURES FOR BUILDINGS", APRIL 1983, THESSALONIKI, GREECE.

by M. Papadopoulos and K. Axarli, Thessaloniki (Greece)

2.1 General conclusions - positions

- There is a linear relationship between the energy consumption and per capita income of each country. Consequently in the immediate future energy consumption will rise chiefly in the developing countries, while traditional energy reserves will decline world-wide.
- Energy saving and new forms of inexhaustible and clean energy can contribute to national energy independence.

- Energy saving is a cheap, directly exploitable, clean and independent "form of energy". The object is to develop new methodologies which will achieve the same satisfaction of people's needs at lower energy consumption levels.
- Soft energy forms, such as solar, wind, photovoltaic and geothermal energy, while inexhaustible, are highly diffuse, so collection costs are high. However, advancing technology should solve this problem, and restrained optimism is in order.
- In every country, it is essential that there be financial support for energy research programmes and their incorporation into national development programmes.
- The design of buildings and in particular of their envelopes must also be energy efficient, which is a complex problem because many parameters must be taken into consideration: insolation-sun protection, conductive, ventilation and air-conditioning heat losses, heat capacity of the building elements, user's behaviour and cost considerations in the broader sense, construction, maintenance, running. Finally, a precondition for an appropriate energy efficient design at the level of the individual building is established previous to energy efficient solutions at the level of the community and the immediate environment of the building area. The application of all the above mentioned factors, together with passive solar heating systems, may lead to cheaper and more human natural ventilation.

2.2 Detailed conclusions

The 29 papers presented in this congress covered the following topics:

- The location of the building and the urban plan
- The energy behaviour of buildings in the past and presence
- Large scale buildings which have special problems concerning their architectural solution and their stability and which use soft energy sources
- Agricultural structures
- Building elements which influence the thermal performance of the building and new materials used in energy conservation
- Special solar structures incorporated in buildings and finally
- Particular projects designed to exploit solar energy, using thermal simulation computer programmes for the prediction of the building thermal behaviour.

In detail, 8 groups of papers can be distinguished:

2.2.1 Experience from tradition

The earth sheltered dwelling in Santorini, by using soft technologies and saving energy, can be considered as a herald of modern energy efficient designs. The semi-closed spaces which function as buffer zones were a necessary part of the Byzantine house (heliakoi), the post Byzantine house (doxata) and the Hellenistic, Asia Minor and Othoman house (sophades). Their absence from new buildings, in contrast to their long history of successful use, is a serious criticism of contemporary architecture.

2.2.2 Buildings erected before the energy crisis and their thermal behaviour

The results of the study which has been presented concerning the energy behaviour of the buildings in Thessaloniki are remarkable: Three times more energy consumption, lack of thermal comfort in winter, uncontrolled quality and quantity of ventilation, and existence of many thermal bridges in the building envelope; while the cost of upgrading the buildings by using thermal insulation and improving the efficiency of heating installations can be repaid in 3-7 years and in a year, respectively.

2.2.3 The energy factor in large scale buildings

Together with the two basic parameters of the design (architectural solution and calculation of stability), the "energy factor" has also been introduced into the design process, especially for large scale buildings.

Some typical examples have been mentioned:

- The Kobe Municipal Sports Center in Japan where the specially designed roof with skylights contributes to natural illumination and natural ventilation, thus saving energy. Also, the use of the energy by the central municipal incinerator has reduced the energy demand of the building for heating.
- The water treatment plant at Edmonton in Canada, where in order to reduce heat losses and to minimise the amount of heat required to prevent freezing of the water during the winter, a hypar roof was constructed to cover the clarifiers.
- The hyperbolic shells constructed in the U.S.A. according to the designs of Hoesch, Estel and Tully, which apart from their functional, structural and cost advantages make an important contribution to energy conservation by being heavily insulated and by incorporating passive and active solar heating systems.

2.2.4 The energy factor in agricultural structures

Greenhouses represent a long tradition for collecting heat from solar radiation, thus reducing the heat demand for various agricultural activities.

An experimental construction has been presented of simple and cheap greenhouses covered with a cylindrically shaped membrane which acts as a solar collector and with an underfloor ventilating system, used for drying and conserving fresh crops.

Also mentioned was a model for the theoretical and experimental testing of inflatable greenhouses, mainly with regard to their construction and thermodynamic properties.

Underground storages built of flexible steel shells combine the advantages of energy efficient traditional cellars with those of contemporary storages.

A study of livestock buildings was also presented.

2.2.5 Building elements and energy. Theoretical studies and experience from experiments.

The window is the main source of heat loss from the building shell. In particular, the heat losses of an opaque wall are influenced by the union between the window frame and the closure wall.

Lightweight structures such as membranes, shells and folded plates have their own special problems in maintaining their internal space temperatures at comfortable levels. Also mentioned were special computer programmes to simulate the climate around and the thermal temperature in response to the climate and thermal parameters. Also presented were lightweight folded plate sandwich structures having heavy insulation between the layers of energy saving material.

2.2.6 Components acting as collectors and materials contributing to energy savings

Details were given for a cladding panel for buildings which combines a solar air type collector with wall function, feasible for multi-storey buildings having a large south façade.

Spectrally selective coatings treated with nickel oxide can increase by 20-30 % the efficiency of flat plate solar collectors made of nickel or stainless steel. Also mentioned was the possible application of these selective coatings on passive solar heating systems and especially on Trombe walls.

Internal thermal insulating plasters for buildings with intermittent use contribute to the rapid heating of the space, creation of thermal comfort conditions, savings in energy consumption, increased fire resistance and reduction in the weight of the building components.

2.2.7 Urban planning. Insolation - shading - winds.

Reduction of energy supply to the city is a goal which may be achieved only through a long-term policy. For such a policy to succeed it is necessary to have appropriate urban planning on city and community level.

The main characteristics of a bioclimatic urban fabric are harmonization with the surrounding environment in its broader sense, the right orientation of buildings and streets, the protection from negative climatic effects, the appropriate vegetation, and the creation of thermal comfort conditions in public areas.

2.2.8 Passive and active solar heating systems

The three solar heating systems for exploitation of solar energy - passive, active and hybrid - were mentioned several times, and specific case studies were presented concerning buildings in Greece, England, France and Germany.

Summing up, the conclusions are:

- Vernacular generic houses evolved by trial and error. Modern building development is faster, with consequent monumental mistakes due to inadequate testing of new designs. However, we now have the tools to simulate and test designs before they are built.
- The design process of a passive solar building consists of three interrelated steps: the architectural design, the energy efficient design and the choice and development of the passive systems. A computer thermal simulation must also be carried out.
- In mild climates such as the Greek one the combination of the three basic passive heating systems has many advantages over the use of purer systems. Direct gain with night insulation from the south-facing windows provides a simple effective passive heat source and is the greatest energy contributor. The Trombe wall adds thermal mass to the building and produces an even heat source. Finally the greenhouse, apart from its rapid heat supply, acts as a buffer zone and functions as an unheated living space during the heating period. The "direct gain" passive heating systems and the "streamed-through concrete slabs" hybrid systems have been tested in West Germany and have turned out to be efficient for similar climates. On the other hand, the hybrid heating system mentioned saves 40 % of the investment costs in the structure and technological equipment of the building, while its operating costs only amount to 1/3.

We have reached the end of the Congress, but not the end of our efforts. Research in the sector of energy must continue with further development of the subjects which have been mentioned here and which have not led to specific solutions, and with an effort for actualisation of the findings and the assumptions of this Congress.

As a common point between us, let be the belief that "the survival of mankind is impossible within the framework created by the unreasonable use of fossil fuels and the destruction of the environment. We are obliged to examine everything from the beginning, without accepting anything as given. It is obvious that the solution to the problem lies in the hands neither of individuals nor single countries. It is a global problem which matters equally to people East and West, to capitalism, socialism and the mixed economies. It is a problem of the survival of Earth, our common home".

3. REPORT ON THE SECOND INTERNATIONAL CONGRESS ON BUILDING ENERGY MANAGEMENT, MAY/JUNE 1983, AMES, IOWA, USA.

by B. Keller, Winterthur (Switzerland)

3.1 Introduction

This congress took place from 30 May to 3 June at Iowa State University, Ames, Iowa. It was organized by J. E. Woods and R. E. Welch of Iowa State University, A. P. Faist of the Federal Institute of Technology at Lausanne, Switzerland, and Eduardo de Oliveira Fernandes of the Faculdade de Engenharia da Universidade do Porto, Portugal. Some 200 scientists, engineers and architects found together at Ames. They came from all parts of the world, although the Mid-European countries dominated, maybe because of their higher energy prices. 58 papers were presented and 20 more could be found in the poster sessions.

The scope of the topics were very large: from technology to economics and to human factors. I will try to summarize the main topics in the following but with no claim for completeness.

3.2 Meteo-data

Some investigations about the distribution and frequency of skylight for daylighting as well as wind data were presented. After the creation of weather data tapes for reference years this seems a reasonable supplement, at least because of the increasing importance of lighting power in the energy management of low energy houses. Moreover, the fruitful aspect of frequency distributions is introduced, which also could be of advantage for outdoor temperature and solar irradiation as a completion of the degree-days and the monthly solar energy sums widely used. This is especially important for the consideration of comfort.

Although the daylight oriented lectures showed some progress, there is still no straight forward way for the accounting of artificial lighting in the energy balance.

3.3 Passive solar techniques

After an impressive review, the results of several measurement campaigns on solar houses were presented. As usual, the variety of parameters and locations allowed only an exemplary but no comparative judgement. The big differences of building standard and climate, e.g. between New Mexico and Central Europe, do not allow a transition of results.

Because of the very wide range of passive solar measures: orientation, greenhouses, storage mechanisms etc., most of the available simulation models seem to be applicable only to a very limited range and even then mostly by iterative adaptation of parameters. Therefore, the discussion about the usable amount of solar gain and the net energy need will continue.

Also problems of comfort: large temperature swings, glare etc. showed up in the discussions. For this reason and especially for moderate to cold climates a tendency away from extreme passive solar houses towards a combination of solar gain and insulation seems to evolve. This was supported by the presentation of a commercially available new window in high insulation technology with U-values of 0.6 W/m^2K and a solar transmittance of up to 50 %, yielding a breakthrough in this direction.

3.4 Active solar techniques

The active solar techniques focused primarily on storage technologies and on heat pump assisted use of solar energy. If one applies economic standards of today, the main applications seem to be the hot water production and some solar assisted cooling in hot climates.

Compared to the passive solar methods, the active use of solar energy for buildings seems to have reduced its presence at the conference very much, not at least because of the decreased rise of energy prices.

3.5 New products

As most of the papers were presented by scientists from universities or research institutes, almost all dealt with measurements and calculations in relation to more or less known combinations of latent heat storage, trombe walls, coolness storage, heat pumps etc. and optimization strategies in the use of these components: software.

Whereas a new cascaded solar absorption heat pump system was studied theoretically, only a desiccant dehumidification device and the above mentioned new high insulation window represented commercially applied really new products.

3.6 Building physics

The calculation of heat losses into the ground and some new cross sections for walls and roofs were presented.

3.7 HVAC-systems

Control strategies, simulation models for oil furnaces, evaporation cooling, ventilation strategies etc. were discussed and demonstrated a big potential for the reduction of energy need in the use of conventional HVAC-systems. The advantage is that much of this knowledge also will have effects in existing buildings and not only for new ones.

3.8 Human factors

The number and importance of the contributions to thermal comfort, air quality and the interaction between man and building fortunately signalized that one begins to remember the main purpose of a building: to serve man for comfort and not just to save energy by all means.

3.9 Energy audits

Energy auditing of existing buildings has made big progress by the extensive use of computer programs on cheap PCs. Most of them are well tested and easy to use. In many countries, a lot of field work has been done and gives relevant numbers for the specific energy need of buildings. Characteristic values like the energy signature and others are used.

3.10 Economic aspects

Although the numeric results of these investigations depend much on the country, the local energy prices etc., they all showed that extreme and exotic measures are at this time not economic and that economy will dictate a much slower pace in the development than many enthusiasts meant.

To sum up, the conference was of much profit for all attendants and generally showed a tendency towards less extreme and more realistic measures to reduce the energy demand of buildings. The interest in very complicated "energy-machine" houses is reduced in favour of the human well-being at as little energy as possible.

It remains the pleasure to express the thanks to the organizing committee and all the helpful people of Iowa State University for the well organized congress.

4. REPORT ON THE 9TH CIB-CONGRESS, AUGUST 1983, STOCKHOLM (AS FAR AS ENERGY RELATED TOPICS WERE CONCERNED)

by C. Zürcher, Zurich (Switzerland)

64 papers described energy conservation programmes, building/installation measures for energy consumption reduction and user attitudes and comfort criteria in energy conservation. The topic area of energy conservation programmes (from single houses to industrial buildings) embraces the national purpose of energy savings at one extreme and detailed energy monitoring at the other. For a succesful implication of energy conservation programmes the individual needs for comfort must be taken into consideration as well as the need to understand and operate the technical systems. Energy consumption reducing measures focus mainly on passive use of solar energy both for heat gain and for reducing the cooling load. Experience has shown that passive solar energy is more cost-effective than active systems. Simple, approved calculation methods are sometimes more appropriate as design tool for many practical applications as they can easily be handled by designers and planners. To reduce the energy consumption, the design and running of the installations are very important, too. Heat recovery from ventilation air will probably play a decisive role in many buildings when suitable technology is applied. As the needs concerning comfort vary between the different occupants, it is necessary to make variations in indoor climate available rather than more automatic control outside the influence of the individual user.

5. REPORT ON THE 8TH PASSIVE SOLAR CONFERENCE, OCTOBER 1983, SANTA FE, USA

by R. C. Ruggli, Dübendorf (Switzerland)

The general feeling at this passive solar energy conference was quite positive, though not euphoric. The knowledge in many fields has been solidified. A realistic and practical approach seems to prevail. In the following I shall try to present the leitmotives reflected by the presented papers, discussions and panels.

Passive research and development seem to have reached a decisive level. Developing, testing and selling specific systems has become less important; the integration of such proven systems in comfortable buildings is the goal now. No longer is the house to be built around the system, but the system is to be adapted to the house and its inhabitants' needs.

Thus new concepts for building will need to be developed. New forms will arise as expressions of the various functions, new and old. The form of the buildings, their three-dimensional structure (not their style) has been historically influenced, during the pre-industrial period by lack of mobility and limited resources; during the industrial expansion by greater mobility, seemingly unlimited resources and high technology. And today it is influenced by limited resources, advanced technology and a hitherto unknown amount of information available by computers. An example of the influence of contemporary technologies and thinking can be seen in advances in daylighting. No longer considered from outside inwards, daylight is examined starting inside, where the user is. The useful daylight is the light the user gets. Interior lighting quality and general comfort come prior to maximal quantity of daylight inside.

ASHRAE's publication in 1984 of a conclusive handbook on passive solar heating, replacing the Los Alamos handbook might have been inspired by the feeling of the new era. One speaker tried to define this new era by looking first at the past, classifying the chief works between the first and eighth passive conference as follows:

Explicitly passive solar architecture
Annual energy savings
Test cells
Simplified calculation methods
Simulations
Balance between solar and conservation
Hybrid systems (fans have reached respectability)
Latent heat storage

In today's transition period, work has shifted to the following domains:

Micro-computer as design tools
Program validation
Passive cooling
Daylighting
Test buildings
Instrumented buildings

The next few years'research will focus more on the following topics:

Comfort
Daylighting
Heat storage
Heat distribution
Combinations of different systems
Integration of systems in buildings
Natural ventilation
Natural convection
Natural cooling
Systems with freon heat pipes
Computer as design tools

The eighth passive conference seems to be a link between the past and future. Following are a few general impressions of new tendencies:

Passive solar design is grown-up, technically and architecturally. Its potential and limits are in hand.
Passive architecture must become still more humane, user-friendly and comfortable.
The solar market is growing.
Public and industrial buildings will get more attention.
Comfort is the supreme parameter.

6. REPORT ON THE 4TH SYMPOSIUM "RESEARCH AND DEVELOPMENT OF SOLAR ENERGY IN SWITZERLAND", NOVEMBER 1983, LAUSANNE, SWITZERLAND

by R. C. Ruggli, Dübendorf (Switzerland)

6.1 Meteorology

Measuring radiation intensivity in Geneva and installing a data base.
Validating a calculation model for radiation on a tilted surface.
Developing calculation methods for global and diffuse radiation on a horizontal surface. (IEA task IX).

6.2 Active

Measuring and comparing different collectors.
Examining possibilities and limits of active solar systems in different Swiss climate zones.
Comparative measuring of flat and big fin heat exchangers.
Discussion of a dynamic model for floor-heating systems in combination with so-

lar.
Practical comparison of different control systems for solar heating.

6.3 Passive

Measurement on test cells and test façades.
Instrumented existing buildings (greenhouses, window-air-collectors).
Calculation and simulation methods for different passive systems.

6.4 Storage

Problems of free convection in water tanks.
Statistical method for the optimization of hot water storage for solar systems.
Latent heat storage in practical use.
Production of chemical energy with solar energy.
Experience with a large earth storage in Vaulruz (IEA).
Work done under IEA VII, windows and fenestration.

6.5 Photovoltaics

Regulation problems with P.V.
Discussion of semi-conductive metal cells.
Discussion of P.V. - thermal combination for collectors.
First results of the experimental P.V. installation TISO 15 in Lugano.

6.6 Calculations

The third, improved version of PASSIM, a dynamic model, was presented.
Validation of different programs under IEA task VIII (passive and hybrid solar low energy buildings).
Assessment of dynamic and stationary models to predict conservation measures in houses.

6.7 A panel discussion on instrumenting buildings focused on the following:

- Before doing any measuring, it is important to decide on whether the user-influence is to be measured.
  Isolating the user-influence seems useful with highly instrumented buildings. Statistical methods with great numbers of cases seem useful when user-influence is measured, too.
- The same quality is to be maintained for all phases of the campaign (planning, installation, measuring, evaluation).
  Watch out for system-inherent mistakes.
- Measuring campaigns are cost-intensive (the first estimate can be roughly multiplied by π). The costs of hardware are a small part of the whole budget. Personnel costs for maintenance, measuring and evaluation (often underestimated), and preparation of a report present the bigger part of the costs. It is useless to save expenses in instrumenting and measuring the house. Errors can boost the costs in many ways.

As a conclusion, some thoughts by the conference's host, Prof. A. Faist:

- Meteorological data can finally be easily used for calculation of solar buildings. A radiation map of Switzerland will soon be available.
- With the TISO Project Switzerland has reached a high level in P.V. research. Within ten years P.V. will play an important role.
- A big leap in knowledge of function and performance of passive systems has been achieved. Architectural application of those systems has become a reality. High-quality solar products reach the market.

Efforts to disseminate information (seminars, IEA-work) has to continue.

- Simple calculation methods to be used in practice, at the beginning of the planning, must be developed.
- Comfort will have to be a main parameter.