VENTILATION TECHNOLOGY - RESEARCH AND APPLICATION

8th AIVC Conference, Überlingen, Federal Republic of Germany
21 - 24 September 1987

POSTER P11

THE IMPORTANCE OF WIND BARRIERS FOR WOOD FRAME CONSTRUCTIONS

SIVERT UVSLØKK

Norwegian Building Research Institute
Division Trondheim
Høgskoleringen 7
7034 Trondheim NTH
Norway

SUMMARY

The main goal of a research project on wind barriers was to get more information about the influence of wind pressure on the heat loss from wood frame constructions. The project was divided into three parts: calculations, hot-box measurements and wind pressure measurements on a rotatable test house. The theoretical studies as well as the experimental investigations in the hot-box, have been restricted to one specific type of forced convection in the thermal insulation, called "anblåsning", i.e. the interchange of air between the insulation and the airspace between the wind barrier and the outer cladding. The results of the project show the importance of protecting the insulation layer with a wind barrier to achieve full effect of the insulation in wind exposed constructions. The measurements indicates that heat loss caused by this type of forced convection, can be three to ten times higher than calculated.

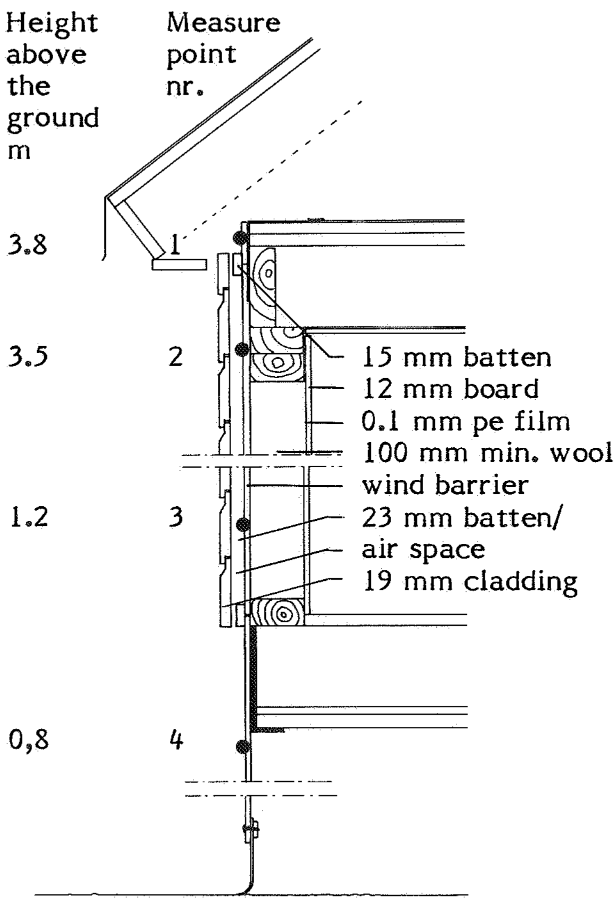
1 INTRODUCTION

Recommended airtightness of wood frame constructions are usually achieved by use of an air barrier, i. e. a polyethylene film, on the hot side of the thermal insulation. This barrier may be mounted with a minimum of joints and it is relatively easy to achieve good protection against airflow through the constructions as measured by use of the pressurisation method. It is, however, still necessary to protect the thermal insulation by use of a wind barrier on the cold side of the constructions. In this project concerning wind barriers the theoretical studies as well as the experimental investigations in the hot-box, have been restricted to one specific type of forced convection in the thermal insulation, called "anblåsning", i.e. the interchange of air between the insulation and the airspace between the wind barrier and the outer cladding. The project has been funded by The Royal Norwegian Council for Scientific and Industrial Research as well as 13 producers of wind barriers or thermal insulation.

2 WIND PRESSURE MEASUREMENTS

The windpressure measurements, which started in November 85, was necessary to get input values for the calculations and the hotbox measurements. Other goals were to obtain morecorrect wind pressure coefficients for use in air infiltration models and to study the possibility of reducing the pressure variations outside the windbarriers by connecting the airspaces behind the claddings and below the roof to a single pressure equalization chamber. This is of interest for reduction of wind induced infiltration in common constructions, but is also of special importance for developing simple constructions based on the dynamic insulation principle.
A test house has been equipped with instrumentation for wind pressure measurements. By use of an electromotor the test house can be rotated to any desired position relative to the wind direction. The basic dimensions of the house are: Length 9 m, width 5 m, height to the top of the roof 6 m and roof angel 36^{o}. The location of this house is on an open test area at the top of the Tyholt Hill in Trondheim.

By use of 20 pressure transducers (Furness) and a fast datalogging system (3530 ORION) the wind pressure at 20 points is recorded simultaneously. By exchanging the plastic tubes connected to the pressure transducers the wind pressure at 52 different points is measured.
Two groups of pressure points are located on a short wall and four groups on a long wall. The eight pressure points in each group are distributed along a vertical line, see Fig.1. In addition, the indoor pressure and the pressure in the middle of the attic are measured.



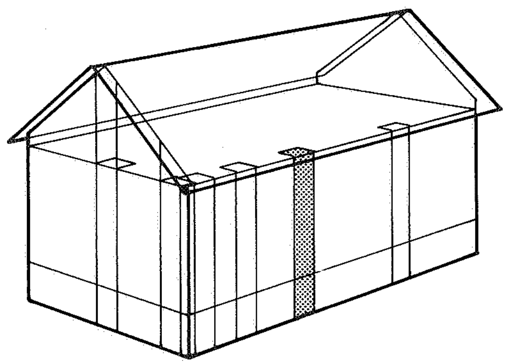


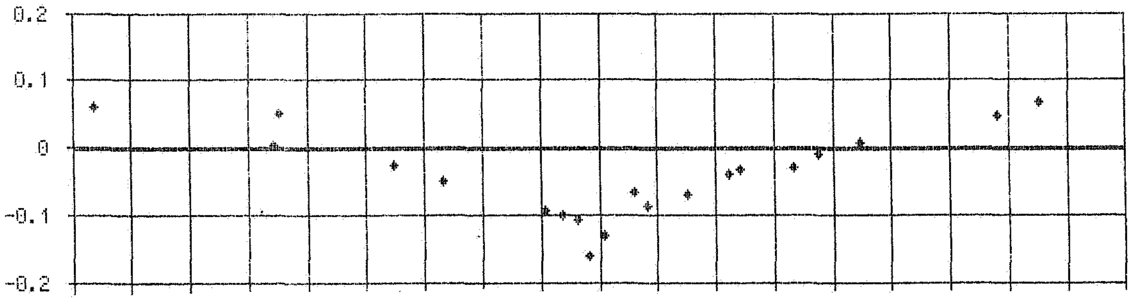
Figure 2.
The test house. Results for the hatched area are shown in the diagrams.

Figure 1.
Example of construction (variant 3) showing the location of measurement points for wind pressure. Only those corresponding to the diagrams are shown. In addition wind pressures have been measured in the attic and at three points on the outside of the wall sections.

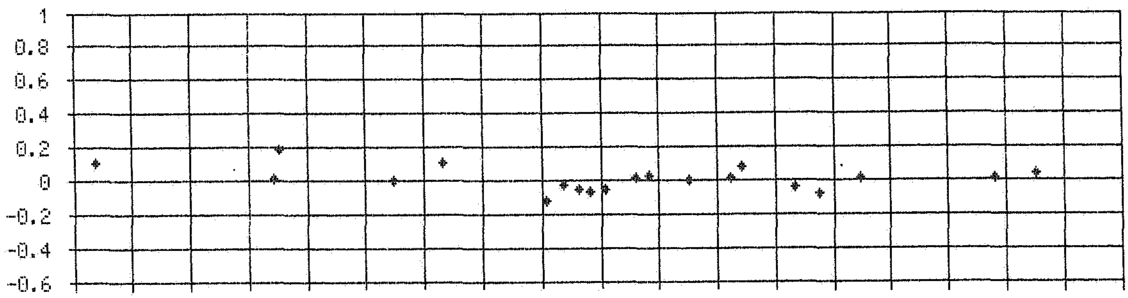
The static pressure measured 10 m above the ground in a mast on the roof, serves as reference for the pressure transducers. The dynamic pressure measured at the same place is used when calculating wind pressure coefficients. The wind pressure gradient coefficient is defined as the difference between the wind pressure coefficients of two points devided by the distance between them.

As the wind pressure behind the cladding will be influenced by construction details like the gaps at top and bottom of the airspace behind the cladding, it is necessary to do wind pressure measurements for various solutions as well as at various wind approach angles. Three variants have been investigated. Variant 3 is shown in figure 1. Variant 2 is identical, but with no wooden board on the under side of the roof edge. Variant 1 is identical with Variant 2, but without horizontal battens at the air space openings. Examples of results are shown in the diagrams 1 to 5.

Wind pressure gradient coefficient in the air space, between point 2 and 3, m^{-1}



Wind pressure coefficient at point 1



Wind pressure coefficient at point 4

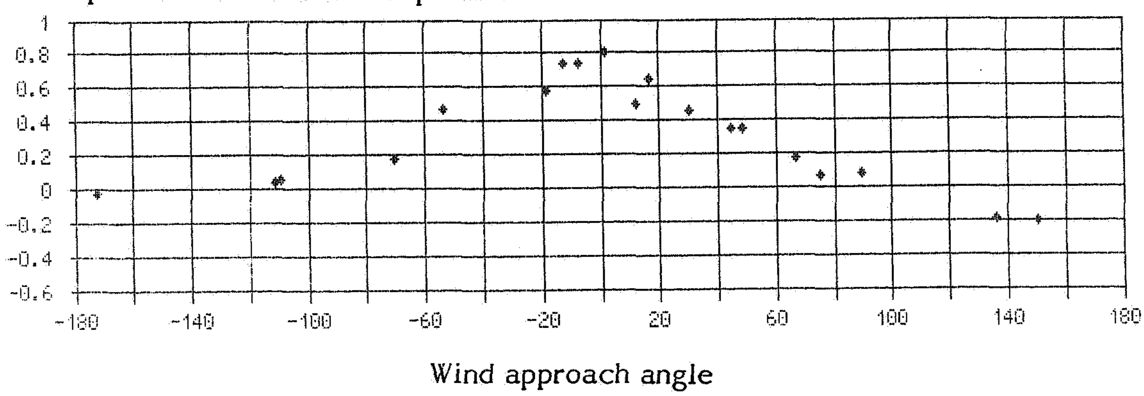


Diagram 1, 2 and 3.
Example of results from the wind pressure measurements. The diagrams show how the wind pressure gradient coefficient and wind pressure coefficients vary with the wind approach angle. (0^{o} = perpendicular to the wall). The location of the measuring points are shown in figure 1 and figure 2.

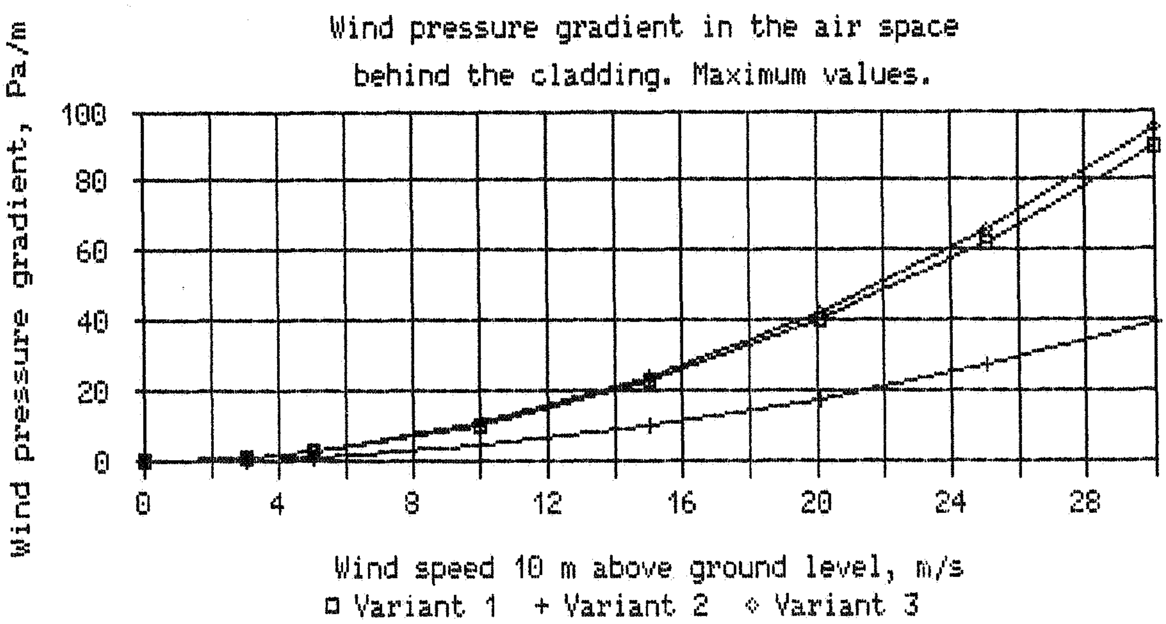


Diagram 4.
Estimated maximum gradients based on the wind pressure measurements. The wind pressure coefficients used are maximum values regarding both test section and wind direction.

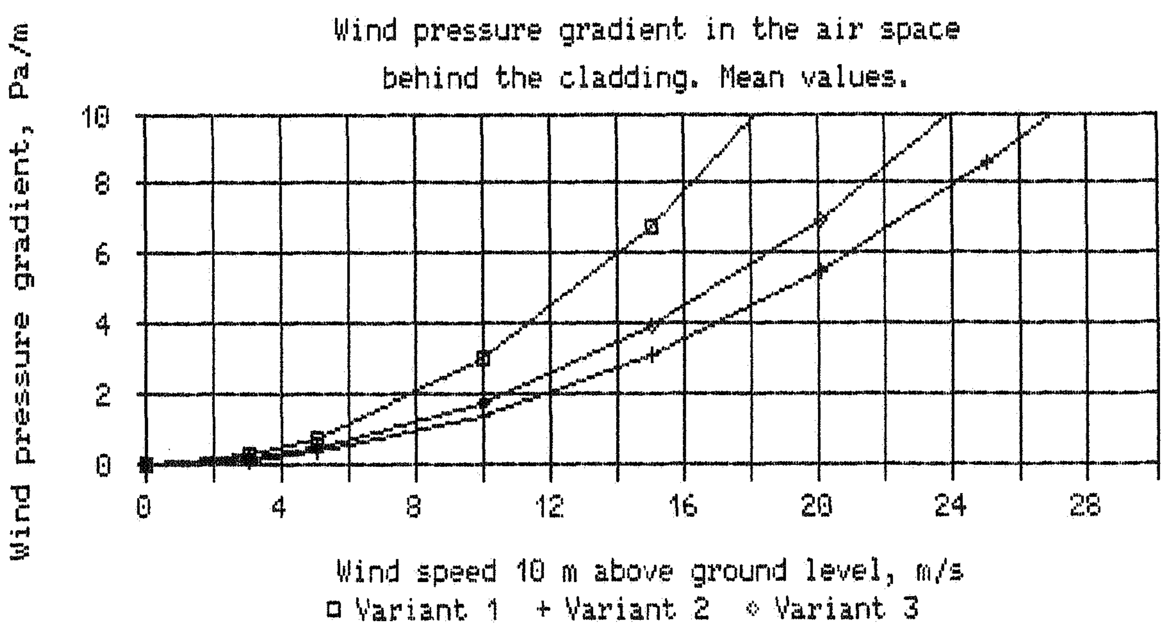


Diagram 5.
Estimated mean gradients based on the wind pressure measurements. The wind pressure gradient coefficients used are average values with regard to wind direction as well as to total wall area of the house.

3 CALCULATIONS

The interchange of air between the insulation and the airspace between the windbarrier and the outer cladding is caused by wind induced pressure gradients in the airspace, which normally has small openings at the top and bottom for moisture evacuation. In the mathematical model, based on references 2 and 3, the inside of the wall is assumed to be air tight, so that there is no airflow through the structure. Main parameters affecting this type of heat loss are pressure gradient in the airspace, air permeance of the wind barrier and permeability of the insulation. The computer program is used to estimate the pressure gradient in the airspace, the airflow in the insulation and the resulting heat loss through the wall.

4 HOTBOX MEASUREMENTS

To verify the theoretical model for the type of heat loss described previously, several hotbox measurements have been carried out on a timber frame wall of normal size. The guarded hotbox which is used has a measuring area of 2,45 m x 2,45 m. The test wall was insulated by a 150 mm thick layer of mineral wool and made as airtight as possible on the warm side by use of plastic film, tape and gypsum board.The forced convection was simulated by regulating vertical air flow in the space between the wind barrier and the outer cladding. The test program includes heat loss measurements at various air speed/pressure gradients without windbarrier and with 9 types of wind barriers. Both the calculations and the measurements show the importance of protecting the thermal insulation with a wind barrier to achieve full effect of the insulation in wind exposed constructions. Some results from the measurements are shown in diagrams 6 and 7.

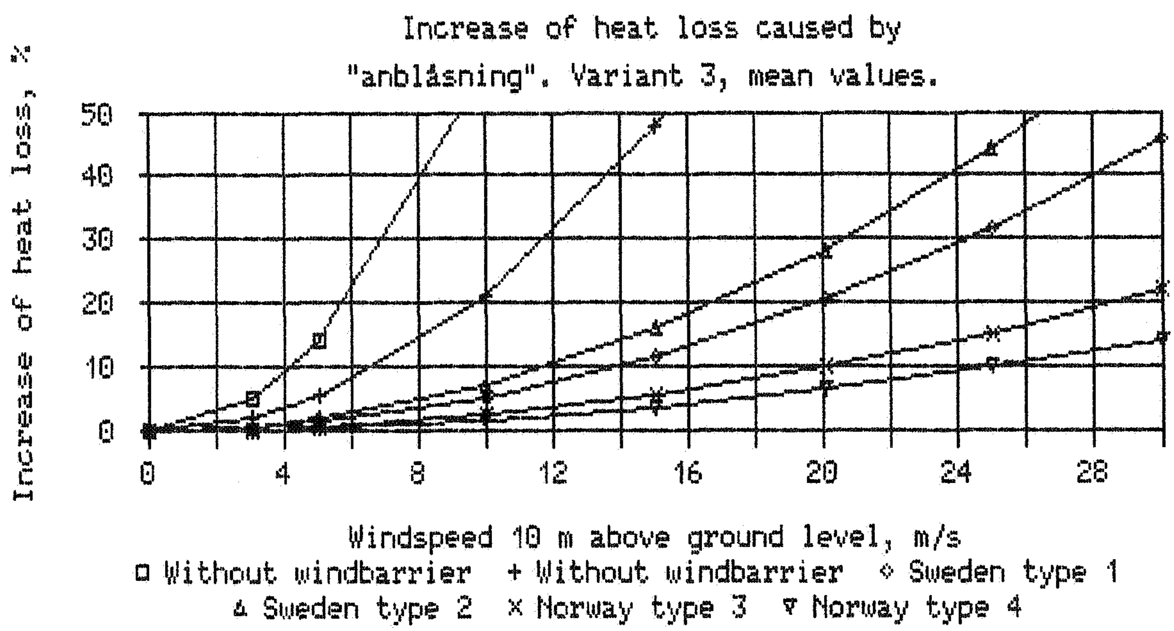


Diagram 6.
Estimated increase of heat transfer through a wood frame wall caused by "anblåsning" (see explanation). Air space and openings as shown in figure 1

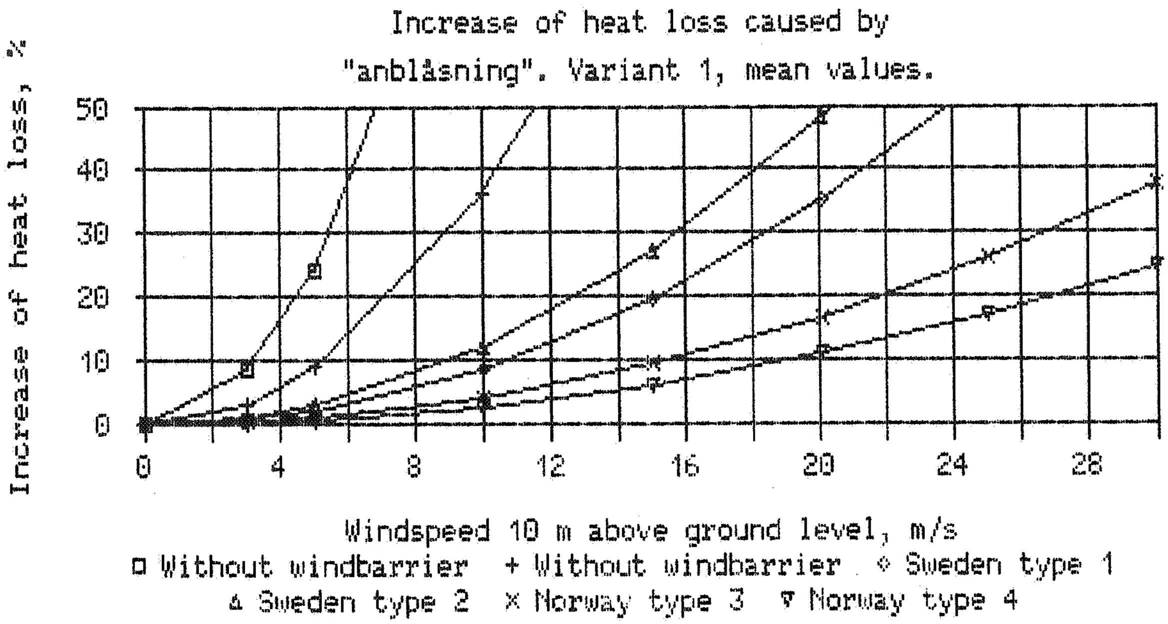


Diagram 7.
Similar to diagram 6 but applied to an other construction, variant 1. It is identical with variant 3, but there are no horizontal battens at the air space openings and no wooden board on the under side of the roof edge.

The estimations are based on the results shown in diagram 5 and on hot-box measurements on a wall with thermal insulation of 150 mm mineral wool. The measurements without wind barrier refer to two different ways of mounting the thermal insulation. The wind barriers type 1 and 2 are examples of wind barriers in common use in Sweden while type 3 and 4 represent the upper and lower limits of wind barriers used in Norway. The permeance of the four materials were 1.70 E-5, 1.5 E-5, 1.70 E-5, 0.22 E-5 and 0.06 E-5 $m^3/(m^2 * s * Pa)$ respectively.

Measured increase of heat loss is about two to five times higher than calculated. The main reason for this divergence seems to bee the influence of the joints in the wind barrier and the fact that, more or less, there are some gaps and inhomogeneities in the insulation layer in real constructions.

During the hot box measurements only vertical joints in the wind barriers were included, while the horizontal joints at the sills were made air tight by use of tape. This was done to minimise the influence of possibly variations due to workmanship. Diagram 8 shows estimated values for normal constructions as well as for fictive walls with no joints. The estimations are based on the hot box measurements as well as data from ordinary leakage measurements on wind barrier materials and on full scale constructions including a normal amount of vertical and horizontal joints. The estimates are made for a wind pressure gradient in the air space of 10 Pa/m. As shown in diagram 8 the influence of the joint leakage varies widely and dominates compared with the material leakage for most types. The diagram illustrates the importance of considering both material and joint leakage data when choosing type of wind barrier.

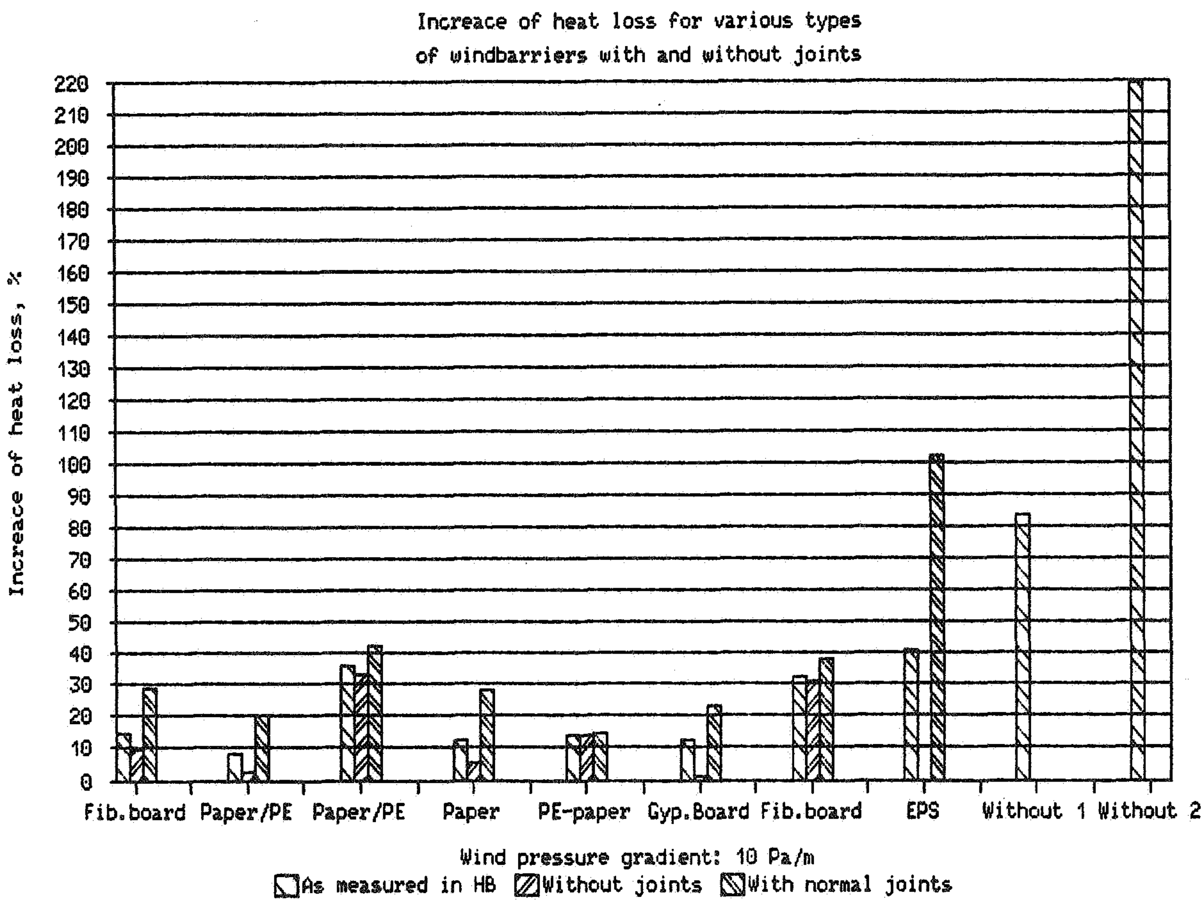


Diagram 8
Increase of heat loss through a wood frame wall insulated with 150 mm mineral wool protected with various types of wind barriers. Both measured and estimated values refer to a wind pressure gradient of 10 Pa/m along the wind barrier. See text for further explanation.

The diagrams shown apply to a particular house and construction details, but simplified estimates based on the diagrams and average wind speed may give good indication on the increase of heat loss during a heating season even for other houses.

REFERENCES

1. Uvsløkk,Sivert. Windpressure in ventilated constructions. Project report, Trondheim 1986, reviced 1987.

2. Bancvall, Claes G. Forced convection. Technical Report 1977:21, reviced April 1979. Swedish Testing Institute, Borås

3 Sandberg, P. I. Airflow and air pressure in airspaces. Lund Institute of Technology, 1975.