THE VENTILATED FACADE

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Introduction

The aim of this paper is to report about activities that took place in the Netherlands concerning the subject of the "ventilated façade", and will take place in the near future. In 1981 the second author was involved in the design and realisation of the building for Billiton International Metals at the Hague. See photo 1.

Photo 1.
West-façades of the Billiton building, The Hague.

A preliminary study resulted in the choice of a ventilated façade for this building. Only very few projects preceded this one in the Netherlands. Therefore, the necessity existed for a practical full-size research to the designed ventilated façade. This work was carried out by the first author, in the Bronswerk Airconditioning Research Centre; it was a test of a real element (3,3 m x 3,6 m) of the façade followed by experiments dedicated to the thermal comfort situation in the occupied space (air velocity distribution, ambient temperature distribution and radiant temperature). In the mean time there is experience in the operation of the realised building: air-tightness of the façade, thermal comfort, efficiency and energy

consumption.

During his part-time activity at Eindhoven University of Technology the first author, in 1983, proposed a more general research to the phenomenon of the ventilated façade or window. A literature research has yet been carried out; a comprehension of the results will be given in this paper. At this moment (feb. 1985) an experimental programme, again in the Bronswerk Laboratory, is ready to start: a full-scale test of a ventilated window including (artificial) solar radiation integrated with a calculation model will be carried out in coöperation with the group Physical Aspects of the Built Environment of the Building Department, Eindhoven University. Results will be available in August 1985.

The ventilated façade

Essential is the application of an extra window, added to the façade, to a normal layer of (double) glass. The intermediate space can now be ventilated with the return air in case of a mechanically ventilated building. In this case the available air quantity is limited. In the intermediate space a sun blind is installed.

The following advantages of the present construction are claimed: high thermal resistance, efficient sun blinding and good sound insulation. And as a result: high thermal comfort/efficient use of floor area, low energy consumption and an attractive solution from an economical point of view. As one of the main items, fig. 1 shows the effect of a varying glass surface temperature on thermal comfort in a standard office room at standard conditions expressed as Predicted Mean Vote (PMV).

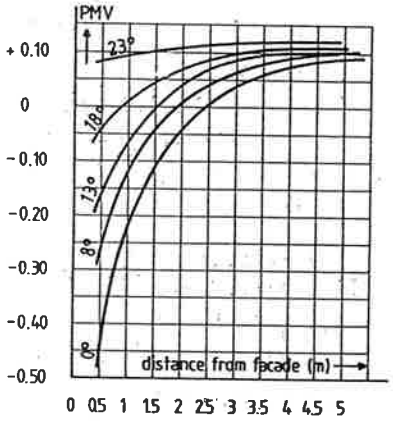

Fig. 1. Influence of radiant temperature on thermal comfort at different glass surface temperatures.

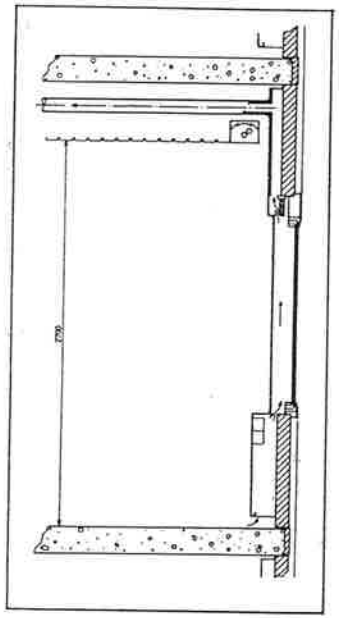

Fig. 2. Vertical cross section of the façade.

The graph shows an increased thermal comfort in the façade zône due to a higher radiant tmperature, thus an improved efficiency of the floor area. And a result like this can be realised without an additional heating system located at the façade! In the architectural design of the building, the window plays a very important role. The thermal specifications of a ventilated façade create highly improved possibilities for a free choice of location and size of the window, within a restricted energy-use and thermal comfort.

In the article "De Klimaatgevel; rekenmodel" (1) the specific items of the Billiton-building are discussed. In this building the entire façade is ventilated, for each floor individually. The sunblinds are Venetian. See fig. 2 for a vertical cross section. A calculation model has been developed for the present façade, also giving way to the aspects of air infiltration. The numeric values in the calculation model are derived from the measurements of the façade, in the Bronswerk Airconditioning Research Centre at Amersfoort.

The present measurements and experiments are described in the article "De Klimaatgevel; proefmodel" (2). The effective U-value of the façade came out to be 0,47 W/m2K at a flow of 175 m3/h (58 m3/h.m' or 42 m3/h.m2).

Another aspect of the ventilated façade is the possibility of condensation on the inside of the outer blade. The temperature is 1 to 2 K lower than would have been without a third layer of glass. At an outside temperature of - 12° C a relative humidity of 34% remained possible without condensation.

A general research

In a coöperation of Bronswerk and Eindhoven University the decision was made to carry out a more general research to the properties of the ventilated façade.

A literature research

At Eindhoven University, S.Renes carried out a literature research on the subject. Results from the main parameters, equivalent U-value (K_{eq}) and sun admittance factors has been collected. See fig. 3 as an example concerning U-values. Some results are calculated (the curves, generally), other are the results of a measurement (the dots, generally). It will be clear that certain differences occur in the results. Some of the differences will come from different starting points in calculations or differences in the façade design. Although the tendencies will be clear, the carrying out of a systematic research is a necessity for the collection of tools in the future design practice.

A laboratory research

A more detailed study on the ventilated façade is planned in order to optimize its performance (especially for Dutch weather conditions) and to get a better knowledge of its physical properties. Experiments in addition to theoretical analyses will be undertaken to evaluate temperature distributions and heat-fluxes under a variety of conditions.

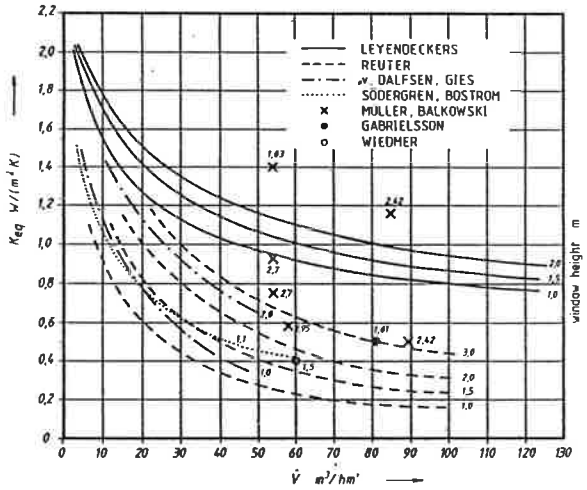

Fig. 3. Equivalent U-values (K_{eq}) from different studies.

Variables of interest include window height, distance between outer and inner pane, sun blinds, outdoor temperature, solar radiation and air flow characteristics (rate cq. inlet configuration).
Figure 4 displays an outline of the experimental setup.

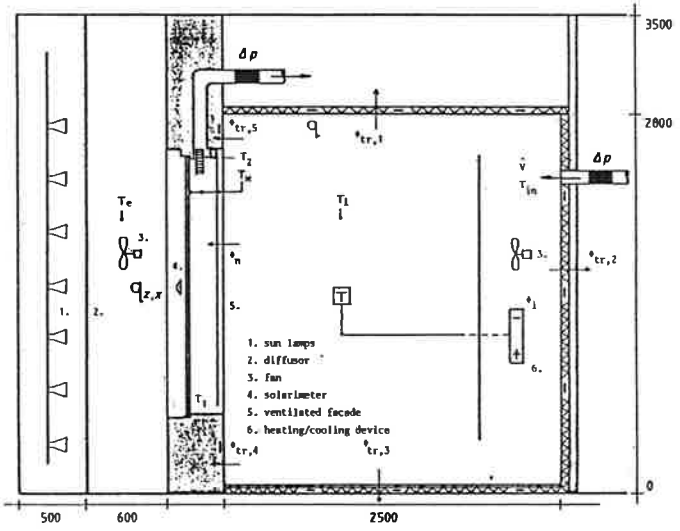

Fig. 4. Outline of experimental set-up.

Conclusion

The application of a ventilated façade is certainly a useful development in building. But the results from different sources show rather big differences in realised values, both from calculations and measurements. We expect that the combined results of an extensive measurement programme and a computerized calculation model, will give a reliable answer to the questions, at least for the Dutch climate.

References

(1) Bekker, J. and van Hove, J. De Klimaatgevel; rekenmodel (in Dutch). Klimaatbeheersing 1984, 13, 5, 128-132.

(2) Bekker, J. and van Hove, J. De Klimaatgevel; proefmodel (in Dutch), Klimaatbeheersing 1985, 14, 4,

(3) Van Hove, J. De Klimaatgevel, financieel-economische aspecten (in Dutch). Klimaatbeheersing 1985, 14, 7.

(4) Leyendeckers, P.H.H. De Klimaatgevel (in Dutch). De Architect, 1982, 8, 36-39.

(5) Reuter, F. Entwicklungstendenzen der Gebäudetechnik im Bürohausbau (in German). Bauwelt 1976, 14, 445-447.

(6) Dalfsen, W.J.B. v., Gies, Th.H. Ventilatiekozijnen: een geïntegreerd venster bouwfysisch doorgelicht (in Dutch). Polytechnisch Tijdschrift/ Bouwkunde, Wegen- en Waterbouw, 1980, 35, 2, 90-96.

(7) Södergren, D. en T.Bostrom. Ventilating with the "exhaust air window". Ashrae Journal, (1971). 1971,4, 51-57.

(8) Müller, H., Balkowski, M. Abluftfenster in Bürogebäuden (in German). Heizung, Lüftung, Haustechnik, 1983, 34, 10, 412-417.

(9) Gabrielsson, J. Extract-air window, a key to better heat economy in buildings. The tenth world energy conference, Istanbul 19-23 september 1977.

(10) Wiedmer, P. Protecta-sol Klimafenster. Ein neues System zur Verbesserung der Behaglichkeit und des Energiehaushaltes in Gebäuden (in German). Ki Klima + Kälte -Ingenieur, 1975, 10, 305-308.

(11) Petzold, K. Zur Durchlässigkeit von Zwischenjalousien in Abluftfenstern (in German). Luft- und Kältetechnik, 1982, 2, 91-93.

(12) Hove, J.v. De Klimaatgevel. De gevel als onderdeel van het systeem voor beheersing van het binnenklimaat (in Dutch). Bouw, 1985.

SUMMARY

J.Bekker and J.van Hove, The ventilated façade. The paper reports about recent developments and about activities in the Netherlands in the near future, concerning the ventilated façade. The building of Billiton International Metals in The Hague (Netherlands) is an early development in the Netherlands. After a study and a laboratory research for this special building the start of a more general research to ventilated façades is reported. A literature research has been carried out, and an extensive measurement programme in combination with calculations in a computerized model, is announced. The research is a combined activity of the Bronswerk Airconditioning Research Centre and the Building Department of Eindhoven University of Technology.

RESUME

J.Bekker et J.van Hove, La façade ventilée. Le présent article revèle des développements récents et des activités dans la future prochaine, concernant la façade ventilée. Le bâtiment de Billiton International Metals à la Haye (Pays-Bas) est un des premiers exemples dans les Pays-Bas. Après un étude et une recherche dans le laboratoire, spécialement pour le présent bâtiment, le commencement d'une étude plus générale est rapporté. Une recherche de la litérature est executée, et un programme extensif de mesure, combiné avec des caculations dans une modèle d'ordinateur, est annoncé. L'étude est une activité commune du Centre de Recherche de Bronswerk et le Département du Bâtiment de l'Université Technologique d'Eindhoven.

KURZFASSUNG

J.Bekker und J.van Hove, Die Klimafassade. Der Vortrag berichtet über rezente Entwicklungen und über Aktivitäten in den Niederlanden in der nächste Zukunft mit Beziehung auf der Klimafassade. Das Gebäude von Billiton International Metals in Den Haag (Niederlande) ist eine Frühentwicklung in diesem Lande. Nach einer Studie und Laborarbeit speziell für das Billiton-gebäude, wird das Beginn einer mehr generell gerichtete Forschung auf Klimafassaden beschrieben. Eine Literaturforschung ist bereits ausgeführt. Ein ausführliches Messprogramm in Kombination mit Berechnungen mittels eines EDV-gesteuertes Modell, wird angekündigt. Die Forschungsarbeit ist eine gemeinsame Aktivität des Bronswerk Versuchslabors und der Bauabteilung der Technische Universität Eindhoven.