Development of method to evaluate energy conservation effects of architectural ideas in houses

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1. Introduction

The amount of primary energy consumption is one of the indexes of the housing and building energy conservation standards. The National Institute for Land and Infrastructure Management (NILIM) is developing methods to evaluate the amount of energy consumption in cooperation with the Building Research Institute. This paper introduces the research and development of methods to evaluate ventilation systems which use ground heat in houses as an architectural idea which matches with regional climates. See the Outline of the Architectural Institute of Japan Conference[1] for details.

2. Overview of the system and demonstration of the effect of reducing energy consumed by heating and cooling

The temperature in the underfloor space of a house with insulated foundation becomes higher than the outdoor temperature in winter and lower in summer because of the ground heat. Thus, energy for heating and cooling is expected to be reduced by taking the outdoor air in via the underfloor space because the outdoor air is preheated by the ground heat. This paper refers to such system as the underfloor-based ventilation system (Fig. 1). The test demonstrated that the energy could be cut by 8.4% for heating and 12.9% for cooling (see Table).

3. Overview of the evaluation method

The energy conservation effect of this system depends on the amount of heat that pre-heats the outdoor air sent into a room and the amount of heat that is lost from a room to the underfloor space. These can be easily found when the underfloor temperature is known. Yet, the underfloor temperature varies depending on the ground temperature. Thus, the team created a new formula to estimate the ground temperature[1] and developed a method to evaluate the energy conservation effect of heating and cooling.

4. Reflection of the method to energy evaluations based on energy conservation standards

The evaluation method was reflected in the computation program[2] that was based on energy conservation standards (October 2014). Figure 2 shows the computation outcome of a building where the test was conducted. While the reduction rates may vary because the test was conducted during a limited period, the trend observed in the test was mostly constant.

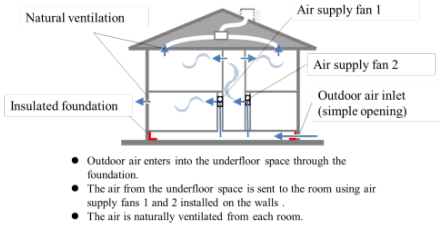

Fig. 1 Overview of the underfloor-based ventilation system

Table Effect of reducing energy for heating and cooling (test result)

	Winter		Summer	
	Type 3 ventilation	Use of underfloor space	Type 3 ventilation	Use of underfloor space
Daily average outdoor temperature (℃)	2.2	2.4	26.4	27.3
Power consumption (kWh)	11.9	10.9	4.2	3.7
Power consumption reduction rate	8.4%		12.9%	

Measured in the test house (total floor area 148.9 m^2) in Higashi Oumi, Shiga, Japan
<Type 3 ventilation> Air supply: natural air supply, Ventilation: Ventilation using fans
<Underfloor-based> Air supply: Air supply using fans, Ventilation: natural ventilation
Measurement period (2013)
Winter: Type 3 ventilation: 2/21-23, Underfloor-based: 2/9-11
Summer: Type 3 ventilation:8/23-25, Underfloor-based: 8/29~31
The power consumption is the total of air conditioners in LDK (living-dining room and kitchen) and bedrooms.

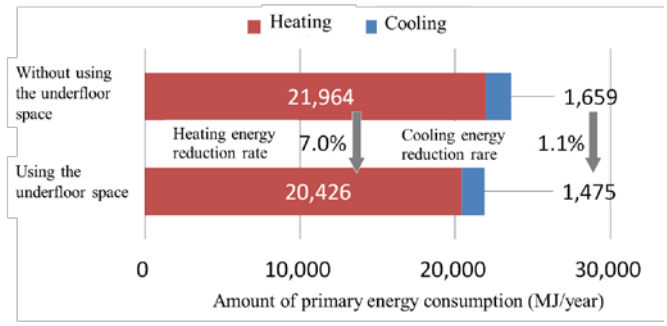

Figure 2. Result of the computation of the energy conservation for heating and cooling in this program

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☞Detailed information

1) Akamine et al. Study of effects to reduce the load of ventilation-style air conditioning using underfloor spaces of houses with insulated foundations (part 1 and part 2) (in Japanese). The Outline of Architectural Institute of Japan Conference. 2014. pp.635-638
2) Energy conservation evaluation program for houses and dwelling units (in Japanese) (Ver. 1.15)http://house.app.lowenergy.jp/