Air tightness test on “Renoveringssockeln” and its estimated impact on energy consumption

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Student report

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On the behalf of

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http://www.renoveringssockeln.se

1 Aim

The aim of this investigation is to evaluate the influence of the “Renoveringssockeln” skirting board installation method on the overall infiltration rate and the energy demand for heating related to infiltration when used in the renovation of an existing apartment block.

2 Method

A blower door test is performed on 4.6 x 2.9 x 2.5 m room of a four storey apartment with a single exterior facing surface (wall), according to the European Standard (EN 13829, method B) for both pressurization and depressurization. All vents and ducts etc. are sealed according to the standard. In order to effectively evaluate the influence of the “Renoveringssockeln” skirting board installation method on the energy demand for heating related to infiltration, only leakages through the exterior wall are considered. Therefore the “Renoveringssockeln” skirting board is only installed along the exterior wall and all major leakages through the interior walls are sealed prior to the testing. The test is first performed with the skirting board in its original condition and then again with the “Renoveringssockeln” mounted. Leakage distribution in the space in the former instance is documented via a leakage investigation. Installation/mounting time is also noted. The rate of infiltration through the exterior wall is then estimated for each test and used in the estimation of the total yearly energy demand for heating related to infiltration for a representative apartment block using the AIM-2 model (Walker & Wilson, 1998).

Figure 2.1 Exterior of house where measurements where performed.

Test equipment

Minneapolis blower door Model 3

DG-700 Pressure and flow Gauge

3 Background

Renoveringssockeln

The “Renoveringssockeln” skirting board and installation method is intended for use in the renovation of existing residential and commercial buildings. The first step in installation is to seal the upper and lower lip of the existing skirting board to the wall and floor respectively with a suitable sealant. The “Renoveringssockeln” skirting board is then placed on top of the existing skirting board and mounted either by nailing or gluing it towards the in-situ skirting board. The installation method negates the removal of the existing skirting board during renovation and means that the “Renoveringssockeln” skirting board can be attached directly to the old one. This could potentially lead to shorter mounting times compared to the traditional renovation method. The “Renoveringssockeln” skirting board also incorporates a channel to accommodate/hide wall mounted electrical cables.

The potential benefits with an improvement in the airtightness of the wall/floor connection when sealing the joint around the existing skirting board before mounting the “Renoveringssockeln” skirting board, shall be investigated in this study.

Figure 3.1 Left: original state of skirting board. Middle: skirting board when sealed. Right: part of “Renoveringssockeln” mounted.

Importance of airtightness

The airtightness of a residential building has an influence on several factors regarding the energy performance and indoor climate. Poor airtightness will increase the energy demand both through decreased performance of the insulation caused by air movements in the insulation material and due to the extra infiltration of cold air into the building. Calculations according to Sandberg and Sikander (2004) show that for a leaky apartment block with an air leakage rate of 2,0 l/sm^2 (corresponding to values typically measured for poorly constructed Swedish apartment blocks from the 60s and 70s) which is placed in a windy open area can have an additional energy demand caused by unintended infiltration which counts for 45 percent of the total energy demand for heating (Sandberg & Sikander, 2004). A summary of the results from the calculation are shown in Figure 3.2.

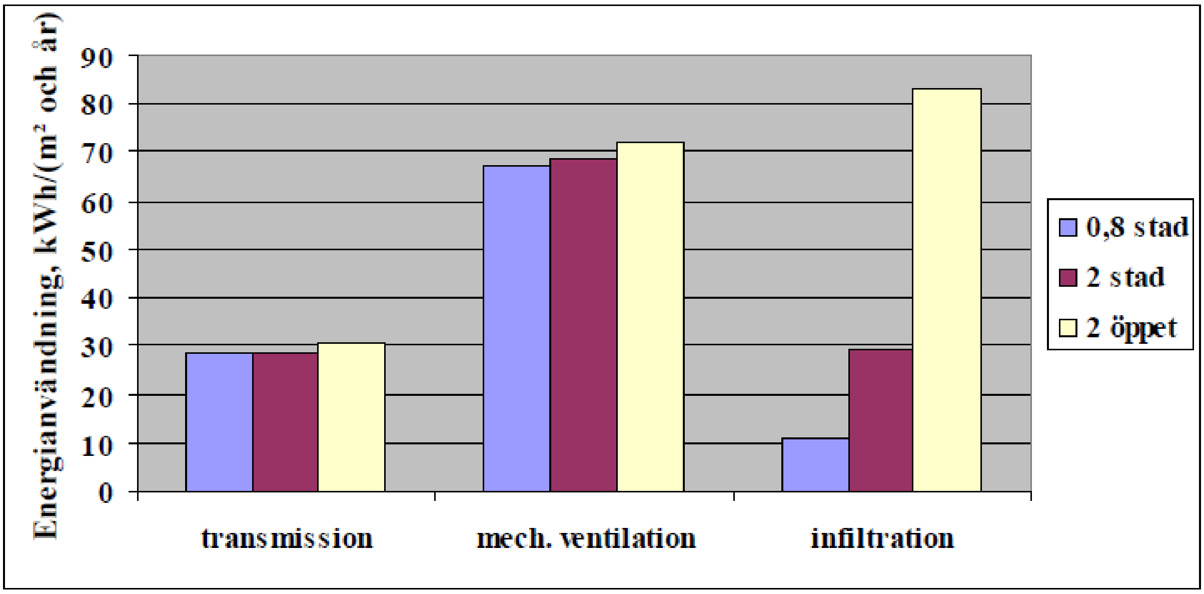

Figure 3.2 Energy losses due to transmission, mechanical ventilation and infiltration for an apartment block with two different leakage rates of 2.0 l/sm², and 0.8 l/sm², placed in areas with a different degree of wind protection (city, and open landscape),(Sandberg & Sikander, 2004).

Air leakages might also cause thermal discomfort due to draft and infiltration of cold air. Also leakages might result in an unintended spread of pollutants resulting in a decreased air quality as well as increasing the risk for moisture damages if there is an exfiltration of moist air.

There are several positions in the building envelope that are particularly sensitive to air leakage:

-Joints between building parts (floor slab- wall, wall- wall, window- wall etc)

-Penetrations for ductwork, pipes or cables

-Joints in the vapour/wind barriers.

4 Measured air leakages

Table 4.1 shows the input data of the tested room. Table 4.2 summarizes the results from the blower door measurements, expressed with different quantities for the air flow at 50 Pascal pressure difference. The air permeability, q_{50} (l/sm^2), value is expressed both per the total envelope area of the pressurized space and per area of the exterior walls. The table also gives the flow coefficient and exponent for calculating the air flow according to the power law (Equation 4.1). The correlation coefficient express how good the curve fit is (closer to 1 is better).

$$V = C \cdot \Delta P^n \tag{4.1}$$

Figures 4.1 and 4.2 visualises the air flows at 50 Pascal, V_{50} (m^3/h), and the leakage curve (according to equation 4.1) before and after "Renoveringssockeln" was mounted.

Table 4.1 Info on tested apartment. Dimensions refer to kitchen dimensions only.

Address	Julias gata 103, lgh 1327 422 51 Hisings Backa
Building year	1969-71
Floor nr	4
Floor area	13.3 m²
Volume	33.4 m³
Envelope area towards exterior	11.5 m²
Total envelope area	64.2 m²
Length of exterior wall	4.6 m

Table 4.2 Measured air flow from blower door test performed at depressurization and depressurization before and after "Renoveringssockeln" has been mounted

	Airflow at 50 Pascal					**Building leakage Curve**		
Name	V50	n50	w50	q50_tot	q50_ext	C	n	
Description	Air flow	Air changes per hour	Flow per floor area	Flow per total envelope area	Flow per exterior envelope area	Flow Coefficient	Exponent	Correlation coefficient
Unit	m³/h	1/h	l/(s*m²)	l/(s*m²)	l/(s*m²)			
Depressurization before	150 *(± 0.6%)*	4.5	3.1	0.65	3.6	11 *(± 7.7%)*	0.67 *(± 0.02%)*	0.997
Pressurization before	165 *(± 0.7%)*	5.0	3.5	0.71	4.0	13 *(± 9.4%)*	0.65 *(± 0.03%)*	0.996
Depressurization after	141 *(± 0.4%)*	4.2	3.0	0.61	3.4	10.6 *(± 5.8%)*	0.66 *(± 0.02%)*	0.998
Pressurization after	158 *(± 0.9%)*	4.7	3.3	0.68	3.8	13.5 *(± 11.7%)*	0.63 *(± 0.03%)*	0.993

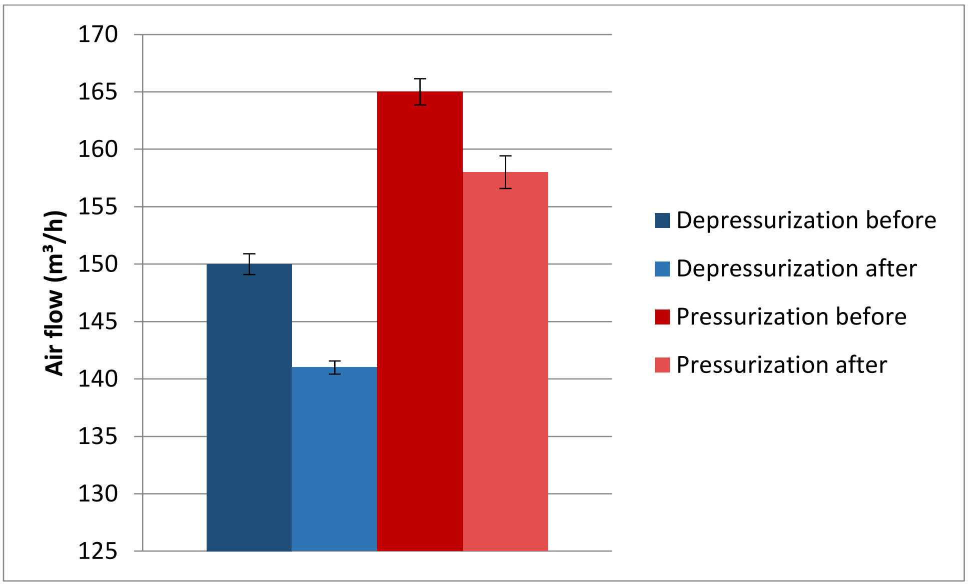

Figure 4.1 *Air flows measured at 50 Pascal for pressurization and depressurization before and after "Renoveringssockeln" has been mounted.*

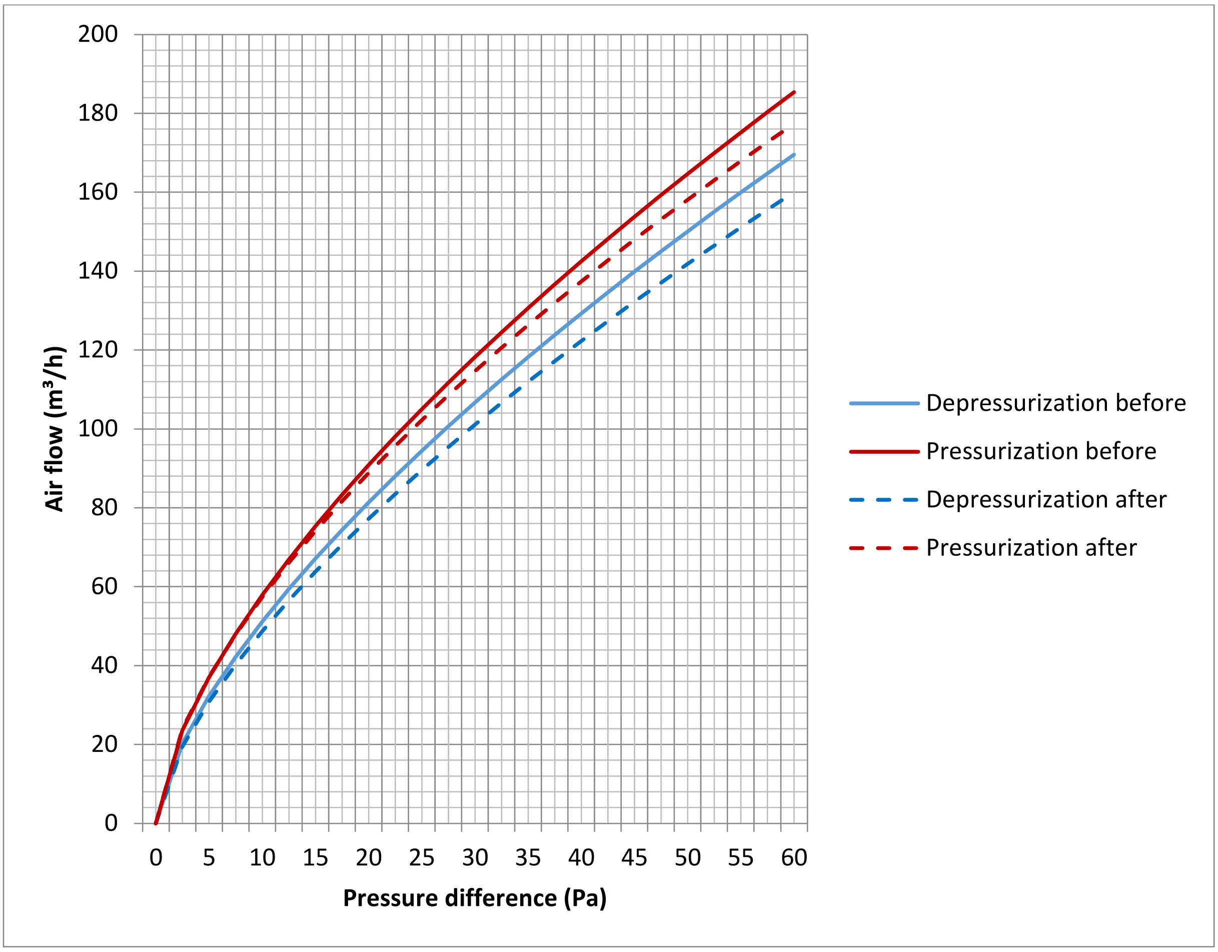

Figure 4.2 *Leakage curve fitted to measurement results according to Equation 4.1. The figure shows leakage curve for depressurization and pressurization before and after "Renoveringssockeln" has been mounted.*

5 Decrease in air flow

If the leakages prior to the mounting of “Renoveringssockeln” are assumed to be evenly distributed over all wall areas (no leakage through floor or roof), then 31% of the air flow passes through the exterior wall. Due to the uncertainty of this assumption, the result for exterior wall air leakage 31% ± 10% is calculated. The decrease in air flow through the exterior wall, after mounting the “Renoveringssockeln”, is shown in Table 5.1.

Tabell 5.1 Calculated decrease in air flow through the exterior wall. Air flows are calculated from the average value of over pressure and under pressure at a blower door test.

Amount of air flow before mounting the “Renoveringssockeln” that is assumed to pass through the exterior wall (31% ± 10%)	21%	31%	41%
Air flow through exterior wall, before mounting, at 50 Pa (m^3/h)	33,1	48,8	64,6
Air flow through exterior wall, after mounting, at 50 Pa (m^3/h))	25,1	40,8	56,6
Decrease in air flow	24%	16%	12%

6 Mounting time

“Renoveringssockeln” was mounted along the exterior wall of the tested room which has a total length of 4.6 meters. Because of the short and irregular length mounted, the noted mounting times should be seen as a rough estimate of the actual mounting time.

The time taken in the sealing of the old skirting board was measured to be 1 minute and 10 seconds per metre skirting board and the time taken in cutting and mounting the “Renoveringssockeln” skirting board was measured to be 3 minutes and 15 seconds per metre. This gives a total of 4 minutes and 25 seconds per meter fully mounted.

It should also be noted that the sealant requires 30 minutes standing time before the mounting of “Renoveringssockeln” skirting board.

7 Energy demand for heating related to infiltration

The energy demand for heating related to infiltration before and after the installation of the “Renoveringssockeln” skirting board was estimated for a representative apartment block in the Gothenburg region of Sweden, with moderate shelter coverage and the dimensions 10 x 50 x 7.5 m over a full year. The estimation was made the according to the AIM-2 model as set forth by Walker and Wilson (1998).

The inputs for the model were extrapolated from the blower door test data. As the flow power law exponent, *n*, was assumed to be a constant value of 0.66 for all leakages in all tests (for this reason only the depressurization tests are considered), the total leakage power law coefficient, C_{tot}, is the sum of the power law coefficients for all leakages, *C*. Before installation of the “Renoveringssockeln” skirting board, 31% of the leakage flow during the blower door test was assumed to pass through the exterior wall of the tested room. This assumption is based on a brief leakage investigation. A corresponding *C* value was then found per metre run of exterior wall. This data was applied to the representative apartment block in the AIM-2 model, along with assumed C values for ceiling and floor leakages (10% leakage through the ceiling and 0% through the floor), to calculate a C_{tot} value for the entire exterior surface area before the installation of the “Renoveringssockeln” skirting board.

The total leakage flow through all surfaces except the exterior wall was assumed to remain constant between blower door tests before and after the installation of the “Renoveringssockeln” skirting board. Therefore all changes in leakage flow before and after installation are attributed to the exterior wall. This in turn alters the *C* value per metre run of exterior wall and so the C_{tot} value for the representative apartment block in the AIM-2 model.

Because of the high level of uncertainly involved in the assumption of the leakage flow through the exterior wall during the blower door test before installation of the “Renoveringssockeln” skirting board, the *C* value per metre run of exterior wall is also calculated for an assumption that 21% or 41% of the total leakage flow passes through the exterior wall.

Table 7.1 shows the total yearly energy demand per floor area for heating related to infiltration (kWh/m²·y) before and after the installation of the “Renoveringssockeln” skirting board.

Table 7.1 Total yearly energy demand for heating related to infiltration before and after installation of the “Renoveringssockeln” skirting board for a representative apartment block with the AIM-2 method.

Presumed percentage of infiltration through exterior facing wall during blower door test before the installation of the “Renoveringssockeln” skirting board (%)	Total yearly energy demand for heating related to infiltration in AIM-2 model		Potential energy saving (kWh/m²·y)	Decrease in energy loss caused by air leakage (%)
	Före montage (kWh/m²·y)	Efter montage (kWh/m²·y)		
21	41	31	10	23
31	70	59	11	16
41	102	90	12	12

8 Conclusion

If 31% ± 10% of the leakage flow measured before the installation of the “Renoveringssockeln” skirting board is assumed to go through the exterior facing wall during the blower door tests on the test room:

- the decrease in leakage flow through the exterior wall due to the installation of the “Renoveringssockeln” skirting board is between 12% and 24%.

- the decrease in the total yearly energy demand for heating related to infiltration for a representative apartment block of the dimensions 10 x 50 x 7.5 m due to the installation of the “Renoveringssockeln” skirting board is between 12% and 23% (as per the AIM-2 model).

These values should only be used as a general indication of the reduction in the leakage flow and total yearly energy demand for heating related to infiltration due to the installation of the “Renoveringssockeln” skirting board. The magnitude of these values is fairly speculative due to the limited test data available and the assumptions made in the evaluation process.

9 References

EN 13829, 2000. *Thermal performance buildings- Determination of air permeability of buildings- Fan pressurization method*, European standard. European Committee for Standardization, CEN.

List & Inredningsbolaget, 2014. www.renoveringssockeln.se

Sandberg, P. I. & Sikander, E., 2004. *Lufttäthetsfrågorna i byggprocessen- Kunskapsinventering, laboratoriemätningar och simuleringar för att kartlägga behov av tekniska lösningar och utbildning*, Borås: SP Sveriges Provnings- och Forskningsinstitut.

Walker, I. & Wilson, D., 1998. *Field Validation of Algebraic Equations for Stack and Wind Driven Air Infiltration Calculations,* ASHRAE HVAC&R Research Journal, Vol. 4, No. 2.