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Why and how is airtightness stimulated in the proposed new energy performance regulation for the Flemish Region?

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The airtightness performances of buildings and ventilation systems can have a major impact on the indoor climate (IAQ, thermal comfort,…) and on the energy performance. Measurement results for Belgian buildings clearly show that the airtightness is often moderate to very poor. As part of the proposed energy performance legislation for the Flemish Region, it is envisaged to pay attention to the airtightness of buildings and ductwork.

In the first part of the paper, results found for Belgian buildings and systems are briefly presented and discussed. In the 2nd part of the paper, specific aspects of the proposed approach for building and ductwork airtightness are explained.

1. Introduction

There are several reasons for achieving building envelopes with a good airtightness level. A poor envelope airtightness can give various types of problems, e.g. :

- It can result in draught complaints (mainly in case of important local leakages);
- It can result in a poor functioning of the ventilation system;
- It can create moisture problems in certain types of building components.
- Moreover, it can substantially increase the energy use of a building.

As a result, there is a general consensus that it is important to have buildings with a reasonable level of airtightness.

As far as ductwork is concerned, the impact of leaky ductwork can be twofold : a reduction of the air quality or an increase in energy use.

→ Impact on indoor environment

In case there is no explicit control of the supply and exhaust air flow rates, leaky ductwork will result in lower supply and exhaust flow rates at room level. As a result, there will be a reduction of the air quality.

→ Impact on energy efficiency

In case the supply and exhaust air flow rates are in line with the specifications, leaky ductwork will lead to an increase in energy for the conditioning of the air (heating, cooling, humidification) as well as for the fan energy.

2. Experiences with airtightness in Belgium

Several extensive studies on building airtightness of Belgian buildings have been carried out. The most relevant studies are briefly discussed.

2.1 Measured airtightness of Belgian buildings

- **Random sample of new dwellings**

The results of this study are included since it concerns new, randomly selected Flemish buildings with rather remarkable results.

In the framework of the VLIET-SENVIVV study (BBRI, 2000), the airtightness of 51 dwellings was measured. The results are presented in figure 1, whereby the airtightness is given as function of the duration of occupancy. A large variation in airtightness is found with n_{50}-values ranging from about 2 h^{-1} to more than 25 h^{-1}. In a number of dwellings, an airtightness measurement was even impossible since the dwellings were not yet sufficiently finished (although several of these dwellings were already occupied for a few years).

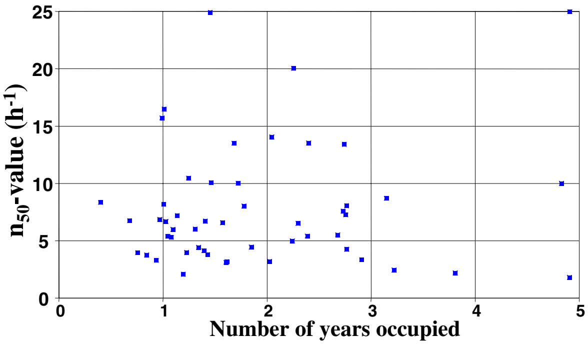

figure 1 : Airtightness of 51 recent Belgian dwellings Source : BBRI(2000)

In figure 2, the average values for the different dwelling types are given. A remarkable trend can be observed. The major explanation for this trend is the fact that apartments have the lowest envelope area per unit of volume whereas the detached houses have the largest one.

If one takes into account the relative importance of the various dwelling types in the Flemish building stock (apartments : 35 %, rowhouses : 8%, semi-detached dwellings : 15 %, detached dwellings : 42 %), one finds an average n_{50}-value of 7.1 h^{-1}.

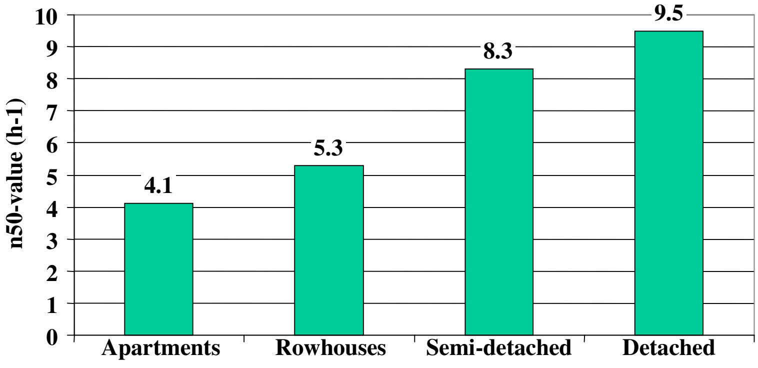

figure 2 : Average airtightness level for various types of VLIET-SENVIVV dwellings Source : BBRI (2000)

- **New dwellings constructed by Belgian system builders**

Partly in parallel with the VLIET-SENVIVV study, a systematic study was carried out on performances of 11 so-called system dwellings. For each of the companies involved, an occupied dwelling was randomly selected and analysed in detail. One of the investigations concerned the building airtightness. The overall airtightness level is presented in figure 3. On average, the n_{50}-value is around 9.7 h-1, which is not below the average found for the VLIET-SENVIVV dwellings.

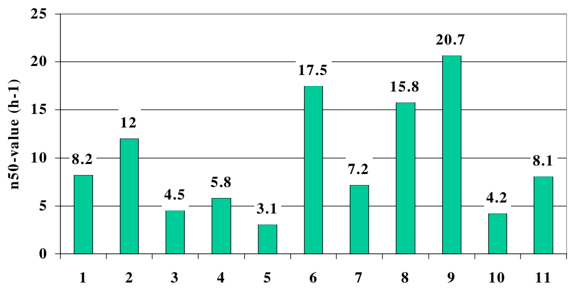

figure 3 : Airtightness results for Belgian system dwellings Source : Bossaer(1998)

This seems to indicate that the fact that a repetition effect in the construction methods does <u>not automatically</u> lead to an improved airtightness.

- **Schools**

Between 1986 and 1988, BBRI has carried out airtightness measurements in a whole range of school buildings (Wouters, 1989). These results are interesting to report because they are the major Belgian sample of non-domestic buildings.

The study showed that a very large spread in building airtightness exist. See figure 4. Moreover, the 2 extreme cases were very interesting since both schools were confronted with specific problems:

- Very airtight school (figure 4, ❶)

  The n_{50}-value was of the order of 1 h^{-1}. There were no provisions allowing ventilation. Serious condensation and mould growth problems occurred. Moreover, extremely high CO_2-levels were measured, with values of more than 6000 ppm.

- Very leaky school (figure 4, ❷)

  In this case, the n_{50}-value for the various classrooms was of the order of 25…30 h^{-1}. The reason measurements were carried out was the fact that it was impossible to reach comfort temperatures in this new and well insulated school during windy conditions. The cause of the problems was quite evident : the inclined roof had 1 cm wide openings between the wooden profiles, which resulted for a pressure difference of 50 Pa in an air flow rate through the roof of about 30 dm³/s.m². In 1 classroom, improvements were applied by installing 6 meters wide polyethylene sheets. The n_{50}-value dropped to 5 h^{-1}. (Wouters, 1986)

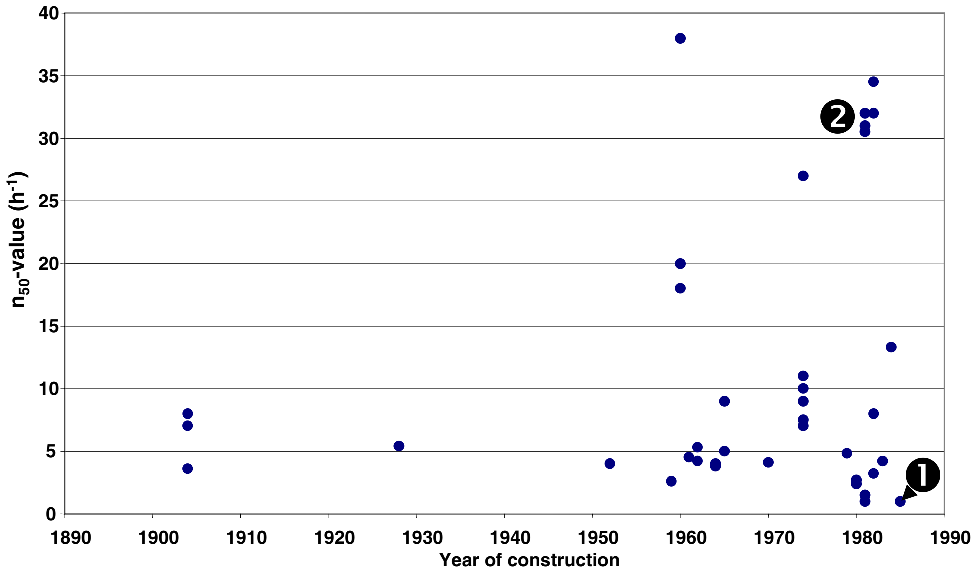

figure 4 : Measured n50-values of various classrooms of Belgian school buildings Source : Wouters (1989)

2.2 Conclusion concerning airtightness of Belgian buildings

An appropriate airtightness level is for several reasons important. Practice shows that a good airtightness of Belgian buildings is not evident. Therefore, it seems justified to consider measures for stimulating a better building airtightness.

- One possibility is to impose airtightness requirements, whereby a pressurisation test is mandatory (figure 5, ❶). This is of course the most straightforward approach but there are several concerns, e.g. what is an achievable level for a given context, how to combine such requirement with the general trend for reducing the number of requirements and rules, what is the cost-benefit relation of such requirement, is it not economically better to stimulate other measures,…
- Another, and as far as the Flemish Region is concerned, more attractive approach is to integrate the airtightness performances in the overall assessment scheme of the Energy Performance (EP) level of a building (figure 5 : ❷). In this case, there is no specific requirement with respect to the building airtightness. However, if the airtightness level is measured and if it is below a certain limit, there will be a bonus on the EP level (figure 5 : ❸).

A crucial requirement for applying this latter approach is to impose that the conformity with the regulation must be proved after construction and not at the moment of the building permit.

Such approach gives more freedom and it probably will lead to a much more positive approach than explicit requirements. In order to achieve improvements in practice, it is important to increase the awareness and knowledge among practitioners.

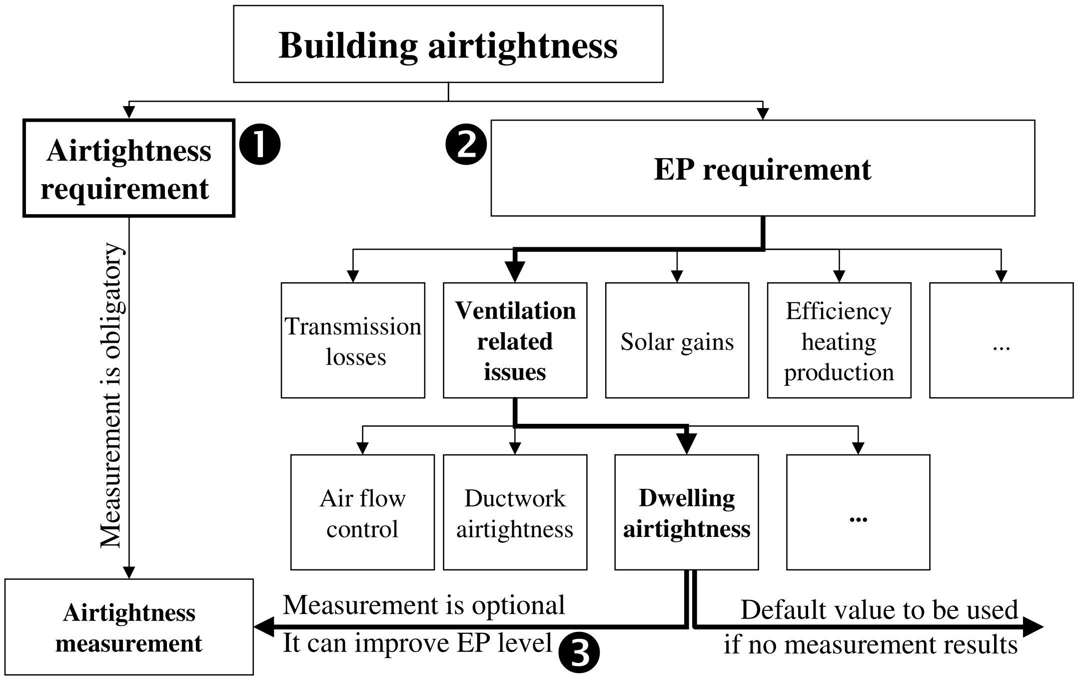

figure 5 : Direct versus indirect stimulation of building airtightness

2.3 Airtightness of Belgian air distribution systems

The EC SAVE-DUCT study (Carrié, 1999) was carried out in 1997 and 1998 and aimed to quantify duct leakage impacts, to identify and analyse ductwork deficiencies, to propose and quantify improvements and to propose modifications to existing standards. Part of the work involved airtightness measurements of ductwork in Belgium, France and Sweden. A detailed description of the outcome of the study is given in Carrié(1999).

The results which were obtained in Belgium and France are quite similar. In figure 6, the results for the Belgian installations are presented. A large part of the installations does not achieve the airtightness class A. Certain installations are 5…10 times leakier than class A. The results found in Sweden are completely different. In figure 7, a distinction is made between installations for which class B is required and for which class C is specified.

Only 2 Swedish installations don't meet class B and, because of the AMA procedure (AMA, 1998), were improved.

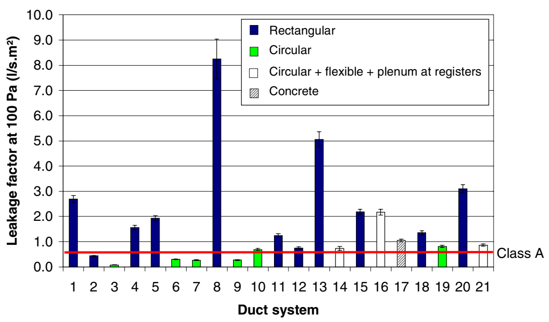

figure 6 : Measured airtightness Belgian ductwork Source : Carrié(1999)

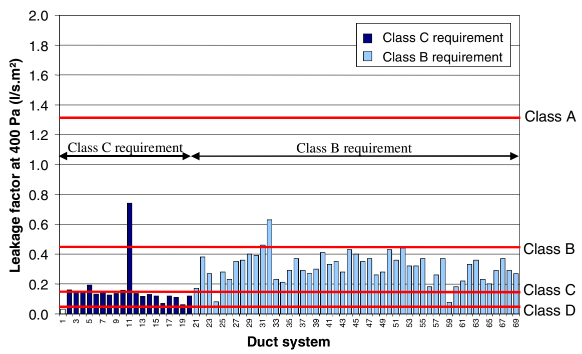

figure 7 : Measured airtightness Swedish ductwork Source : Carrié(1999)

3. The envisaged new Flemish Energy Performance Regulation

The new regulation for the Flemish Region envisages the calculation of the primary energy use for heating and cooling under well defined boundary conditions, whereby attention is paid to thermal comfort in summer and indoor air quality.

In practice, the energy efficiency of buildings is not only determined by the performances of the components and of the design but also by the workmanship performance (figure 8):

Component performance:

All aspects involving manufacturing of components

Design performance :

All aspects concerning the design : ease of design, performances at global building level, potential differences between performances at component level and at building level,…

Workmanship performance :

All aspects concerning the application in reality and especially the quality of workmanship (e.g. installation of insulation panels in a cavity wall);

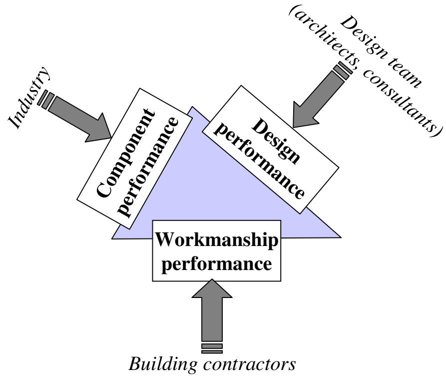

figure 8 : Critical elements in relation to performance assessment and related sectors

There clearly is a target group for each aspect :

- Industry is the major actor with respect to the performances of components;
- Architects and consultants clearly play a key role with respect to the design performances;
- Building contractors are directly concerned with the quality of workmanship.

The proposed Flemish EP regulation intends to pay attention to the execution related aspects. Because of practical reasons, this is mainly related to ventilation aspects : airtightness of the building envelope, airtightness of ductwork and air flow control.

Practice has shown that it is not evident to achieve the envisaged performances unless there is a coherent concept of quality specifications and control. Therefore, the concept of dossier as built is introduced. It requires that a building professional has to describe in detail all the executed works and the related energy performance of the building. In case of control, fines have to be paid if the installed components are of less quality than the specifications in the dossier as built.

4. Flemish regulation : Handling of building airtightness

Important remark : the proposal for the Flemish EP regulation is still under discussion.

The envisaged EP regulation foresees 2 possibilities for getting a value for the airtightness of a given building:

- Either to measure the building airtightness;

  The airtightness has to be measured in line with the ISO-CEN procedures. These measurements have to be done once the building is finished.

- Or to make use of a default value for the building airtightness. It is expected that this default value will be of the order of 15 m³/h.m² of envelope area.

The airtightness is expressed as an air flow rate at 50 Pa pressure difference. It is then assumed that there is a rather good relation between the air flow rate measured at 50 Pa and the seasonal air flow rate de to air infiltration.

5. Flemish regulation : handling of ductwork airtightness

Important remark : the proposal for the Flemish EP regulation is still under discussion.

As is the case for the building airtightness, the envisaged EP regulation foresees 2 possibilities for getting a value for the airtightness of a given ductwork:

- Or to measure the ductwork airtightness;

  The measurements have to be done in line with the CEN procedure.
- Or to make use of a default value for the ductwork airtightness. It is expected that the default value for the ductwork airtightness will correspond to a leakage air flow rate which is 3 times the leakage rate corresponding with class A or 18% of the nominal air flow rate.

6. Conclusions

The envisaged new Flemish Regulation on Energy Performance of buildings has as a general objective to substantially improve the average energy efficiency of Belgian buildings while at the same time paying attention to indoor climate (thermal comfort in summer and indoor air quality). As part of this approach, building and ductwork airtightness is taken into account. If the airtightness is not measured, one has to use default values which correspond to a high leakage rate. Essential in the whole approach is the dossier as built which allows a detailed description of the building after the works have been finalised.

7. References

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