PARTIAL INSULATION RENOVATION PROJECT AT JAPANESE TRADITIONAL WOODEN HOUSE

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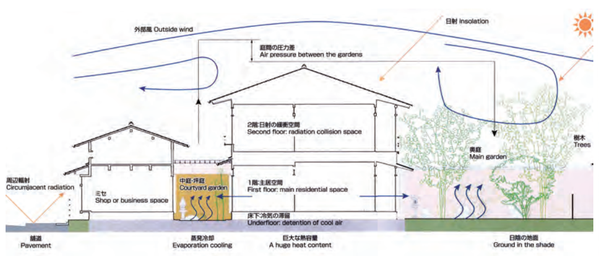
Introduction

Thermal Environment of Japanese Traditional House

- Japanese traditional houses are designed to spend cool in summer by promoting as much wind flow through the house as possible.
- Intermediate spaces (called ENGAWA) are designed to take indoor-outdoor relationships seriously.
- However, the envelopes of these houses have low thermal insulation performance.



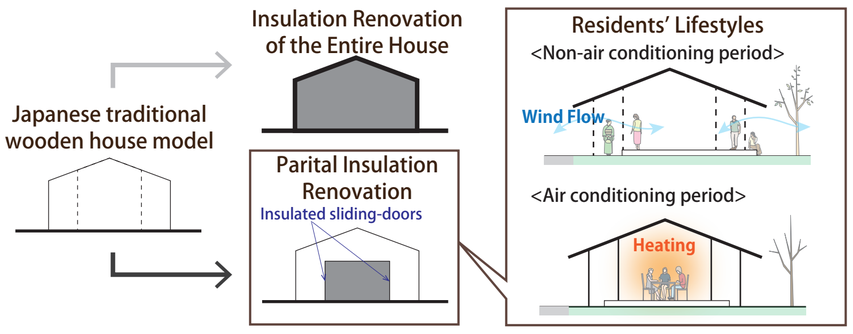
Cross-section of Machiya (air flow inside and outside)

indoor-outdoor relationships in Machiya

【Source:Kyoto Center for Community Collaboration, "Machiya Revival" , 2009】

Proposal : Partial Insulation Renovation

- It is difficult to apply insulation renovation of the entire area at Japanese traditional wooden houses. Because, this method needs thick wall and small window.
- Partial insulation renovation is a method to improve thermal environment of the only partial area of the house by utilizing the intermediate spaces.



Concept of Partial Insulation Renovation

Research Purpose

(1)To propose the partial insulation renovation design in Japanese traditional wooden house.

(2) To verify the effect of the partial insulation renovation in winter.

The outline of the target house

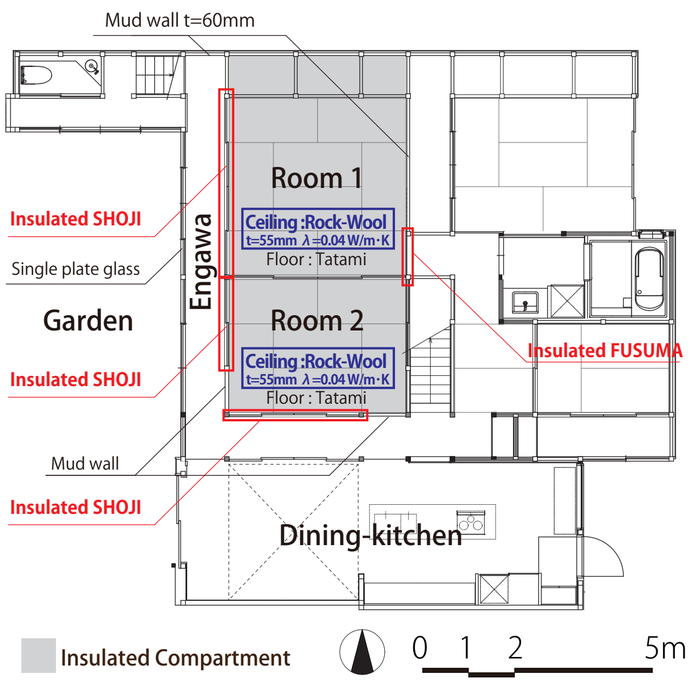
Location: Kyoto city
Built Year: 1932
Renovated Year: 2014
Site Area : 213.97m²
Building Area : 125.79m²
Total Floor Area : 233.19m²

Target house

Design of the Partial Insulation Renovation

Renovation Outline

- Room-1 and Room-2 were selected as the insulated compartment in consideration of the floor plan and residents' lifestyles.
- The condition of this renovation was to renovate this house without changing the traditional design.
- The contents were to use the insulated sliding-doors and to install insulator on the ceiling of the first floor.



Target house Plan on the First Floor

Conetnts of the Renovation

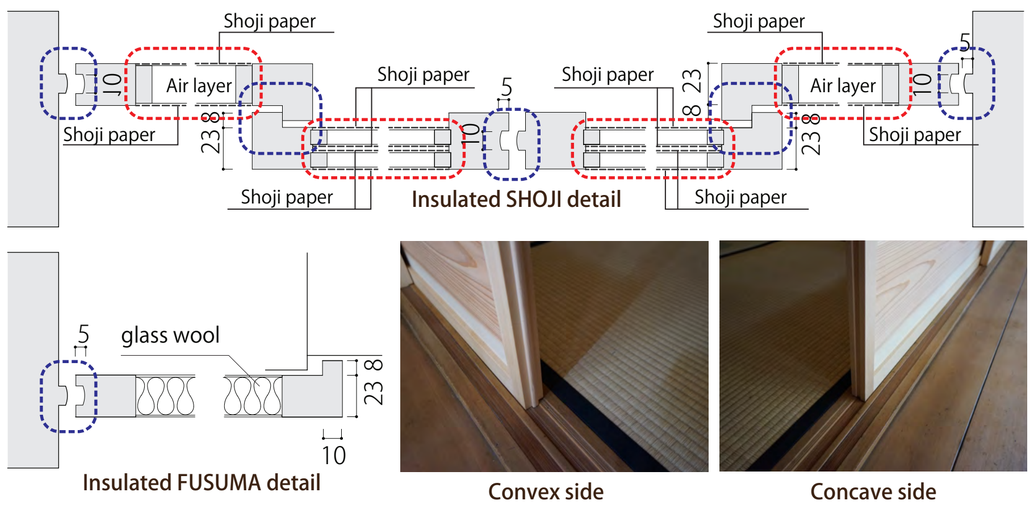
Development of the insulated sliding-doors

Method to improve the insulation performance

Shoji papers are affixed on both sides of the sliding-doors. And air layers are made in the sliding-doors.

Method to improve the air- tight performance

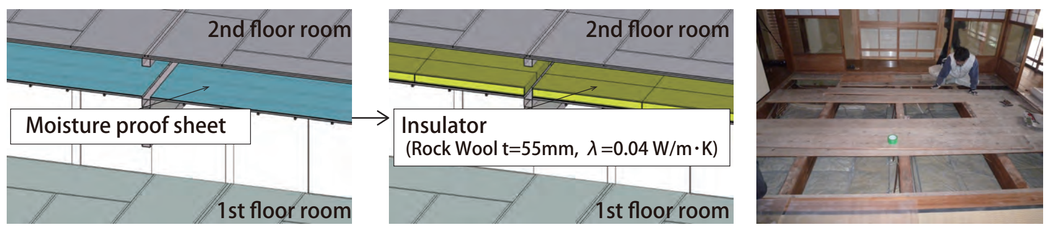
A convex side and a concave side are designed at the Interfaces of sliding-doors .



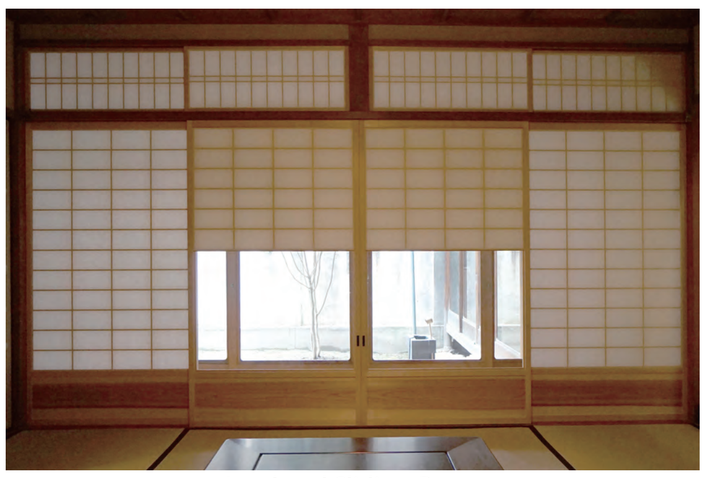
Convex side

Concave side

Installaiton Insulators on the ceiling of the first floor



Rooms in the Insulated Compartment



Insulated Sliding-Doors

Verification of the Partial Insulation Renovation through Measurements in Winter

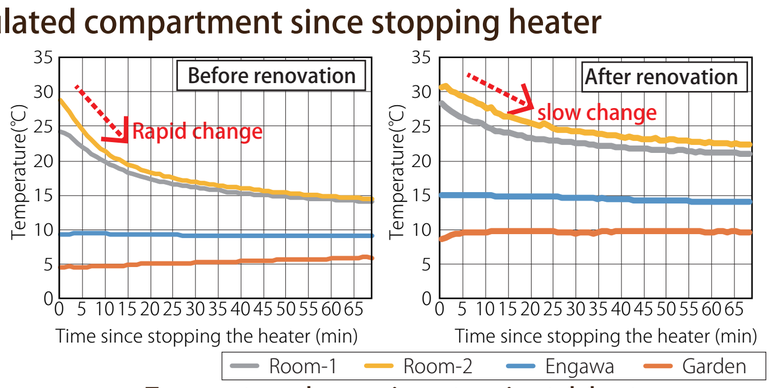
① Thermal Environment Measurements

Temperature change in the insulated compartment since stopping heater

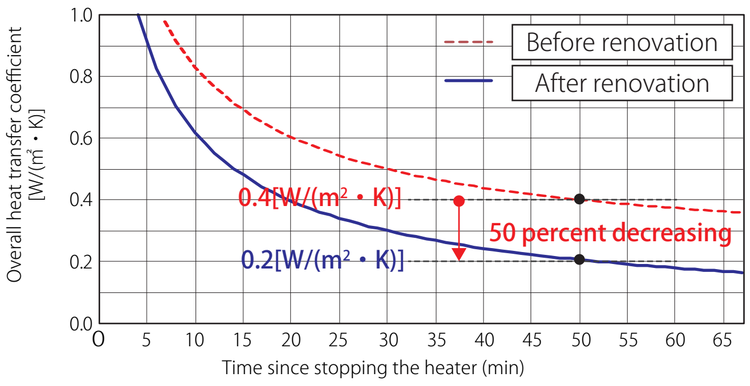
- After the temperature in the insulated compartment (Room-1 and Room-2) was heated up about 30 degrees, the heater was stopped. Temperature change was measured since stopping the heater.
- The outside temperature of two days were different. The overall heat transfer coefficient was calculated by the following formula.

$$K = \frac{c\rho V \Delta\theta_{in}}{S(\theta_{in} - \theta_{out})}$$

K	: Overall heat transfer coefficient[W/(m²·K)]
S	: surface areas[m²]
$c\rho V$	: heat capacity[J/K]
$\Delta\theta_{in}$	: temperature Change[K]
θ_{in}	: Room Temperature[℃]
θ_{out}	: Outside Temperature[℃]



Temperature change since stopping teh heater

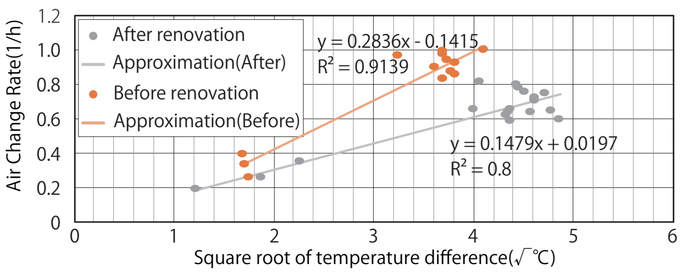


Overall heat transfer coefficient

② Air-tight Performance Measurements

Air change rate measurement

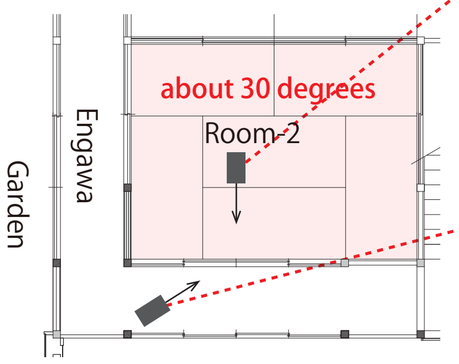
- Air change rate in Room-2 was measured by tracer gas method.
- Air change rate after renovation was smaller than that before renovation. So, it was clarified that the air-tight performance is improved.

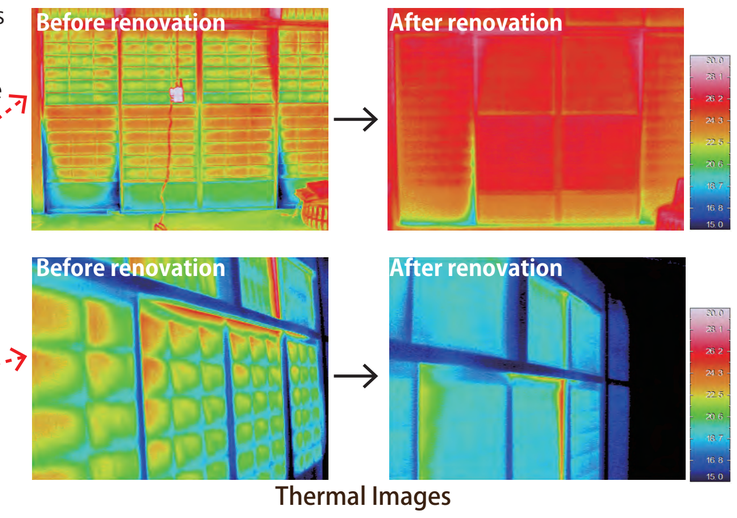


Air Change Rate

Thermal images of the sliding-doors

- Surface temperature of the sliding-doors was improved.
- Temperature at the interface of the sliding-doors was also improved.





Thermal Images

Summary

(1)Proposal of the partial insulation renovation design in Kyo-machiya

- We proposed the partial insulation renovation using the insulated sliding-doors at Japanese traditional wooden house. The insulated sliding-doors were developed by applying Japanese traditional techniques.
- It was possible to conduct this renovation without changing Japanese traditional design.

(2)Verificaton of the effect of the partial insulation renovation

- It was clarified that thermal environment in the insulated compartment was improved through analysis of temperature changes since stopping heater.
- It was clartifird that air-tight performance was also improved through the air change rate measurement and thermal image analysis.