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A Study on Temperature Distribution Property Evaluation of the Exterior Wall of Apartment Housing using Thermography Technique

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Abstract. This study, with the aim of evaluating thermal insulation performance of the exterior wall, measured the exterior wall surface temperature of a total of 25 apartment buildings and analyzed the temperature difference(⊿T) from the outdoor temperature. As a result of the analysis, it was found that the average ⊿T of an apartment building with the elapse of more than 25 years after its completion was 3.4℃ while ⊿T of the apartment building with less than 10 in the number of lapse years was analyzed to be 1.9℃. In addition, according as ⊿T was analyzed to increase by about 0.4℃(13.5%)on an average at an interval of 5 years after the year of completion, the increase in ⊿T consequent on the number of the elapse years was judged as the decline in thermal insulation performance due to physical performance change of the exterior wall.

Keywords: Infrared Camera, Exterior Wall Surface Temperature, Apartment Housing, Thermal Insulation

1 Introduction

The thermal insulation performance of the existing building exterior wall is lower than the present on the basis of the legal insulation design standard and the degree of precision in construction at the time of planning. Along with this, according to time flow after completion, the physical changes in the wall structure are evaluated to lower thermal insulation performance.

Accordingly, this study evaluated the deteriorating insulation performance of the exterior wall due to physical performance changes consequent on the number of the elapse years by measuring & analyzing the difference(hereinafter, referred to as "⊿T") between the outdoor temperature and exterior wall surface temperature targeting the representative type in Korea, i.e. apartment housing among the residential buildings.

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2 Method

2. 1 Object for Measurement & Analysis Range

As the object for measurement, this study selected a total of 25 apartment buildings located in the same district(Seoul, Incheon, Gyeonggi-Do Province),whose legal thermal insulation standard was the same, by taking into account the optimal distribution frequency of the number of buildings by the year of completion.

As for the analysis range, this study limited the range to the exterior wall on the side of the mid-level (5F~10F) excluding the lower level where it's difficult to grasp the temperature distribution of the whole wall surface due to the influence of its surrounding environment and the upper level where measurement error occurrence was big due to the measurement distance. The following Figure 1 shows the appearance of measuring the exterior wall surface temperature using the Infrared thermographic camera (FLIR-T620).

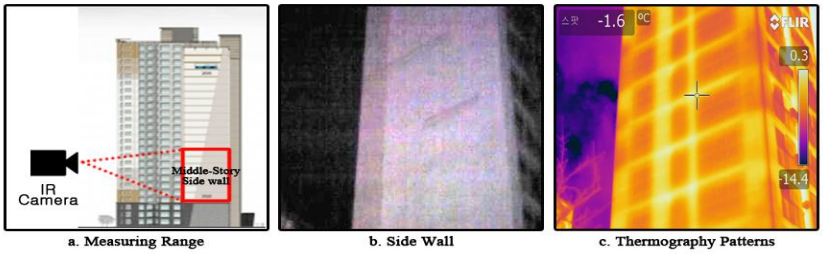

Fig. 1. Analysis Range and Surface Temperature Measurement

2. 2 Measurement & Analysis Range

This study measured the surface temperature of the exterior wall of apartment buildings using the Infrared thermographic camera that made it possible to capture the temperature distribution at a time, and used a Digital measuring instrument to measure the outdoor temperature, indoor temperature, humidity and wind velocity.
This study carried out the Infrared thermographic measurement method in according with the standard of KS F2829(2005)suggested by the Korean Standards Association on the basis of ISO 6781 Standard, and the detailed measurement conditions reflecting this are shown in the following Table 1.

Table 1. Overview of Measurement Date

Date	2015.02.01 ~ 2015.02.28
Time	AM 00:00 ~ 06:00
Weather conditions	Day when the difference between indoor and outdoor temperature was at least 10℃
	Day when the wind speed was below 3m/s
	Day when the amount of clouds was below 7 (clear)

	Excluding rainy or snowy days and the next day

3 Analysis Result

3.1 Measurement of Exterior Wall Surface Temperature

According to the analysis range and evaluation method already presented, the following Figure 2 indicates the measurement result of the outdoor temperature and exterior wall surface temperature at the time of measurement by object(25 apartment buildings) for measurement.

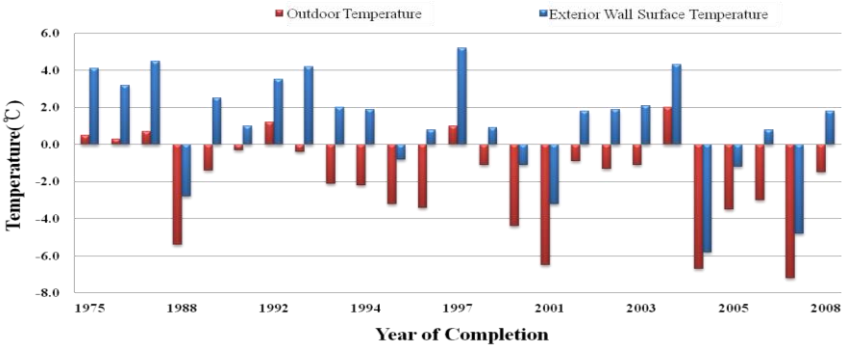

Fig. 2. Outdoor Temperature & Exterior Wall Surface Temperature Measurement Result

As a result of the analysis, the surface temperature of the exterior wall among all objects for measurement was found to be higher than outdoor temperature, and it was analyzed that ΔT of the apartment building whose elapse year was more than 20(before 1995) was 4.6℃(Average ΔT 3.2℃)to the maximum while ΔT of the apartment building, whose lapse years was less than 10, was 3.8℃(Average 1.9℃) to the maximum. Accordingly, the thermal insulation performance of the exterior wall was judged to deteriorate due to the physical performance changes of the exterior wall consequent on the elapse years after completion.

3.2 ΔT Analysis consequent on Elapse Years

The difference between the outdoor temperature and exterior wall surface temperature comes to occur due to no other than the difference in thermal insulation performance of the exterior wall, and in the light of such a property, it is officially announced that the thermal insulation performance of the exterior wall should be planned and constructed more than the standard heat transmission coefficient in point of law.

The following Table 2 shows the classification of the year of completion of the object for measurement(25 apartment buildings) in 5 years' interval by group, and

Figure 3 indicates legal thermal insulation design revision standard and the average ⊿T analysis result of the exterior wall.

Table 2. Classification of the Objects for Measurement by the year of Completion

Classification of the year of Completion by group(5 years' interval)						
Object for Measurement	A group	B group	C group	D group	E group	Total
Year of Completion	Before 1989	1990~1994	1995~1999	2000~2004	2005~2009	
Buildings	5	5	5	5	5	25

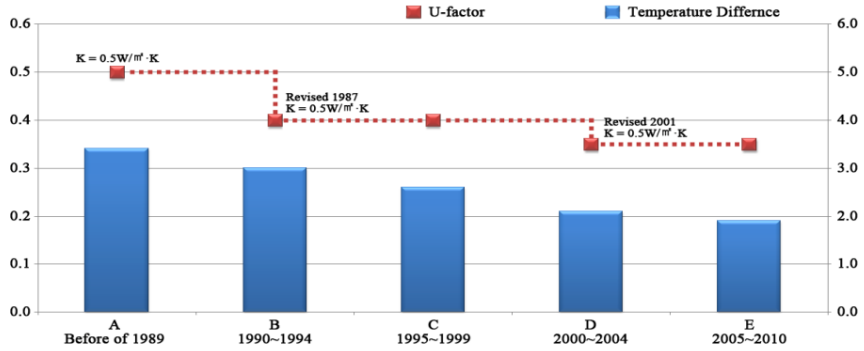

Fig. 3. Average ⊿T Analysis Result by Completion Year Group

As a result of analysis, the average ⊿T of the apartment building belonging to A, B, C, D, and E Group(Table 2) was found to be 3.4℃, 3.0℃, 2.6℃, 2.1℃, and 1.9℃, respectively, it was analyzed that about 0.4℃ increased at 5 years' interval of the year of completion.

In the legal standard heat transmission coefficient of the exterior wall on the side, the apartment building belonging to E Group(2005~2010) was found to be 0.35W/㎡·K, being intensified in its thermal insulation performance by 30% over the apartment building belonging to A group(before 1989, 0.5W/㎡·K). However, the average ⊿T of the A-group apartment building, whose elapse year after completion was more than 25, was analyzed to be higher than E-group apartment building(less than 10 years' elapse after completion)by about 44.1%, through which this study judged that the physical change of the exterior wall structure increased the thermal insulation performance deterioration rate in comparison with the legal standard intensification rate due to changes in the elapse years besides thermal insulation performance deterioration due to the difference in the legal thermal insulation design standard at the time of building planning.

4 Conclusion

This study analyzed the difference in the temperature(⊿T) between outdoor temperature and exterior wall surface temperature for the purpose of evaluating the thermal insulation performance of the exterior wall consequent on the elapse years targeting apartment housing, and major research results are as follows:

As a result of measuring the surface temperature of the exterior wall through the thermographic camera, the surface temperature was found to be higher than that of outdoor, and its maximum ⊿T was analyzed to be 4.6℃. In addition, as the average ⊿T by completion year group(Table 2) of the object for measurement was analyzed to increase by about 0.4℃ at 5 years' interval, thermal insulation performance was found to deteriorate due to the physical change of the exterior wall consequent on the elapse year.

Accordingly, it is judged that the thermal insulation performance of the exterior wall deteriorates due to changes in the elapse years of insulation materials consequent on the number of elapse years, the wet condition of the exterior wall, and cracks, etc.

Conclusively, this study thinks that it's necessary that follow-up research should deal with the evaluation of the thermal insulation performance, which deteriorates due to the physical changes of the exterior wall structure, and thermal insulation performance evaluation by area of the whole exterior wall of a building, through which the later research should be focused on how to arrange the legal basis for thermal insulation performance intensification and plan for reinforcement of the thermal insulation performance of the existing buildings.

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