#4335

TEMPERATURE AND MOISTURE CONDITIONS IN CAVITY WALLS

Kenneth Sandin

University of Lund

Department of Building Technology

Box 118, S-221 00 LUND, Sweden

ABSTRACT

There are many questions to be answered about the temperature and moisture conditions in a cavity wall and therefore measurements have been carried out in a test building.

The facades of the test building consist of 16 different sections, which can easily be changed. For example, the air gap between the outer masonry and the inner wall, the ventilation openings and the thickness of the insulation can vary.

The temperature and moisture conditions in the masonry, in the air gap and in the inner wall were measured. Furthermore the ventilation in the air gap was measured in different outdoor climate.

The measurements, which are not yet completed, preliminarily show that

- the masonry is dry in the summer and capillary saturated in the winter
- the air gap has a minor influence on the moisture conditions, both in the masonry and in the inner wall
- the thickness of the insulation has a minor influence on the temperature and the moisture content in the masonry.

1. INTRODUCTION

Moisture problems in cavity walls have become more common during latter years. Examples of problems that can be mentioned are mould and rot in the wooden framework and frost damage in the bricks.

It is evident that driving rain is one important cause of many problems. To avoid water coming into the framework and the insulation, the wall is constructed with an air space between the brick masonry and the inner part of the wall.

There are different opinions about this air space. Is the air space necessary? Lately it has become increasingly more common to fill the air space with heat insulation. But can this lead to problems in the future?

In order to study this, measurements have been carried out in a test building. The measurements started in 1987 and will be finished in 1990. In this paper the test building, the measurements and some preliminary results are described.

2. TEST BUILDING

The test building (FIGURE 1) is situated in a field adjacent to the Lund Institute of Technology. The facades facing south-west (SW) and north-east (NE) are changeable. The indoor temperature is +20°C.

The SW facade is exposed to quite heavy driving rain and sun radiation. The NE facade is exposed to little driving rain and little sun radiation.

Today there are 16 different test sections, 1.2 m long and 2.6 m high, in the facades. The test sections are all different types of cavity walls with an inner wooden framework (FIGURE 2). The test sections have

- different thickness of insulation, 100-300 mm
- different width of air space, 0-50 mm
- different openings for ventilation

Most sections have no surface treatment on the outer side. However, one section has undergone water repellant treatment and one section has been rendered with a LC-rendering.

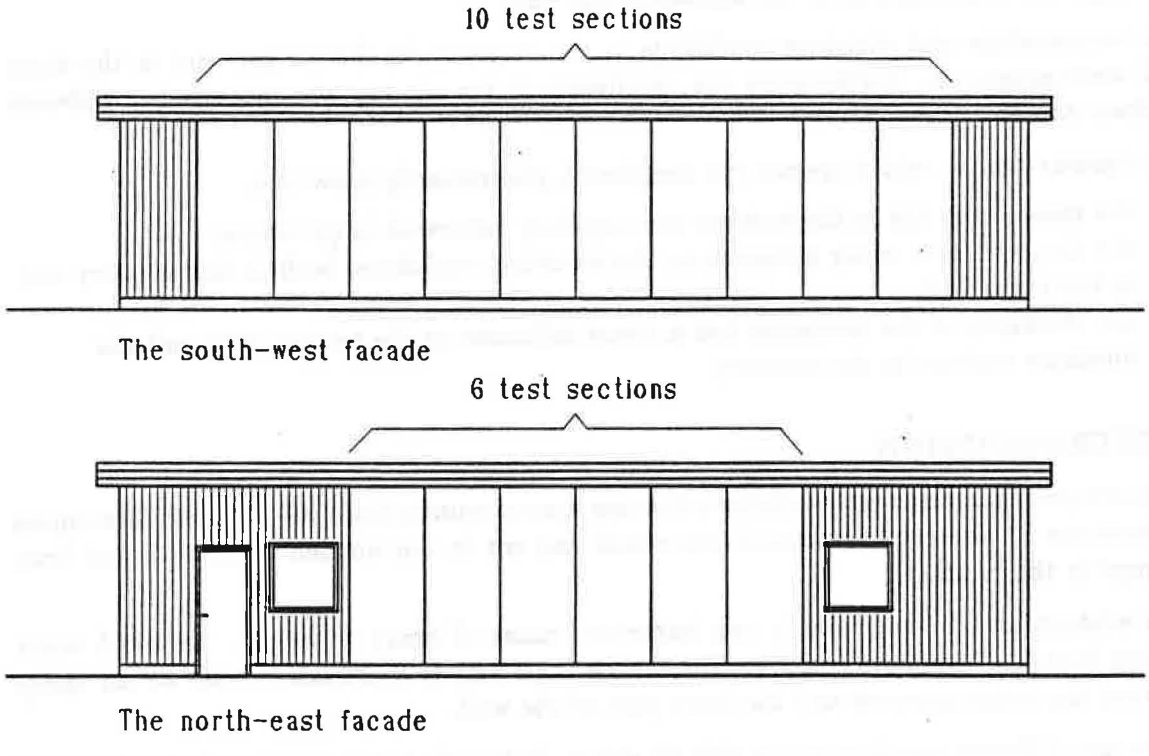

FIGURE 1. Test building.

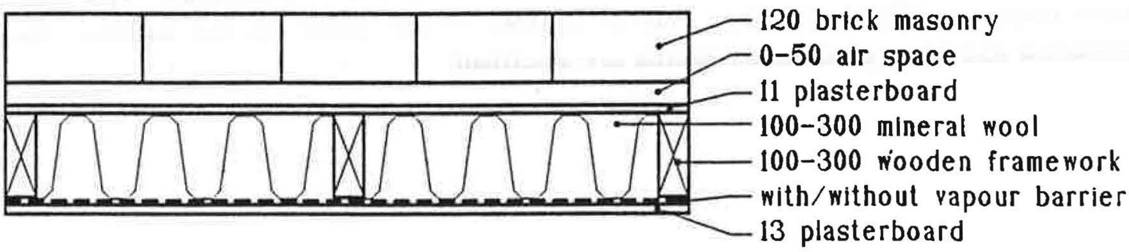

FIGURE 2. Test section.

3. MEASUREMENTS

3.1 General

The aim of the investigation is to clarify the building physics in the cavity wall. To fulfil this aim the following measurements are carried out

- outside climate (sun radiation, temperature, wind velocity and direction, humidity, rain and driving rain hitting the facades)
- ventilation in the air space
- moisture conditions in the bricks, in the air space, in the insulation and in the framework
- temperature in the bricks, in the air space and in the insulation

The measurements started in the winter 1986/87 and will continue at least until 1990.

Only a few examples of the results can be shown in this paper. A complete report will be published during 1990.

3.2 Ventilation in the air space

The ventilation rate of the air space has been measured using the tracer gas method, decreasing gas concentration. Measurements have been carried out in different climates and some results are shown in TABLE 1.

According to TABLE 1 the ventilation rate is highly dependant on the outdoor climate. With normal ventilation openings the ventilation rate is low. To achieve a high ventilation rate both the width of the air space and the ventilation openings must be very large.

3.3 Moisture content in the brick masonry

The moisture content in the bricks has been measured using the gravimetric method on whole bricks. Some results, on the SW facade, are shown in FIGURE 3.

The moisture content is always low during the summer and rises in the autumn. The bricks are very often capillary saturated during the winter. The different staples in FIGURE 3 represent different wall constructions. According to the figure there is no difference between the different walls with the exception of number 4. This wall has no insulation.

Measurements have also been carried out in walls with a LC-rendering and with a water repellant treatment respectively. These walls were quite dry while the other walls were capillary saturated.

TABLE 1. Air changes per hour in the air space.

Width of the air space (mm)	20	20	50
Ventilation openings at the bottom	no	one vertical joint	one brick changed for a lattice
sunny and windy	3	4	12
cloudy and calm	1	2	2

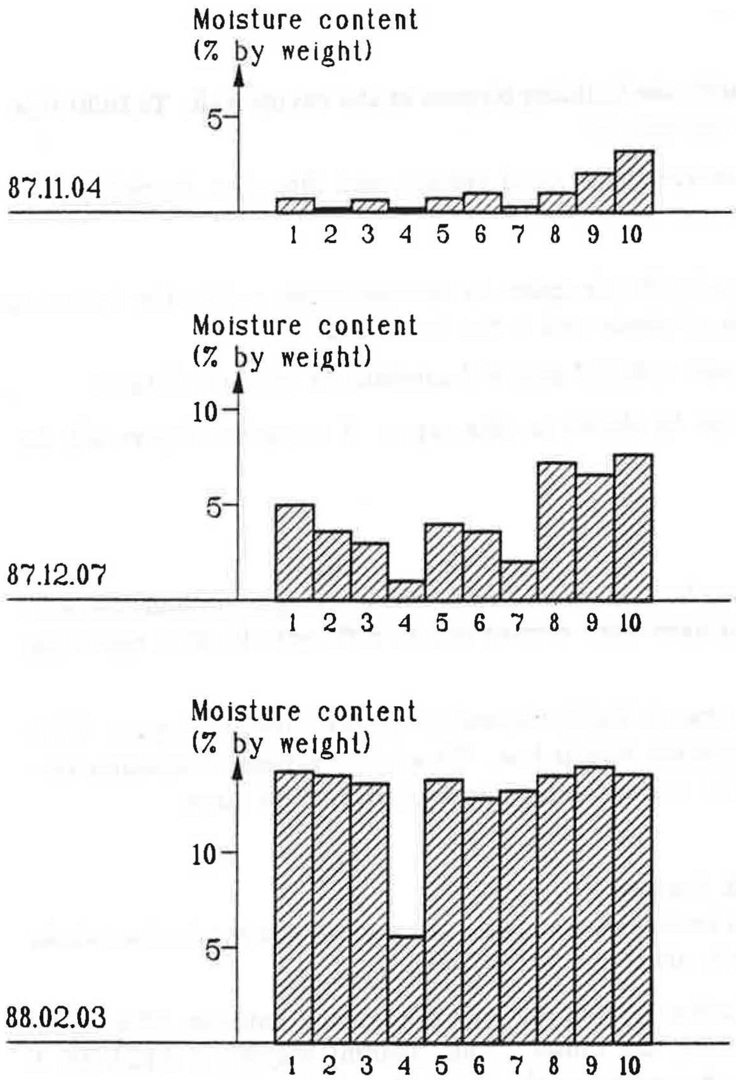

FIGURE 3. Moisture content in the brick.

3.4 Temperature in the brick masonry

The temperature has been measured with thermocouples fixed at different depths in the bricks. Measurements have only been carried out in the walls with different thicknesses of the insulation.

Some results of the surface temperatures are shown in FIGURE 4. As can be seen there is no essential difference between the walls facing south-west. Consequently the insulation has a minor influence on the temperature in the bricks. On the other hand the orientation of the walls has a great influence, depending on the different degrees of sun radiation. This can be seen clearly in FIGURE 5. The outdoor temperature is about -10°C. The sun radiation on the SW-facade causes a temperature rise to about +10°C.

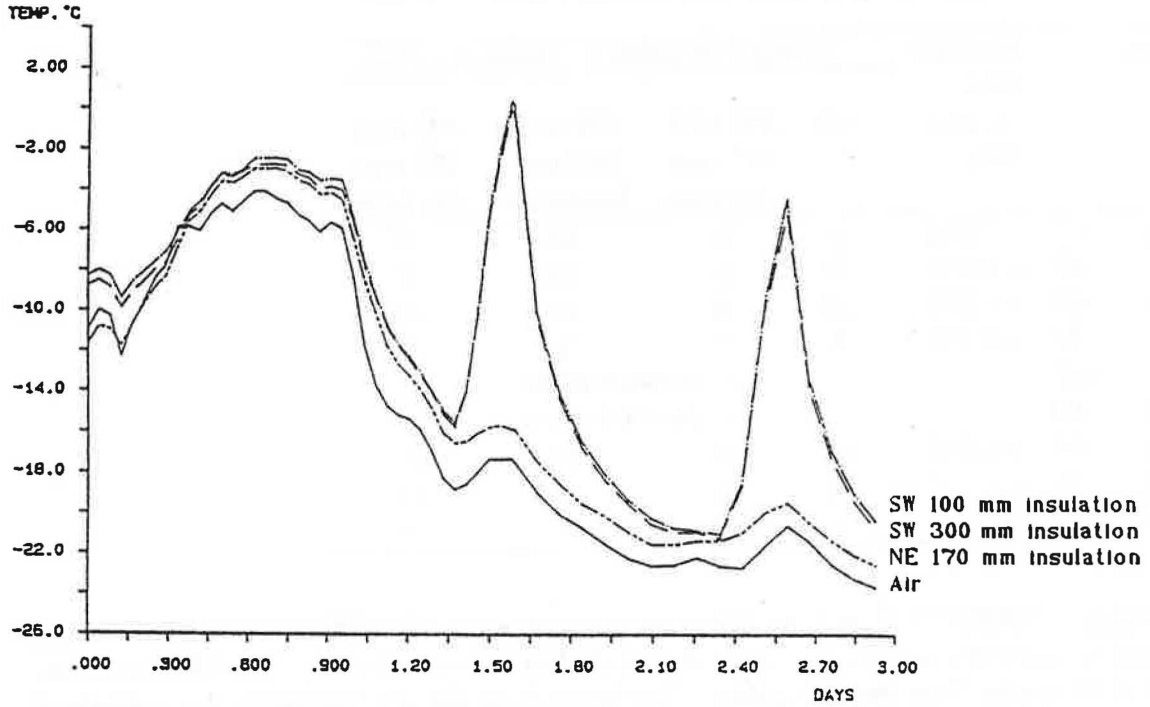

FIGURE 4. Surface temperature on the brick masonries with different insulation and different orientation.

FIGURE 5. Temperature conditions in the brickwork facing SW during a day with sun radiation. Outdoor temperature is about -10°C.

3.5 Freezing - thawing cycles

The number of freezing - thawing cycles has been measured at different depths in the brick masonry. The results of these measurements on the outer surface are shown in TABLE 2.

TABLE 2. Freezing - thawing cycles in the surface and in the air.

Time	Monthly mean tempera-ture	Number of freezing - thawing cycles			
		Air	SW with 100 mm insulation	SW with 300 mm insulation	NE with 170 mm insulation
Jan -87	- 7.0°C	3	16	15	4
Feb -87	- 2.2°C	5	19	19	7
Mar -87	- 4.2°C	10	17	17	10
Nov -87	+4.9°C	5	2	2	2
Dec -87			no measurements		
Jan -88			no measurements		
Feb -88	+1.4°C	17	9	12	10
Mar -88	- 0.1°C	14	11	11	11
Apr -88	+3.9°C	9	6	6	8

According to TABLE 2 there is no difference between walls with different thicknesses of the insulation. However, the orientation of the facade has a great influence. The SW-facade has many more cycles than the NE-facade. This depends on the sun radiation. An example of this effect is shown in FIGURE 5. Despite an outdoor temperature of -10°C, the surface temperature rose to +10°C.

TABLE 2 also shows that the number of freezing - thawing cycles in the bricks is much higher than in the air when it is very cold outside.

4. DISCUSSION

The results shown in this paper are only a few examples. From these results we can draw some preliminary conclusions.

The outer brick masonry is barely affected by the construction of the wall behind, within reasonable limits.

The masonry absorbs driving rain during the autumn and winter until it is capillary saturated. The ventilation of the air space is not sufficiently efficient to affect the moisture content to a greater extent.

On the basis of TABLE 1 the maximum daily drying out through the air gap can be estimated at 0-0.1 kg/m^2. This figure should be compared with the driving rain that is absorbed. It is not unusual with monthly driving rain about 20-50 kg/m^2.

When the brickwork is capillary saturated it will be exposed to several freezing - thawing cycles. Consequently the masonry must have a very high frost resistance. You cannot solve any problems with frost damage by making more ventilation openings in an ordinary cavity wall.

The only way to lower the moisture content in the masonry is to apply some surface treatment.