

EFFECT OF MEASUREMENT LOCATION OF AIR AIR-TIGHTNESS PERFORMANCE ON APARTMENT UNITS IN KOREA

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ABSTRACT

The purpose of this study is to evaluate the effects of measuring position of air-tightness performance in Flat-type and Tower-type apartments. Air-tightness performance was measured on entrance doors using the Blower Door System in accordance with CAN/CGSB 149 and on the windows using air-tightness Measuring (KNS-serise) in accordance with JIS A 2201. The air-tightness test was performed with newly built apartments in 2011. The air-tightness test results on location were converted into ACH50 for comparison. The result on the windows was higher compared to the result of the entrance door. According to the results, the entrance door has greater air-tightness performance than the window which has less air-tightness. In conclusion, it is appropriate to take measurements of air-tightness performance on the windows of apartments in Korea

KEYWORDS

Airtightness, Field studies, Measuring Position, Apartments

INTRODUCTION

Recently, there is an increase in air-tight and high insulation construction material being used in order to save energy. Accordingly, the airtightness of materials applied to the exterior of buildings is becoming increasingly important. Korea's apartment housing are generally constructed using a wet-construction method into flat-type and tower-type buildings. Compared to the probability of leakage or infiltration from gaps in the building structure, the probability of leakage or infiltration from windows, front doors, construction material itself or copula is much higher. This study has used the airtightness performance measurement method that is most used worldwide, the fan pressurization / depressurization method, on Korean apartment buildings to measure the airtightness performance of houses from various locations within the house and analyzed the airtightness performance based on the position of the measurement equipment.

MEASUREMENT EQUIPMENT AND METHOD

Air-tightness Measurement Equipment

This study applied “ISO 9972 (Thermal performance of buildings - Determination of air permeability of building-Fan Pressurization method)” as the air-tightness measurement standard. Table 1 show on site pictures of the equipment used when measuring air-tightness. The two methods shown here are similar to the measurement method where the air volume under fixed differential pressure levels is measured to measure air-tightness performance. The Blower Door System is a measurement equipment that is generally installed on the entrance door and measures the air volume depending on the rotation count of the fan and shows air-tightness performance results in accordance to ISO 9972^[2], ASTM E779 and CGSB-149. KNS-serise is a measurement equipment that is installed on small windows in the kitchen or entrance door which measures the air volume by the differential pressure sensor installed on the whole blower and shows air-tightness performance results in accordance to Japan’s JIS A 2201^[3]. Blower Door System was installed on the entrance door while, the KNS series were installed on the small windows in kitchens. The depressurization measurement method was in accordance to ISO 9972.

Content	Blower Door System	KNS-serise
Equipment		
Measurement Flow Rate	34 ~ 10,700 m ³ /h	1 ~ 9,999 m ³ /h
Measurement Pressure	± 1,250 Pa	± 147 Pa
CODE	ISO 9972, ASTM E779, CGSB-149	ISO 9972, JIS A 2201
Equipment position	entrance door	Window

Table 1. Airtightness Measurement Equipment

Description of the apartment

Air-tightness performance was measured in 36 apartment houses among 6 complexes that were to be lived in starting 2011. Complexes A, B, C and D had mechanical ventilation equipment while complexes E and F had natural ventilation equipment. The table below shows an outline of the air-tightness measurement subject complexes.

Content	A (Daejeon)	B (Pusan)	C (Bucheon)	D (Seoul)	E (Suwon)	F (Daejeon)
Measured units	6	6	6	6	6	6
Floor space	132m ²	84m ²	84m ²	115m ²	51m ²	84m ²
Number of floors	21	23	17	26	15	22
Ventilation systems	mechanical ventilation	mechanical ventilation	mechanical ventilation	mechanical ventilation	natural ventilation	natural ventilation

Table 2. Outline of the apartment buildings subject to measurement.

Comparative analysis of test result

Generally, air-tightness is expressed as CFM50, ACH50, EqLA, ELA and etc. in literature in and out of Korea. There are small differences in measurement equipment, standard pressure differences and detailed application methods within different literature. However, in general they have similar concepts or rules based on the differential pressure measurement method.

The Blower Door System can find ACH50, EqLA (10Pa), ELA (4Pa) and more which show the rate of ventilation at differential pressure 50Pa. On the other hand, KNS serie shows the amount of ventilation (Q) at the standard differential pressure 9.8Pa measured at JIS A 2201's standard differential pressure levels. This study used Equation (1) to convert the amount of ventilation measured by the equipment stated above into the amount of ventilation at 50Pa to find ACH50 (h⁻¹) per house.

$$Q = C(\Delta P)^n \quad (1)$$

RESULTS

The comparison of average air-tightness performance of Korean apartment buildings with air-tightness performance of major developed countries^{[5],[6]} can be shown as in the figure below. The average ACH50 of the 6 complexes subject to the air-tightness test was 2.89 h⁻¹ when the Blower Door System (BD) was used and 3.12 h⁻¹ when the KNS series (KNS) was used. Compared to the air-tightness performance of major developed countries such as the US, Japan, France, Czech Republic and etc. the results were relatively satisfactory. However in comparison to countries such as Norway, Germany, Finland and Canada, the results were somewhat low.

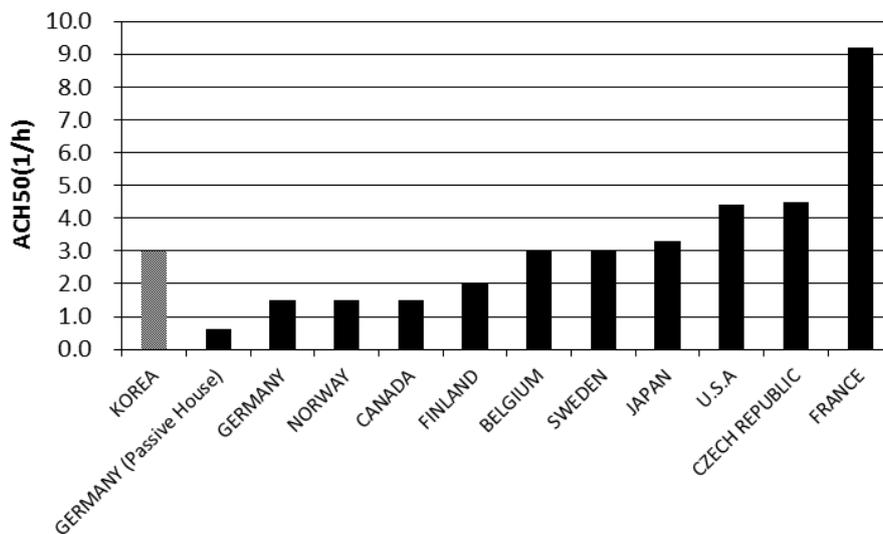


Figure 1. ACH50 Measurement results (Three-sided exposure appear on the outside)

One representative flat surface type house (2 or 3 sides exposed to the outside) from each of the subject apartment complexes was chosen and one house from each of the low, middle and top floors in the same vertical line were chosen. A total of 33 houses were measured and after comparing and analyzing these houses, the total air-tightness measurement value was converted into ACH50 and is shown in Fig. 1. Because the areas of the representative houses of each complex are different, the air-tightness performance measurement values were different. Comparing the air-tightness performance measurement values of the low, middle and top floors, it could be seen that air-tightness was generally higher or similar in the top floors compared to the low floors and a few houses showed different results.

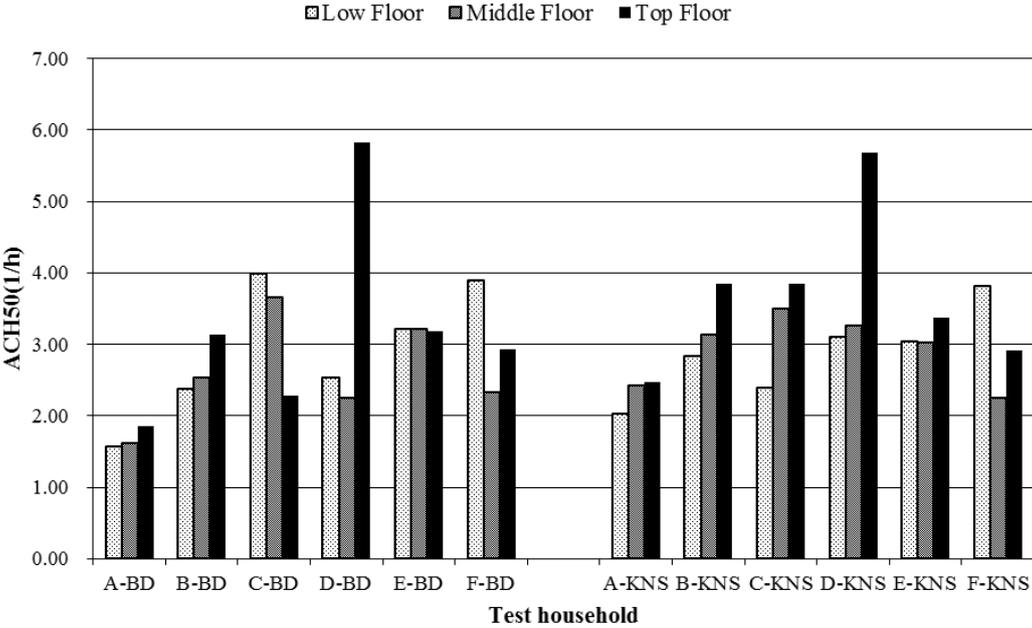


Figure 2. ACH50 Measurement results (Two-sided exposure appear on the outside).

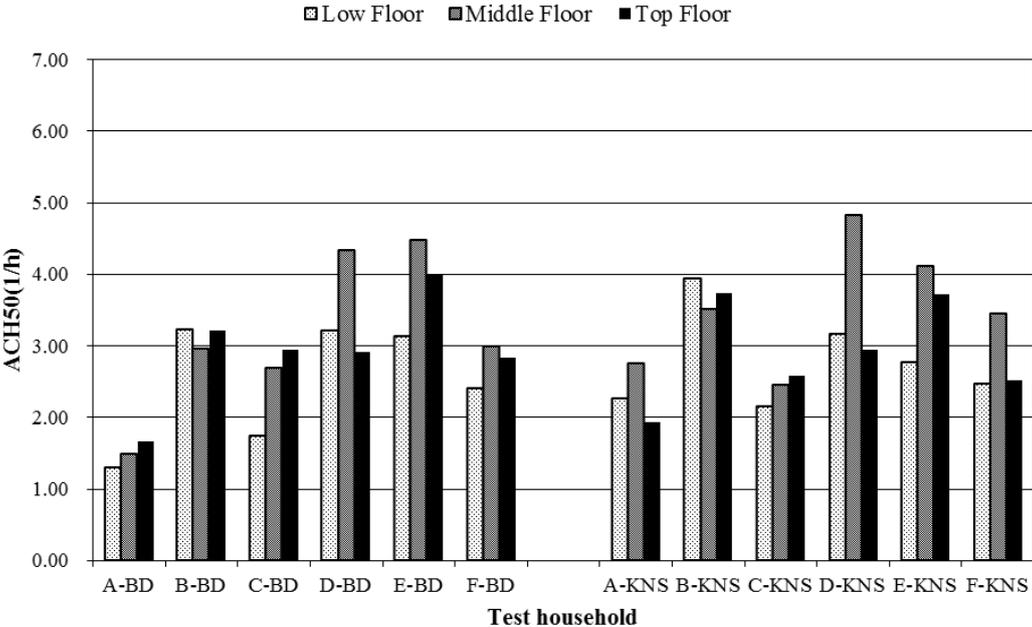


Figure 3. ACH50 Measurement results (Three-sided exposure appear on the outside)

In addition, in apartment D, where houses had two sides exposed to the outside, the top floor measured using the BD was extremely high compared to the other measurement values. This is most likely because the top floor has the highest altitude and is exposed to the outside through the ceiling. The average ACH50 values of the different houses based on the installation position of the measurement equipment is shown in the table below. Comparing the ACH50 values of the BD installed in the entrance door and the KNS series installed in the kitchen windows, it can be seen that the KNS series values were higher in four complexes compared to the BD values. The BD ACH50 for apartments E and F had a tendency of being about $0.06 \text{ ACH50 h}^{-1}$ higher than the KNS series values but this difference is considered to be insignificant.

Content	A	B	C	D	E	F
Measuring at entrance door (BD)	1.68	2.69	3.31	3.54	3.21	3.06
Measuring at Window (KNS)	2.31	3.28	3.25	4.03	3.15	3.00

Table 3. Comparison of average ACH50 (Two-sided exposure appear on the outside)

Content	A	B	C	D	E	F
Measuring at entrance door (BD)	1.49	3.14	2.46	3.49	3.88	2.75
Measuring at Window (KNS)	2.32	3.74	2.40	3.65	3.54	2.82

Table 4. Comparison of average ACH50 (Three-sided exposure appear on the outside)

CONCLUSION

This study analyzed the air-tightness performance of 36 houses in 6 apartment complexes built in Korea depending on the location of the air-tightness measuring equipment and the following conclusion was derived. The air-tightness performance of Korean apartments is on average $\text{ACH } 50 \text{ } 3.01 \text{ h}^{-1}$, indicating that it is similar to the North European countries with relatively weak external environments.

Of the 7 apartment complexes, after carrying out air-tightness performance tests on one house each in the the low, middle and top floors - all vertically aligned – it could be seen that an increase in height led to a slight increase in ACH50 although the difference was insignificant. In addition, air-tightness analysis on houses with 2 sides exposed to the outside and hoses with 3 sides exposed to the outside showed that showed that houses with 2 sides exposed to the outside had higher ACH50 values to a certain degree compared to houses with 3 sides exposed to the outside.

Air-tightness performance measuring equipment was installed to the entrance door and kitchen window which are expected to have the largest influence on the infiltration or leakage of an apartment house and comparison experiments were carried out. Results show that apartments A, B and D have high measurement values when the airtightness performance

equipment was installed on the windows. This is because the air-tightness performance of A, B and D's entrance doors were relatively lower. In the case of the other three complexes, there was no significant difference between the values from the Blower Door System or the KNS series. This is because the air-tightness performance of the front doors of these three complexes were high.

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