VENTILATION AND COOLING
18TH AIVC CONFERENCE, ATHENS, GREECE
23-26 SEPTEMBER, 1997

Title: **Airtight Buildings - A Practical Guide**

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Airtight Buildings - A Practical Guide

Although several investigations on how to design airtight buildings have been performed and the results furthermore have been published, many designers and contractors are still unaware of this knowledge. Therefore, the aim of this work is to collect existing knowledge and put it together to a practical guide. The target groups are architects, designers, contractors and building services engineers.

This paper is a summary of the report "Good Airtightness - guidelines to architects, building designers and contractors" published in Sweden during the autumn of 1997 [1]. The guide contains six different chapters: 1) motives for air-, diffusion- and windtightness; 2) materials that may be used for the purpose; 3) 70 drawings and specifications on how to make air-, diffusion- and windtight constructions; 4) theory; 5) measurements; and, 6) quality assurance system for gaining air-, diffusion and windtight buildings.

The content of chapter 1, 3 and 6 are emphasised in this conference paper.

1 Introduction

Almost all of us trust in the positive effect of having a wind barrier in a building. The wind barrier will prevent the wind from blowing into the building envelope, e g the external wall, and reduce the function of the thermal insulation. The wind barrier will also prevent rain, which has penetrated through the facade from finding its way into the building envelope.

In the same manner there are a number of motives why a building should be airtight (preventing air to leak through the envelope of the building): thermal comfort for the users, rational use of energy, control of ventilation and reducing the risk for moisture problems.

Book Chapters
1
2) Materials
3) Details → 70 drawings
4) theory
5) Measurements
6) Quality Ass. system

2 Objectives

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3 Results

This paper is a summary of the report "Good Airtightness - guidelines to architects, building designers and contractors" published in Sweden during the autumn of 1997 [1]. The guide contains six different chapters: 1) *motives* for air-, diffusion- and windtightness; 2) materials that may be used for the purpose; 3) 70 drawings and specifications on how to make air-, diffusion- and windtight constructions; 4) theory; 5) measurements; and, 6) quality assurance system for gaining air-, diffusion and windtight buildings.

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3.1 Motives for making air-, diffusion- and windtightness

There are four major motives for making a building *airtight*. The first one is to save energy. In a building with poor airtightness the air will flow in and out through the envelope of the building. These air movements cause an extra energy flow. The size of the extra energy flow depends however on the ventilation system used. In natural ventilation systems and mechanical supply and exhaust ventilation air, the energy flow increases linearly with the air leakage through the envelope of the building. In mechanical exhaust ventilation the air leakage through the envelope is of minor importance for the extra energy flow, since the exhaust ventilation creates a negative pressure in the building, which prevents the exfiltration. In a building with a heat exchanger or heat pump in the ventilation system, the air tightness is of greater importance. In these systems the heat exchanger/heat pump will not perform to its fully extent, since all the air will not pass the exchanger.

The second motive is thermal comfort. When cold outdoor air is leaking through the envelope of the building, the indoor surfaces will be cooled. These surfaces will cause cold down draught. The consequence is unpleasancy for the user. Also direct draught is unpleasant. In order to solve this problem, the user might want to increase the indoor temperature, which means an increasing energy use.

The third motive is to prevent moisture problems. In a building with poor airtightness the air flows through the envelope. When air is flowing from indoor to outdoor, the air brings moisture since the indoor air contains more vapour than outdoor air. When indoor air flows through the envelope, humidity will increase when temperature decreases. If the envelope has a poor airtightness there might be moisture problems in the envelope.

The fourth motive is that if the airtightness of the envelope is poor, the wind and outdoor temperature will affect the ventilation flows in the building. A ventilation system that works properly in one outdoor climate may work poorly in another extreme situation. The consequence is that the air change rate sometimes is too high or too low, depending on the outdoor conditions. An increased air change rate will cause an extra energy use.

The motive for making a building diffusion tight is to prevent indoor air containing moisture to diffuse out in the envelope of the building. The moisture content in indoor air is normally larger than in outdoor air. The moisture flow caused by diffusion, is however smaller than the moisture flow due to poor airtightness (convection).

The motive of having a wind barrier in a building is to prevent the wind in getting into the envelope of the building and reduce the function of the thermal insulation. The second motive is to prevent rain, which has penetrated through the facade from getting into the building envelope.

3.2 Drawings and specifications

The hardest part in getting an air-, diffusion- and windtight building are the connections between different constructions and around services penetrations, Figure 1, and it's actually these parts that have the largest influence on the air- and diffusiontightness.

The original report "Good Airtightness" contains over 70 drawings and specifications on different connections. Figure 2 is an example of a connection between a crawl space, an intermediate floor and an external wall. Figure 3 is an example of a connection between an external wall, an intermediate floor and a roof.

Figure 4 is an example on how to make an airtight construction around a service penetration.

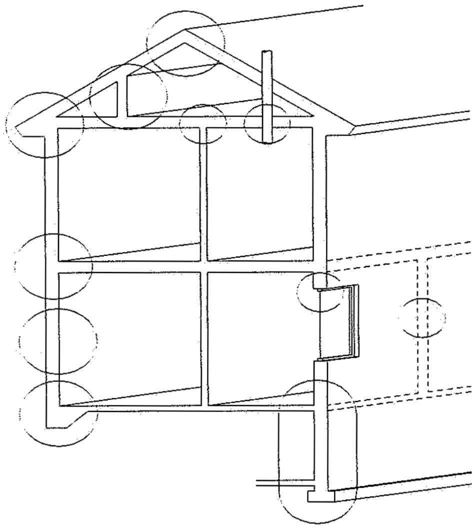

Figure 1: The hardest part in getting an air-, diffusion- and windtight building are the connections between different constructions and around services penetrations These areas are marked in the figure.

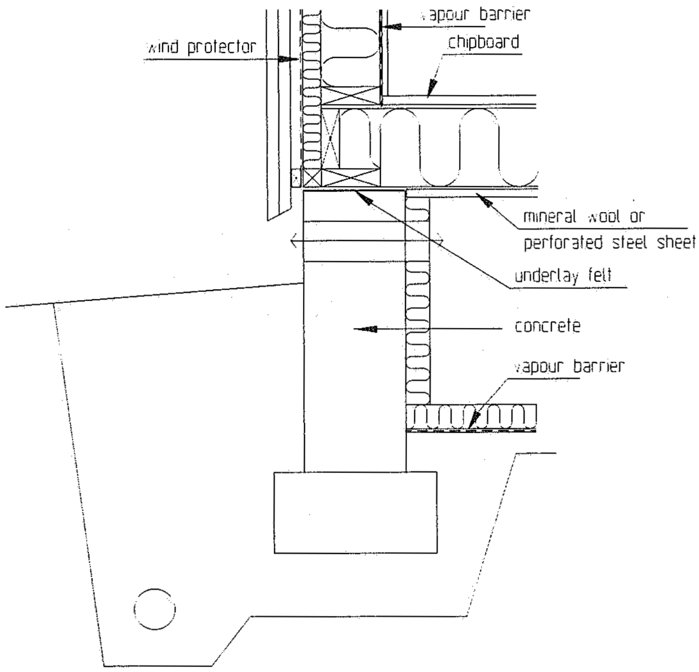

Figure 2: The figure shows how a connection between a crawl space, floor structure and external wall may be designed by means of air-, diffusion and windtightness [2]. The floor structure should have no diffusion barrier since the vapour content in the crawl space is sometimes higher and sometimes lower than indoor. Nevertheless the intermediate floor should have good airtightness. This may be achieved by having tongue-and-groove chipboards, glued and screwed to the joints. The counter floor is covered with a non organic material, e.g. mineral wool or perforated steel sheet.

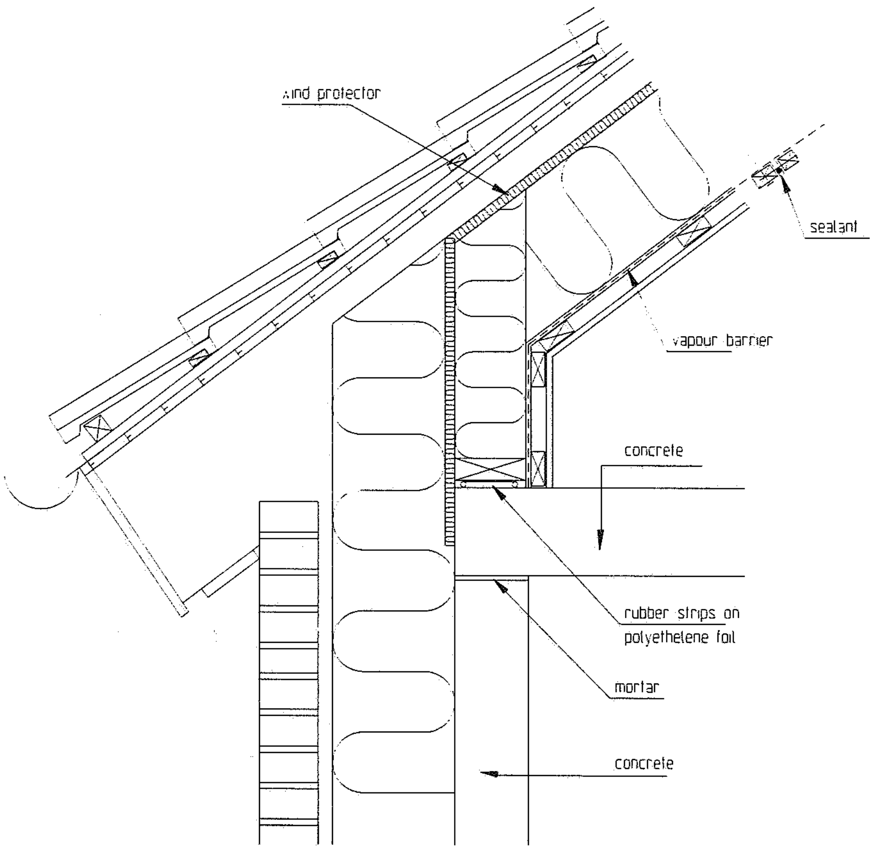

Figure 3: The figure shows a connection between an external wall, an intermediate floor and a roof. Mortar is placed in-between the external wall and the intermediate floor to achieve airtightness. Polyethelene foil with rubber strips are placed under the extra wooden sill between the roof trusses in order to achieve airtightness. The overlap joint of the polyethylene foil in the ceiling is clamped between two battens and to the sill.

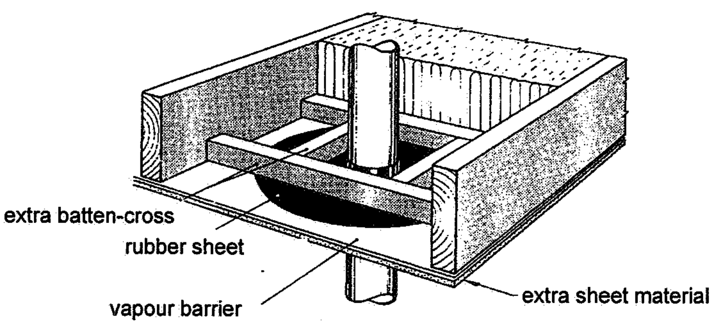

Figure 4: The figure shows how to achieve airtightness around a service penetration [3]. A rubber sheet is surrounded the pipe. The hole in the rubber sheet should be smaller than the dimension of the pipe. In this way the rubber sheet will surround the pipe airtight. The vapour barrier in the ceiling is clamped with the rubber sheet and pressed with a sheet material to the extra "batten-cross".

3.3 Quality assurance system

If the building has a poor air-, diffusion- and windtightness, the risk of getting inconvenience increases. Table 1 shows what kind of inconvenience you may get if the constructions in the buildings have poor tightness.

airleakage through:	inconveniences:					
	moisture	energy	draught	radon	airflow	noise
foundation	x	x	x	X	X	
external wall	x[1]	x	x		x	x
sill and top plate	x[1]	x	X			x
around a window	x[1]	x	X			x
roof	X[1]	x				
walls between apartments					X	X

[1] only if there is a positive pressure indoor

Table 1: The table shows what kind of inconvenience you may get if the constructions in the buildings have poor tightness. The inconveniences are marked with a x. A capital X means a larger inconvenience than the smaller x.

In order to help designers and contractors to achieve good air-, diffusion- and windtightness, special check-lists have been made, see Table 2.

4 Conclusions

It is important to build a house with good air-, diffusion- and windtight envelope. Otherwise you will increase the energy use, reduce the thermal comfort, increase the risk of moisture problems and have less control over your ventilation.

Acknowledgements

This research was supported by The Swedish Council for Building Research (project 960100-4), The Development Fund of the Swedish Construction Industry (project 6024) and AB Jacobson & Widmark.

Checklist for building contractors	OK	Date	Comment
Have the site manager and the tradesmen discussed the motives for air-, diffusion- and windtight?			
Have the site manager and the tradesmen overviewed the drawings of air-, diffusion- and windtightness produced by the designers?			
Have the building, electrical and vent contractors met an agreement of whom making airtightness at serv-ices penetrations?			
Have these connection been tightened:			
foundation/bottom floor/external wall			
external wall/windows			
external wall/doors			
external wall/intermediate floor			
external wall/roof			
external wall/internal wall			
roof/internal wall			
roof/attic door			
Are the services penetrations airtightned?			

Table 2: The table shows an example of a check-list for building contractors, which may be used for obtaining good air-, diffusion- and windtightness.

References

1. Adalberth K, 1997: *Good Airtightness - guidelines to architects, building designers and contractors* (in Swedish). Department of Building Physics and Indoor Environment. AB Jacobson & Widmark. Malmo. Sweden.

2. Norwegian Building Research Institute, 1987: *Bindingsverk av tre - Varmeisolasjon og tettesjikt* (in Norwegian). Byggforskarserien. Byggdetaljer A 523.255. Oslo. Norway.

3. Elmroth A and Levin P, 1983: *Air Infiltration Control in Housing - A Guide to International Practice*. D2:1983. Swedish Council for Building Research. Stockholm. Sween. Also available through AIVC. Coventry. United Kingdom.