Air Leakage Tests for the requirements of the LEED in two high-rise residential buildings

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Abstract

Air leakage test was carried out according to ASTM E779-03, Standard Test Method for Determining Air Leakage Rate by Fan Pressurization to meet the requirements of the LEED-NC v2.2(EQp2). Air leakage tests for quality assurance can be performed once all work on the air barrier has been completed and all windows and doors have been installed in two high-rise residential buildings. Test units selection was carried out in accordance with the following guidance, California's 2001 Energy Efficiency Standards. That is, 1 in 7 dwelling units was sampled, and dwelling units were grouped for testing according to unit size and type. Finally, we completed pressurization and de-pressurization tests for 240 residential units and the final readings were a level of 0.87 square cm per square meter of surface area or less.

Keywords: Airtightness, Blower door, LEED, Residential Building

Test building descriptions

Two high-rise residential buildings in Korea are selected as the test buildings for airtightness measurements. Both buildings are now constructed and have similar types of inter-walls and

slabs. But there is a quite difference in the exterior walls; one is a curtain wall system, the other is a punched window. These residential buildings are similar to tower shaped-office buildings in various aspects; they generally have a central core, elevator shafts and stairwells, are surrounded by corridors, and have 4 to 5 residential units on each floor. General information regarding these two buildings is given in Table 1.

Table 1 Test building summaries

Classification	A	B
Building address	Yeonsu-gu, Incheon, SOUTH KOREA	
Number of stories	2 basements , 47 stories	2 basements , 11~33 stories
Test date	Feb. 2010 ~ Jun. 2010	Apr. 2010 ~ Sep. 2010
The estimated year of construction	Nov. 2010	Dec. 2010
Ventilation system	balanced ventilation	
Air view		

Test method and conditions

Dwelling unit air infiltration performance shall be tested to required standards as outlined in LEED-NC Reference Guide under EQp2 Option 3. Dwelling units must be constructed to a level of air infiltration performance such that blower door testing carried out in accordance with ASTM E779-03 results in readings of air infiltration at a level of 1.25 square inches of leakage area per 100 sq. ft. of surface area or less (0.87 square cm per square meter of surface

area). Both “Preliminary” and “Final” Blower Door Testing shall be performed to full test requirements as described in ASTM E779-03 “Standard Test Method for Determining Air Leakage Rate By Fan Pressurization” Should any units fail the Blower Door Test procedure – to exceed allowable air leakage parameters as outlined herein (excluding “preliminary” Blower Door Testing) – the re-testing procedure for failed units shall adhere to the requirements as outlined in the Residential Manual for Compliance with California’s 2001 Energy Efficiency Standards, Chapter 4 “Compliance Through Quality Construction.” Pressure differential testing shall be required where entry doors into dwelling units from common corridors are not weather-stripped. Pressure differential testing shall be required to demonstrate a pressure differential of an average of 5Pa and at all times at least 1Pa as measured at 10 second intervals for a 15 minute period of time. Testing shall be performed as per test conditions outlined in the LEED-NC v2.2 Reference Guide (Second or Third Editions). Test shall be based on “worst case conditions” of transport of air from dwelling unit to adjacent spaces, with all entry doors and windows closed. Testing shall be performed as per previously described sampling methodology, and can be performed on same units identified for “Final Blower Door Testing.”

The envelope air tightness test was carried out in accordance with the following standards: ASTM E779-03 "Standard Test Method for Determining Air Leakage Rate by Fan Pressurization" The building was pressurized and depressurized using a blower door system. The blower door system comprises of a portable fan capable of supplying 40,776/hr at 50 Pascal's. The fan was set up in the entrance door of the test residential unit. Pressure differences across the fan and the building were measured using a digital manometer (Retrotec DM-2A) at the start, during and the end of the test. Air temperatures were measured using a Data Logger TH-101. Measurements were taken at the start and end of test. Wind

speeds at the start and end of the test were measured using a TESTO 445. Barometric pressure readings were taken using a PTB220 Class A.

Table 2 Test equipments

Equipment Type	No.
Blower door set: Retrotec 2200 Fan	2
Blower door set: Retrotec 3300SR Fan	3
Retrotec DM 2A Manometer	3
Digital thermometer: Data Logger TH-101	3
Multi-function meter: TESTO445	1
Digital barometer: PTB220 Class A	3
Smoke generator	1
Notebook	3
2-way radios	6

Table 3 Openings and temporary sealing conditions

Detail	Response
All external door and windows	Closed
All internal doors	Open
All extracts (check kitchen and bathroom(s) extracts and the oven hood)	Sealed
All drainage traps (check all toilet sinks)	Sealed
Combustion appliances	Off
Ventilation openings	Sealed
Dryer	No

Fig. 1 Supporting photos of the air leakage test

Fig. 2 Supporting photos of the temporary sealing

Checking test limits

Section 8.4 of the ASTM E779-03: The product of indoor-outdoor temperature difference and building height must be less than 200m℃. In this case, the building is a dwelling house with a floor to ceiling height of 3.1m (4.8m for penthouse). The indoor-outdoor temperature

difference during the test is 1~7℃. Multiplied together, these temperature difference give 3.1m × (1~7℃) = 3.1~21.7m℃ (4.8m × (1~7℃) = 4.8~33.65m℃ for penthouse), therefore, this test passed. The average wind speed is 1m/s or less, and the average outdoor temperature is 15℃, thus meeting the specifications of 8.5 of the ASTM E779-03. Ten pressure difference and flow measurements are made between 10 and 60 Pa, thus meeting the requirements of 8.10 of the ASTM E779-03.

Test units selection

Test units selection was carried out in accordance with the following guidances: 'Reference Guide - Blower Door Test' and 'California's 2001 Energy Efficiency Standards, Chapter 4, Compliance Through Quality Construction'. That is, 1 in 7 dwelling units was sampled, and dwelling units were grouped for testing according to unit size and type.

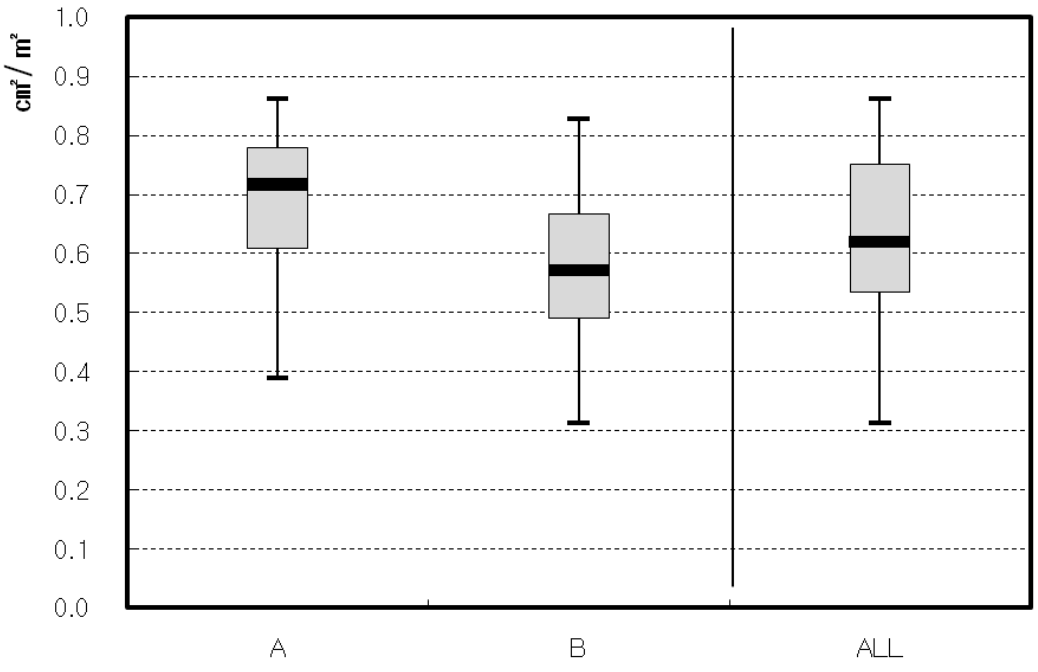

Fig. 3 Airtightness results

Conclusions

Air leakage tests of two high-rise residential buildings were carried out according to ASTM E779-03 "Standard Test Method for Determining Air Leakage Rate by Fan Pressurization" to meet the requirements of the LEED-NC v2.2(EQp2). Air leakage tests for quality assurance can be performed once all work on the air barrier has been completed and all windows and doors have been installed. Finally, we completed pressurization and de-pressurization tests for 240 residential units and the final readings were a level of 0.87 square cm per square meter of surface area or less which are the 'pass'.

Acknowledgments

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