# DAMPING OF WINDS PRESSURE AND FORCED CONVECTION IN MINERAL FIBRE WALL STRUCTURES

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## SUMMARY

Damping of winds effects and forced convection in ventilated small house wall structures with light weight continuous mineral fibre insulations have been studied theoretically and experimentally. Pressure conditions in different ventilating air spaces are computed with a static-multicell-airflow-model called MOVECOMP. Thermal effects of steady state forced convection in insulations are simulated with a computer program CCC2D (Coupled heat convection and conduction in two dimensions). Both pressure conditions and thermal effects have been measured in a test house envelope. Structural variables were the construction of ventilating air space, permeance of windbreak and frame construction in thermal insulation layer.

## 1 INTRODUCTION

According to measurements and calculations (Kohonen & al. 1986) forced convection through well permeable continuous insulation in a small house envelope may increase the average heat flow significantly because of the effect of wind pressure. Airflows and their thermal effects can, however, essentially be damped with different structural methods including windbreak, tight layers of frame constructions in the insulation and well damping ventilating air space construction outside the insulated part of wall structure. The last method means an air space where pressure level is practically independent on winds speed and direction, and where pressure gradient remains always small. The present paper introduces both calculated and in a test house measured results concerning forced convection and its thermal effects in mineral fibre wall structures.

## 2 PRINCIPLE OF DAMPER AIR SPACE

The conventional ventilating air spaces of small house envelope can be changed into a damper air space with relatively small changes of certain details (Fig. 2a). The lower edge of air spaces should be closed or strongly throttled. The connection between wall spaces and attic space should be nearly frictionless. Also the flow resistances in horizontal direction from one wall space to another should be insignificant. The flow resistances of eaves should be small and symmetrical on both sides of the house. The airtightness of outer wall surface is not very critical and sufficent values can be obtained with conventional building materials.

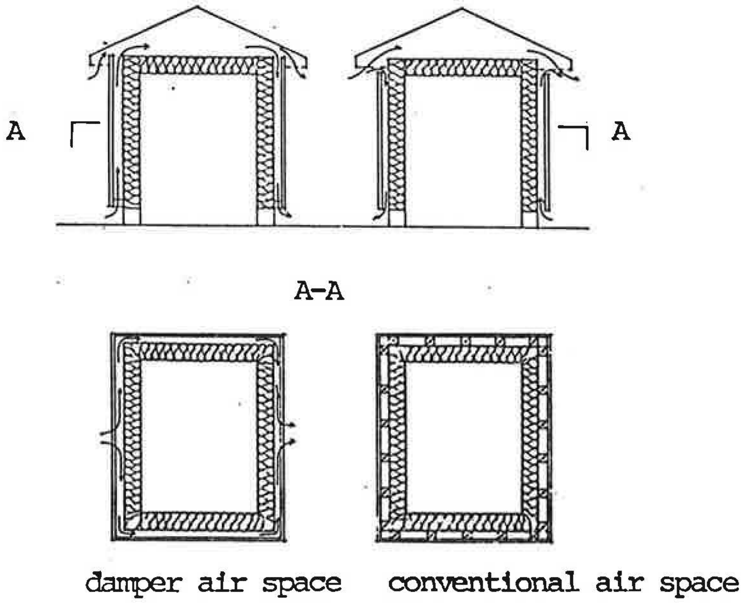



Figure 2.a. Principle of damper air space.

## 3 EXPERIMENTAL AND CALCULATED RESULTS

### 3.1 Pressure conditions in ventilating air spaces

**Figure 3.1.a shows the experimental mean pressure difference ($\overline{\Delta P}_a$) between air spaces on both sides of wall corner as a function of pressure difference between outer surface of windward and leeward walls ($\overline{\Delta P}_o$). Figure 3.1.b shows the experimental mean pressure difference between air space and room air ($\overline{\Delta P}_{ar}$) as a function of pressure difference between outer surface of wall and room air ($\overline{\Delta P}_{or}$). Both figures show that pressure level in a conventional air space is strongly dependent on wind pressure at outer wall surface while pressure in damper air space is almost independent of wind.**

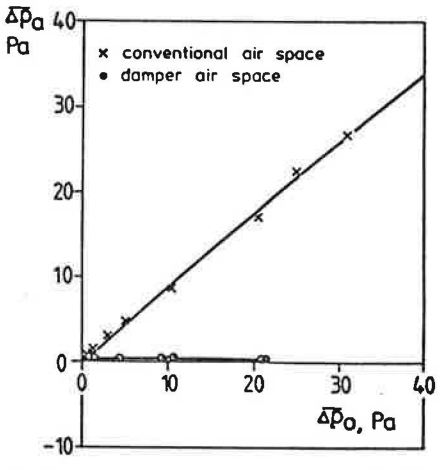



Figure 3.1.a. Mean pressure difference between air spaces over wall corner ($\overline{\Delta P}_a$) as a functions of mean pressure difference between outer surface of windward and leeward walls ($\overline{\Delta P}_o$).

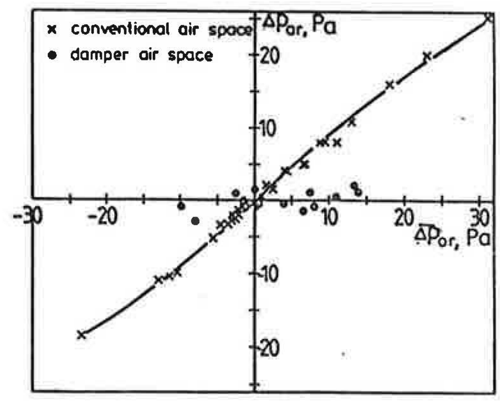



Figure 3.1.b. Mean pressure difference between air spaces and room air ($\overline{\Delta P}_{ar}$) as a function of mean pressure difference between outer wall surface and room air ($\overline{\Delta P}_{or}$).

Figure 3.1.c shows the calculated pressure conditions in a damper air space of a typical small house. Computed and experimental results of the behaviour of damper air space are in a good agreement with each other.

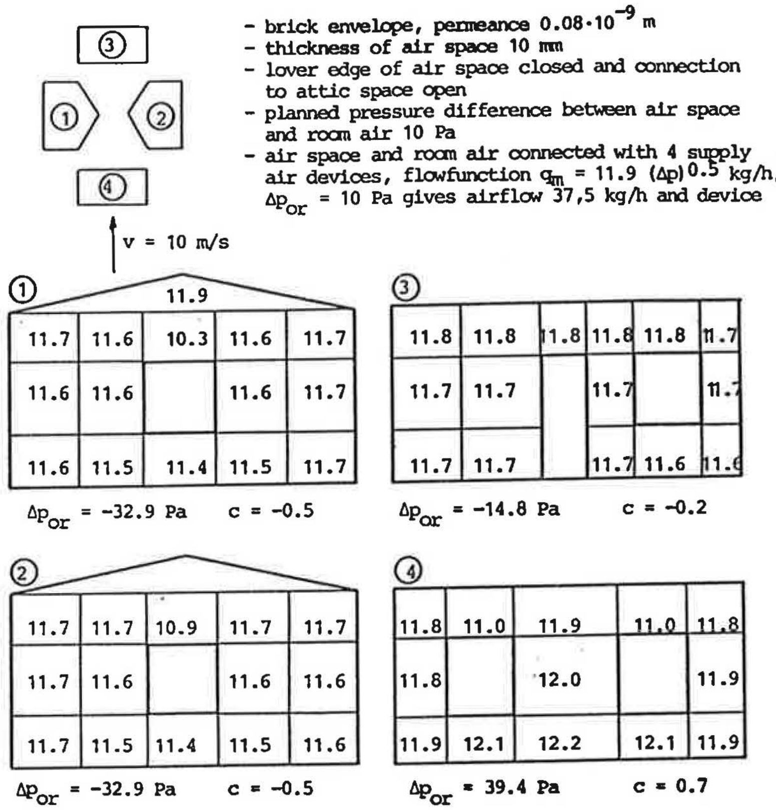
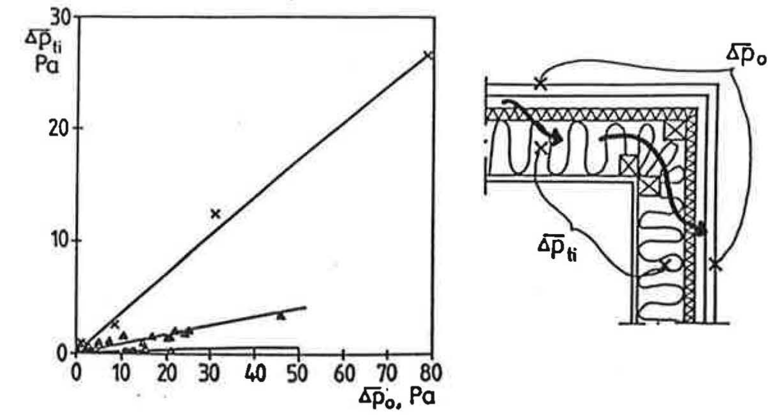



Figure 3.1.c. Computed pressure distribution in a damper air space of a 10 x 10 x 2,5 $m^3$ small house wall structure. $\Delta P_{or}$ is pressure difference between outer surface and room air.

## 3.2 Pressure conditions in continuous mineral fibre insulation

Figure 3.2.a shows the experimental mean pressure differences ($\overline{\Delta P_{ti}}$) between light weight mineral fibre insulations on both sides of the wall corner as functions of the mean pressure difference between outer surface ($\overline{\Delta P_o}$). Thermal insulation is continuous, the permeance of windbreak and air space structure are parameters. According to measurements the damper air space with permeable mineralwool windbreak acts well while conventional air space gives occasionally significant pressure differences and forced convection flows through corner insulation.

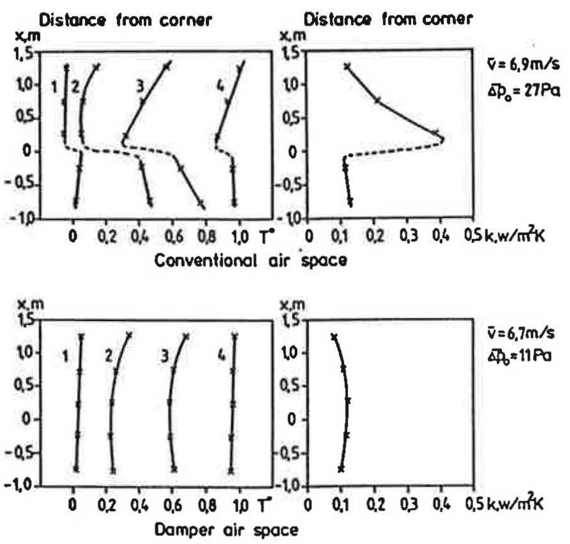



× Conventional air space, mineralwool windbreak $L_x = 8{,}6 \cdot 10^{-9}$ m
▲ Conventional air space, tight windbreak $0{,}2 \cdot 10^{-9} \leq L_x \leq 1{,}3 \cdot 10^{-9}$ m
⊙ Damper air space, mineralwool windbreak $L_x = 8{,}6 \cdot 10^{-9}$ m

3.2.a. The experimental mean pressure differences between thermal insulations on both sides of a test house wall corner ($\overline{\Delta P_{ti}}$) as functions of pressure difference between outer wall surfaces ($\overline{\Delta P_o}$).

## 3.3 Thermal effects of forced convection in continuous insulation

Figure 3.3.a shows the measured horizontal temperature distributions in different depths of wall structures and the apparent k-value according to heat flow measurements of inner wall surface. Results are concerning both conventional and damper air space with permeable mineralwool windbreak. Thermal insulation is continuous in corner structures. The forced convection through insulation is strong in the conventional structure.




1 is cold surface of windbreak
2 is warm surface of windbreak
3 is in the midle of insulation
4 is warm surface of insulation

Figure 3.3.a. Horizontal distributions of relative temperature $T^*$ at different depths in the wall structure and apparent k-value at the height of 1,25 m.