AIVC 12147

THE ENERGY AND INDOOR CLIMATE PERFORMANCES OF THE RECENT HOUSING STOCK IN BELGIUM: OUTCOME OF THE VLIET-SENVIVV STUDY

A. Bossaer[1], J. Demeester[1], L. Vandaele[1], P. Wouters[1], B. Vandermarcke[2] and W. Vangroenweghe[2]

[1] Division of Building Physics and Indoor Climate, Belgian Building Research Institute (BBRI), Brussels, Belgium
[2] Department of Architecture, WenK Sint-Lucas, Gent, Belgium

ABSTRACT

A systematic analysis of recently constructed dwellings in the Flemish Region has been undertaken within the SENVIVV-project (1995-1998). In total 200 dwellings have been examined in detail. The study involved various aspects: energy related building data (thermal insulation level, net heating demand, installed heating power,..), indoor climate (temperature levels in winter and summer), building airtightness, ventilation, appreciation of the occupants,... This paper especially focuses on the results for thermal insulation, airtightness and ventilation. In the field of the thermal insulation several calculations were performed with great care, indicating that a large number of the investigated dwellings does not comply with the Flemish requirements, although it should be no problem from the technical point of view to obtain even much better performances. With respect to the indoor air quality, the presence and performance of ventilation devices was evaluated in all 200 dwellings. A comparison was made with the requirements of the Belgian ventilation standard. The results seem to be rather disappointing. Measurements of the airtightness were performed in 50 dwellings, revealing that the global airtightness is often very bad, while some rooms are very airtight.

KEYWORDS

Insulation, U-value, heating, ventilation, airtightness, dwelling, building, survey, energy, IAQ

INTRODUCTION

Each year about 35.000 new dwellings are constructed in the Flemish region. During the nineties a standard related to ventilation and building regulations related to thermal insulation came into application. As little was known about the building practice and the compliance with the new regulations, a profound study was set up to examine the energetic performances of new dwellings. From 1995 1998, 200 representatively selected houses and multifamily buildings were investigated in detail. This paper discusses on the one hand results in the field of thermal insulation and on the other hand aspects related to ventilation.

THERMAL INSULATION

Building regulations

For the moment two levels of requirements exist in the Flemish region for the insulation of individual dwellings and multifamily buildings. First, there are requirements for the U-value of different parts of the building envelope (these are shown in TABLE 1) and moreover the building as a whole must comply with a certain level of global thermal insulation, which is called the K-level. This K-level is a function of the surface-weighted average U-value and the compactness (C) of the building, which is the ratio between the volume (V) and the total heat loss surface (A) (C=V/A). Figure 1 shows the relation between the K-level, the average U-value and the compactness of the building: the higher the compactness, the higher the average U-value for a certain K-level.

TABLE 1

Maximum U-value for the different building parts in the Flemish region

External vertical wall	0.6 W/m^2K
Vertical wall in contact with the ground	0.9 W/m^2K
Roof and upper ceiling	0.6 W/m^2K
Floor in contact with the ground	1.2 W/m^2K
Floor above frost-free basement	0.9 W/m^2K
Floor above non frost-free basement	0.6 W/m^2K
Window	3.5 W/m^2K
Common wall	1 W/m^2K

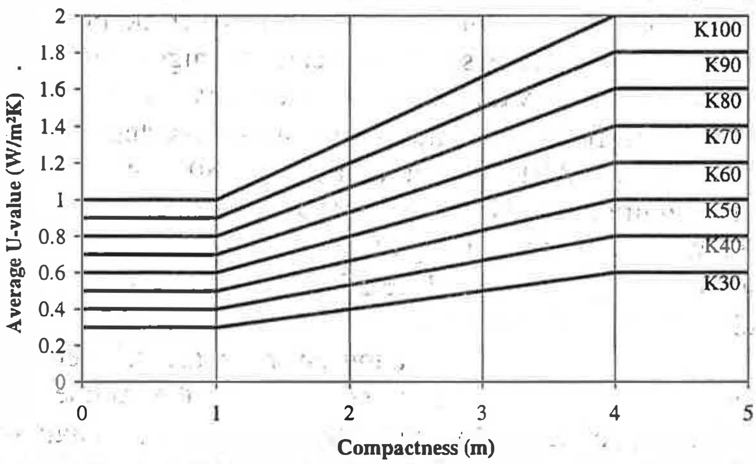

Figure 1: K-level as a function of compactness and global average U-value

Until September 1992 no requirements existed regarding the insulation of dwellings (except for social housing). Since September 1992 all building parts have to comply with the maximum U-values of TABLE 1 and the K-level has to be lower than 65. In September 1993 the requirements became more severe: From then on, all individual dwellings and multifamily buildings have to comply with the level K55.

Results and discussion

For all individual dwellings and multifamily buildings the U-values, surfaces and insulation levels were calculated based on information from plans, invoices, visual inspection and additional remarks from the occupants. Figure 2 shows the K-level of all 200 investigated individual dwellings and multifamily buildings.

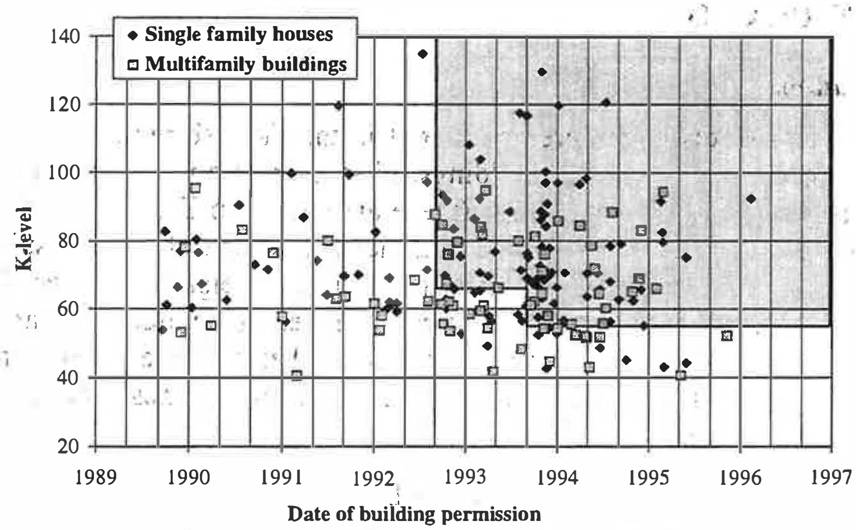

Figure 2: Level of global insulation (K) as a function of the date of building request

The following remarks can be made:

- ♦ The grey dashed area indicates the buildings which don't comply with the requirements: only 40% (out of 50) fulfil the requirement K65, while only 20% (out of 100) fulfil the requirement K55.
- ♦ The existence of a building regulation doesn't seem to have a significant impact on the average level of global insulation, which remains about K72. On the contrary, the number of well insulated buildings (< K55) increases due to the requirements.
- ♦ In some cases the K-level is very high (above 100). This is due to the fact that some dwellings were still not finished (insulation in the roof) at the moment of the visit on site, although they were occupied at least for one year: in a high percentage of dwellings a part of the finishing work is done by the occupants and not by the contractor.
- ♦ At component level the floors give the worst results: less than 40% of the floors comply with the requirements of TABLE 1, while more than 80% of the vertical walls, roofs and ceilings fulfil the requirements. Nearly all windows have a U-value lower than 3.5 W/m²K; only 0.5% of the windows have single glazing.
- ♦ Compliance with the values from TABLE 1 is no guarantee for a sufficient global insulation level.

Figure 3 shows the thickness of the insulation layer for the different building components, delimiting the heated volume (if the attic is not occupied the inclined roof is not taken into consideration if it is not insulated). More than 50% of the floors contain no insulation layer (λ < 0.065 W/mK). In nearly all cases the thickness of insulation in vertical walls is limited to 6-7 cm. 90% of the inclined roofs have an insulation layer of more than 8 cm. More than 10 % of the external walls and up to 30% of the upper ceilings don't have any insulation.

In order to prove that there should be no problem to comply with the existing requirements and also to investigate the possibility of more severe requirements in the future, a number of calculations were performed. Based on discussion with industry, the maximum (practically and technically) applicable insulation thickness for a traditional (Belgian) construction was determined for each building component. The U-value of the windows was calculated assuming the use of improved double glazing ($U_{glazing}$ = 1.1 W/m²K). The insulation level of all buildings was recalculated using these theoretical U-values. The calculations revealed that:

- ⇨ The average insulation level (of the 200 buildings) becomes about K30.
- ⇨ The maximum value is K43.
- ⇨ Only 1.5% have an insulation level above K40.

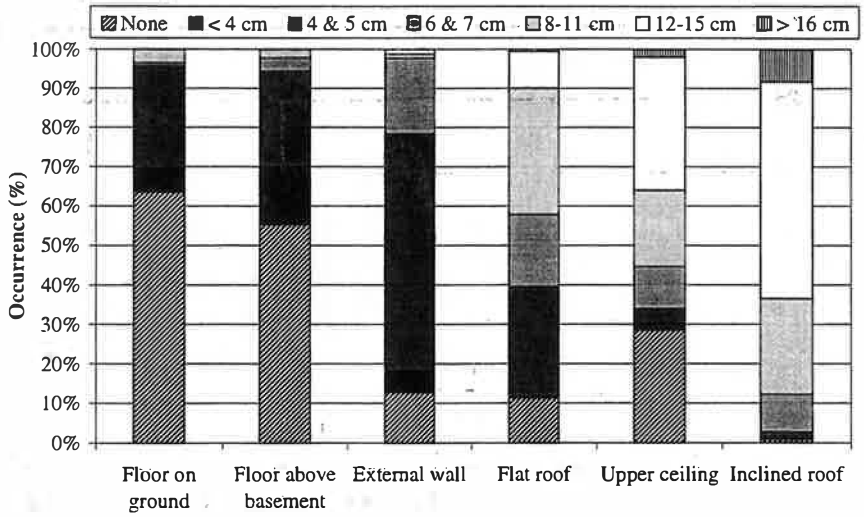

Figure 3: Insulation thickness of different components

Conclusions

The global insulation level of Flemish individual dwellings and multifamily buildings is rather poor, due to the inadequacy or total absence of insulation in certain building components. Only a small number of the investigated buildings complies with the latest requirements. Nevertheless, there are no technical constraints to perform a lot better. The key aspect for better energy performances of the Flemish (and Belgian) housing stock is the application of performance check on site during construction, rather than more severe requirements.

VENTILATION AND AIRTIGHTNESS

Standard

The Belgian standard NBN D50-001 describes the requirements for ventilation in dwellings. In the Flemish region this standard is not compulsory (except for social housing), but every standard has to be seen as a rule of good practice, and as a consequence the performances of the installed facilities have to be comparable with the requirements of the standard.
The philosophy of the standard is that a good ventilation consists of the following aspects:

- A good airtightness: the standard doesn't give requirements, only some guidelines.
- Presence of facilities for basic ventilation: the philosophy is that fresh air has to be supplied in the "dry" rooms and extracted from the "humid" rooms (naturally and/or mechanically). The air has to be transferred from the dry rooms to the rooms via transfer openings in doors or inner walls. The standard describes the necessary air flow rates to be realised.
- Presence of facilities for intensive ventilation: the standard gives requirements for the minimal surface of windows (or doors) which can be opened.

All these aspects were investigated in detail in the SENVIVV study. Some of the results are presented next.

Results and discussion

Airtightness

In 51 of the 200 dwellings pressurisation measurements were performed in order to determine the airtightness. A common way to express the airtightness is the n_{50} value (which is the air change rate for a pressure difference of 50 Pa). In Figure 4 the average result (also the minimum and maximum value) is shown for different building types.

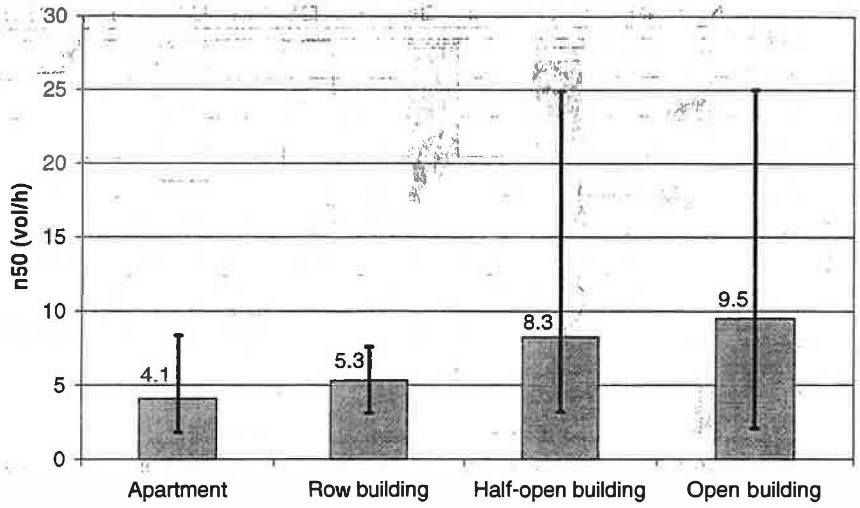

Figure 4: Airtightness of dwellings

The following remarks can be made:

- ♦ There is a large spread on the airtightness of the investigated dwellings: the values are situated between 1.8 an 25.0 h^{-1} and the average is about 8 h^{-1}. The airtightness of apartments and row buildings is remarkably better than the average result for open and half-open buildings.
- ♦ The worst results are caused by a poor finishing (at inclined roofs, connections between windows and walls,...), which is probably due to the fact that a lot of owners do a part of the work themselves.
- ♦ In addition to the global airtightness, the distribution of the leaks over the different rooms of the house was investigated. The most important conclusions were that even in leaky houses very airtight rooms could be found (especially bedrooms, bathrooms), while the most important leaks could be found in garages and insulated attics.

Ventilation facilities

In all dwellings the presence of ventilation facilities was investigated. The result is shown in Figure 5. It is obvious that there are no ventilation facilities at all in the majority of rooms. Especially in the dry rooms (living room, sleeping room and study) the situation is very bad.

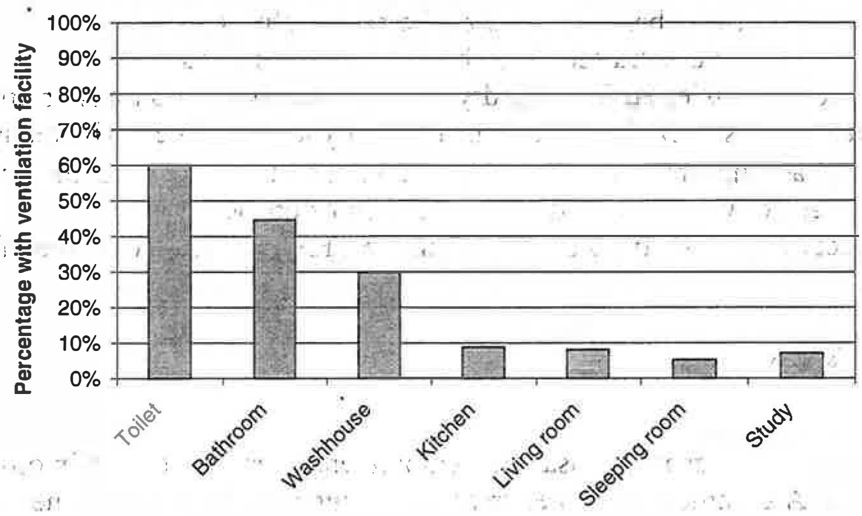

Figure 5: Presence of ventilation facilities in investigated dwellings.

Important to mention is that a part of the ventilation facilities presented in Figure 5 is not in accordance with the philosophy of the standard (e.g. window grille in humid room...).
There is not only a problem with the presence of the ventilation devices, often the installed air flow rates are not at all in agreement with the standard. Figure 6 shows the result of the measurement of the mechanical air flow rates in toilets and bathrooms. The dark bars represent continuous air flow rates, while in the case of the light bars the extraction is operated temporarily by a switch (light,...). Both methods are accepted by the standard. It can be seen that the air flow rate in the toilets is often higher than the requirement in the standard (in the case of a continuous extraction this can have an important impact on the energy loss), while in the case of bathrooms the air flow rates are often largely insufficient, causing problems with the indoor air quality and condensation.

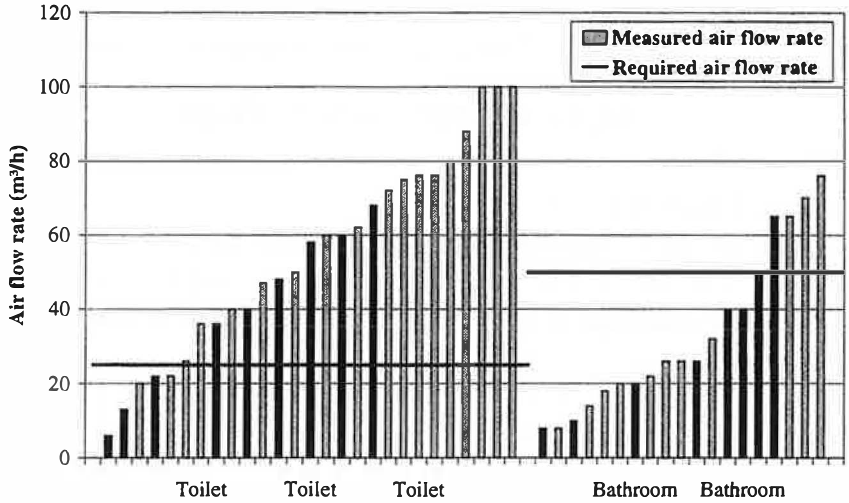

Figure 6: Air flow rates of mechanical ventilation facilities

Conclusions

The study revealed that very often the global airtightness of Flemish dwellings is rather bad. On the other hand, certain rooms are usually very airtight, which can cause problems if there are no ventilation facilities. In spite of the existence of a standard for ventilation of dwellings, the presence of ventilation facilities is quite poor, especially in dry rooms. As a consequence, a lot of complaints (about 30%) in relation to IAQ could be recorded in the investigated dwellings. This indicates that there is a lack of understanding of the importance of ventilation and the way it can be done correctly. As in the case of thermal insulation, the possibility of control on site could improve the situation.

REFERENCES

Belgian Building Research Institute, WenK Sint-Lucas Gent: SENVIVV: Study of the energy aspects of recent dwellings in the Flemish region: insulation, ventilation and heating; Final report; Brussels, 1998 (in Dutch).

ACKNOWLEDGEMENTS

The SENVIVV-study was made possible by the financial support of the Minister of Economy of the Flemish Region (in the framework of the VLIET programme) and 16 companies active in Belgium (Insulation: *Isoglass, Isover, Owens-Corning, Rockwool Lapinus*; Glazing: *Glaceries de Saint-Roch, Glaverbel*; Ventilation: *Air Trade Centre, Alcoa, Aldes, Aralco, Bemal, Duco, Renson, Sobinco, Stork, Ubbink*).