A Research of Detached Houses with Air-Based Solar System Intended to Full Solar Energy Use
Part.1 Abstract of Three Experimental Huts and measurement

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SUMMARY: In these days, there is much more needs for Solar-Energy. In this research, we deal with solar house system with solar heat collector which moves air. There are some important elements, Heat load determined by the skin performance, the amount of heat collector on the roof, and the amount of thermal mass. We built three huts in Hamamatsu City, and we've been trying some study for improving the system. In this report, we introduce the air-based solar system and the abstract of experiment.

Keywords: air-based solar heat system, experiment, heat balance, heat storage

INTRODUCTION

Using solar heat energy has been paid attention to as effective natural energy use. In this survey, we deal with air-based solar heat system, which is used for not only hot water supply but heating and ventilation by hot air. This system works as follows (shown in the Figure 1.),

a) Heating outdoor air by solar collector on the whole roof.

b) Supply heat to water tank by antifreeze fluid which received heat by heat exchanger in the air handling box in the attic.

c) Blow hot air under the floor from the fan in the air handling box.

d) Store heat into the basis concrete under the floor by hot air.

e) Heating the whole room by supplying warm air from the underfloor.

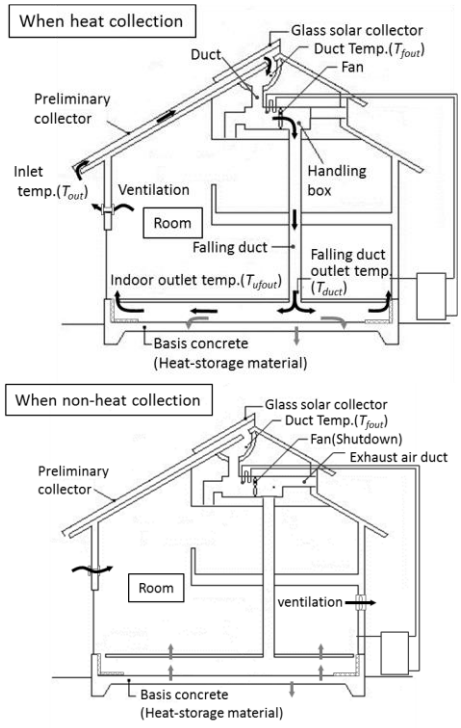

Figure 1. Conceptual diagram of the existing system

In Japan, this system has been quite popular and installed into many buildings, but there is a few survey on the system by precise measurement. Then, we started the survey by building three huts with different specification and measure precise data of these in same weather condition. So we can analyze heat balance in these huts. Heat collection, thermal environment and heat storage are very important in the system. Especially, to use stored heat in night time is difficult because the solar heat is collected in the daytime. We thought there must be many improvements about heat storage. The purpose of this research is to make some suggestion to improve the system by the measurement and simulation.

In this report, we explain the system and the abstract of the measurement.

HEAT BALANCE AND THE POINTS OF IMPROVEMENT

Heat balance of the building with the system

It is important to understand the heat balance in the building with this solar system in order to think about the improvement of the system. The heat balance diagram is shown in the Figure 2.

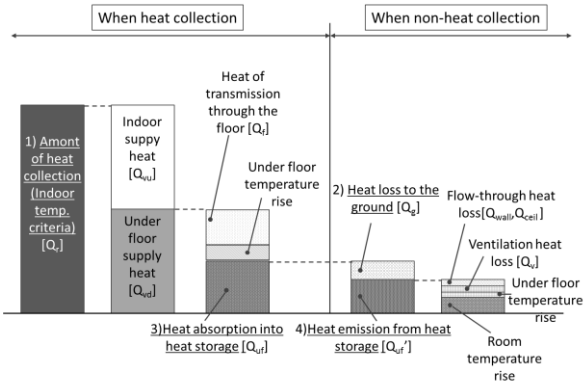

Figure 2. Heat balance of air-based solar system

The points of improvement

There are four points for improvement as follows,

1) Increase the amount of solar heat collection.

2) Decrease the amount of heat loss from the basis concrete as the heat mass to the outdoor air and soil.

3) Increase the amount of heat absorption into the heat storage material.

4) Increase the amount of heat emission from the heat storage material.

SPECIFICATION OF HUTS AND MEASUREMENT

We built three huts in Hamamatsu City in Japan, of which size is same. These huts are equipped with well insulation which fills the energy saving standards in Japan. The specification is shown Table 1. Hut no.1 with the system and air conditioner has no insulation under the basis concrete. Hut no.2 with the system and air conditioner has insulation under the basis concrete. Hut no.3 doesn't have the solar heat system and equip only air conditioner. For example, we can compare the previous system with the improved system at the same time.

Table 1. Specification of experiment huts

Basis concrete	Walls : Width 150 * Height 600mm
	Plane : Thickness180*Width3,790*Length6,520mm
Walls (U-value: 0.335W/m^{2}K)	Color steel plate, PB t=9.5mm, vent layer t=36mm, waterproof sheet, structural plywood t=9mm, High performanceGW16K 100mm, PB t=12.5mm
Floor	Structural plywood 28mm (thermal conductivity : 0.13W/mK)
Ceiling (U-value: 0.361W/m^{2}K)	Structural plywood t=28mm, phenolic foam t=80mm, Air layer 40mm, PB t=9.5mm
Roof (U-value: 0.627W/m^{2}K)	Resin-based roofing t=0.42mm, Structural plywood t=12mm, GW32K t=50mm
South and North windows	Low-E(insulation)glass(3-A12-3, U-value : 1.7W/m^{2}K) +aluminum multilayer・resin composite frame (Solar radiation through south window is shielded)
Insulation under basis concrete	extrusion method XPS 3-B t=50mm (hut no.2,3 only) (Thermal conductivity : 0.03W/mK)
Insulation on basis concrete	Walls : extrusion method XPS 3-B t=50mm
	Outer periphery : extrusion method XPS 3-B t=50mm (Width : 700mm)
Partition door between target room and store room	Plywood t=3mm, GW32K t=25mm, Plywood t=3mm

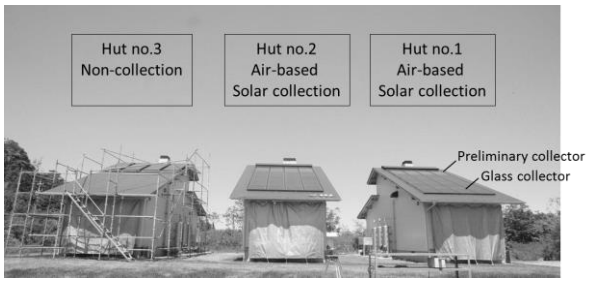

Figure 3. Overview of experiment huts

The measurement was set to analyze the heat balance in the whole huts. Especially, many thermocouples, heat flow sensors, mass flow maters and so on were set in the solar collector, duct space and underfloor. The data was recorded every minute. We confirmed the measurement is very precise and grasp the heat balance in the real situation.

CONCLUSION

We built three experimental huts for improve the air-based solar heat system and surveyed in Japan. We studied the method of increasing heat absorption and emission through the heat storage under the floor. The results of experiments are shown in the next paper.

References

[1] Youngjin Choi et al., "Evaluation of the characteristic of heat flow under the floor in the test buildings in winter". *Journal of environmental engineering (Transactions of AIJ)*, **79,** No.697, 2014, pp. 271-280.

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