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[City Name]

36.8	①Asahikawa
	②Sapporo
35.2	③Nemuro
	④Morioka
	⑤Akita
	⑥Niigata
	⑦Matumoto
31.8	⑧Toyama
31.3	⑨Sendai
	⑩Yonago
	⑪Maebashi
	⑫Hiroshima
	⑬Osaka
27.1	⑭Tokyo
26.8	⑮Nagoya
	⑯Fukuoka
25.1	⑰Kumamoto
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Engineering of Japan

STUDY ON THE NIGHT-TIME VENTILATION FOR COOLING THE BUILDING HAVING THICK WALLS WITH OUTER INSULATION

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ABSTRACT Hokkaido is distinguished from the other island of Japan by having colder winters and cooler summers. The average monthly minimum is about -10℃ and summer daily average maximum around 25℃, so that efficient space heating becomes the dominant aspect. But on hot days the temperature may reach 35℃, though for short period of time. There are few houses constructed to prevent overheating in summer. I have designed and built a house for my family in Sapporo which has cavity walls of concrete blocks insulated with urethane 100mm thick and deeply recessed, but operable windows. I detected the thermal performance of my house to solve overheating problems at design stage.

1. INTRODUCTION

Hokkaido was pioneered about 130 years ago by the emigrant from warm-wet Honshu. The well-ventilated, traditional wooden frame houses in Honshu were brought in to the first stage of pioneering. The improvement of a suitable house for the cold region started really after the Second World War by the influence of the United States. Concrete block walls were thought to be warm because they had fewer clinks than wooden frames, and had a higher insulation value by the core of blocks. At the same time the room arrangement that the bedroom was placed on the left and right side of the living room was devised so that fuel consumption for heating could be little. Figure 1 shows a typical block house of a triangular roof.

However, heavy condensation was caused for insulated shortage. The block houses have decreased rapidly since 1969 when the Housing Loan Corporation could be permitted to finance wooden houses too on condition of using the heat insulator because they were suffered severely from the dewy damage.

The wood stove and the coal stove of a thin iron plate were long used for heating. They were replaced by the kerosene fired stove with the energy revolution in the 1960s, but the intermittent and partial heating was still popular.

The danger of the environmental making relied on oil stove heating was taught to the two oil crisis from 1973. That is, the house principle in the warm region worked basically and the achievement of the house which was suitable to the cold region was prevented though various devices had been done in respects of an insulated industrial method and the heating equipment.

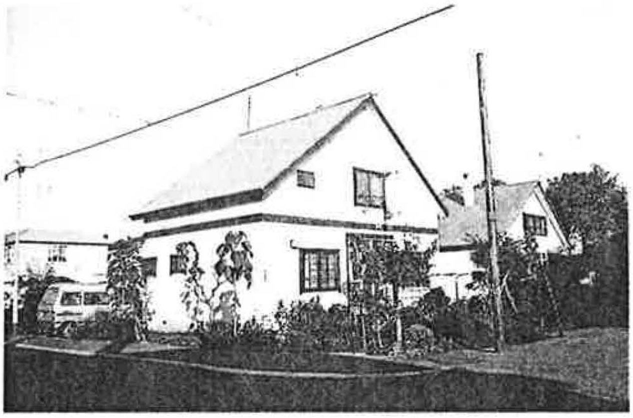

Figure 1 A block house of a triangular roof in Hokkaido

2. DOUBLE BLOCK HOUSE DEALLING WITH THE COLD OF WINTER

I was given a chance to design a new house to review of concrete-block masonry construction in 1979. I developed the outside insulation method that is hard to make heat bridge to improve the insulation of the block walls. Figure 2 illustrates the detail of the block walls. The foam styrene board 100mm thick was put outside on the inner skin of block 150mm thick which is load bearing. The outer skin of block 120mm thick is " fair-faced" and is tied the inner structural wall with 9mm steel bars as a measure to counter earthquakes. External cavity walls help keep structure dry. This double block wall method by which the thickness of the wall exceeds 400mm is accepted by architects in Hokkaido and have been adopted at more than 200 houses since then.

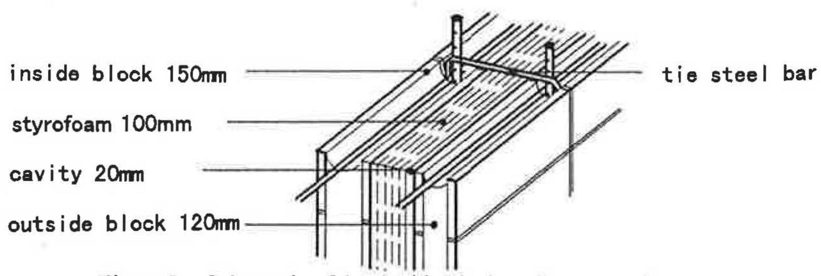

Figure 2 Schematic of the double block wall construction

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4. DESIGN OF HOUSE

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Figure 4 illustrates the
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are two bedroom for children

3. DOUBLE BLOCK HOUSE DEALLING WITH THE HEAT OF SUMMER

A recent improvement of the insulated making and airtight method in Hokkaido and the popularization of the central heating equipment have the remarkable. However, provision to prevent overheating in summer is missed and new houses become hotter than old houses where their insulation is low. Though the double block wall house is cooler than wooden frame houses in ordinary summers, occupants feel oppressively warm when very hot days continue because the fall in the room temperature at night is few.

When I designed a new house for my family (figure 3) in 1995, the task I set for myself was to design substantial summer cooling. That is,

a. Provision of continuous and effective ventilation
b. Protection from the sun in summer
c. Minimization of internal temperature during the evening and night

Firstly I devised thicker insulation and the sunshade not to let outside heat in. Secondly I provided all the rooms with windows that are easy to open and shut on both windward and leeward sides. Thirdly I arranged opening plan of the first floor to cool interior by natural ventilation at nighttime.

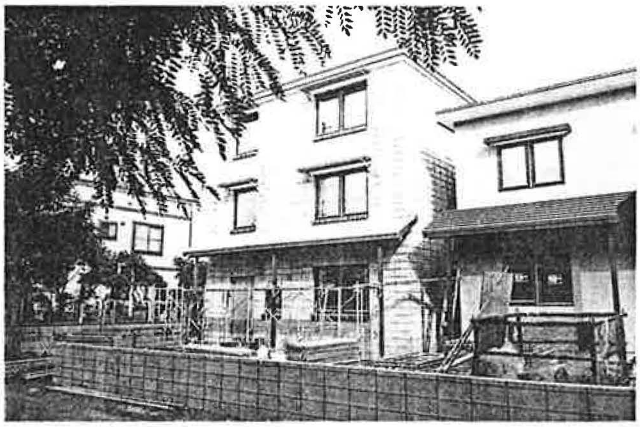

Figure 3 The double block house

4. DESIGN OF HOUSE AND PASSIVE SYSTEM

I found the remaining building lot in Sapporo whose southern boundary is contiguous to a primary school's playground, thereby providing unshaded access to maximum available sunlight .

Figure 4 illustrates the floor plans for the house. The house has three stories and the total floor space is about 140 m². The ground floor is one continuous living and dining area. The expanded entrance hall is equipped a wood stove made in Denmark. On the second floor, there are two bedroom for children with separate rooms for bath/shower and utility along the west wall.

On the third floor, the master's bedroom and the study are strung along the south wall.

Concrete blocks used for internal and external load bearing walls are 190 mm thick. The external cavity walls are insulated by the urethane 100mm thick and the cavity is 50 mm wide. The concrete flat roof is covered with the foam styrene board 200 mm thick on the exterior. The foam styrene board 100 mm thick is placed on the outside of the foundation around the perimeter to a depth of 900 mm.

The eaves and horizontal louvers on the south facing windows are attached to protect from the sun. All windows are of horizontal pivoted type made in Sweden and are protected from intrusion of insects by wire screen.

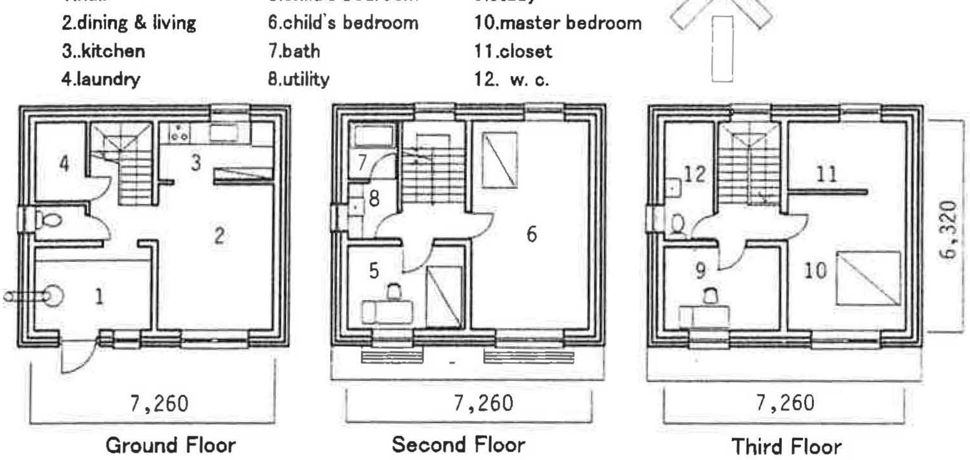

Figure 4 Floor plan

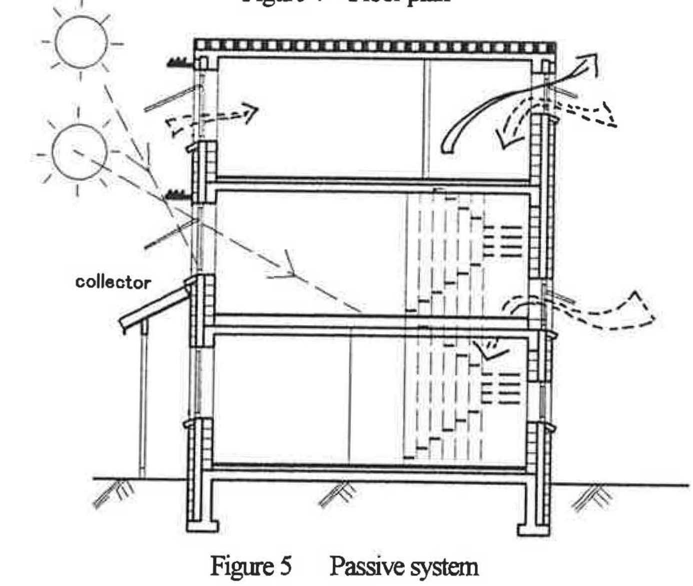

Figure 5 Passive system

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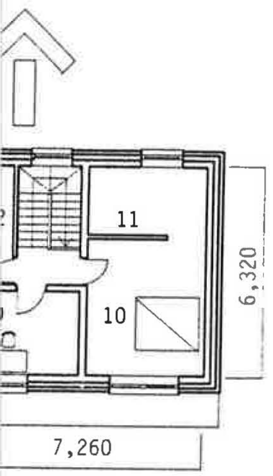

Third Floor

Figure 5 illustrates a simplified diagram of the solar heating and summer cooling system of the house. The basis for this system is a direct gain type. The house has an expanse triple glass facing south. A amount of window area on the south wall roughly 12.4 m² and that on the north and west walls is about 6.7 m². The house is equipped heat a recovery ventilation system and a solar water heater system.

I have used direct natural thermosypon solar water heater systems for 20 years. Though drive power and the control are unnecessary in this system, I changed them to indirect forced circulation systems. The reason is that it is difficult to protect direct natural thermosypon solar water heater systems against freezing accidents.

The heat loss for the building is calculated by conventional analysis to be about 14.6MJ/h at -10℃ outside temperature. The backup heating system consists of a kerosene-fired water boiler with a net delivery of 20.9MJ/h. Panel radiators are placed on the wall at every windows. In addition, a wood stove will provide heat .

5. PREDICTION OF PERFORMANCE

I will move in during October 1996, approximately six months after construction commenced, so operating experience has not been obtained. Table 1 illustrates the calculated contributions of the various heating sources. The kerosene consumption in my house would be 50 % less than average consumption in dwellings of Hokkaido (about 2,000 liters).

Table 1 Performance estimate for winter heating (DD_{18}=3,800)

Heat Loss (GJ)	45.8
Miscellaneous Heat gain (GJ)*1	6.0
Space-Heating Requirements (GJ)	39.8
Kerosene Boiler Contribution (GJ)	24.1
Solar Contribution(GJ)	15.7
Fuel Bill(space Heating)*2	¥36,700

*1 Lights and occupants

*2 Based on ¥45 per liter of kerosene

The computer simulation on a hot day was done by building elements at design stage. The used computer program was based on the Successive Integration Method. The model house was the same dimension with my house. Figure 6 shows a comparison of two cases A and B.

case A: roof insulation 200mm thick, night-time ventilation and outside sunshade

case B: roof insulation 100mm thick, day-time ventilation and inside sunshade

The room temperature of case A is about 2℃ lower at the highest temperature than that of case B and continues low at night.

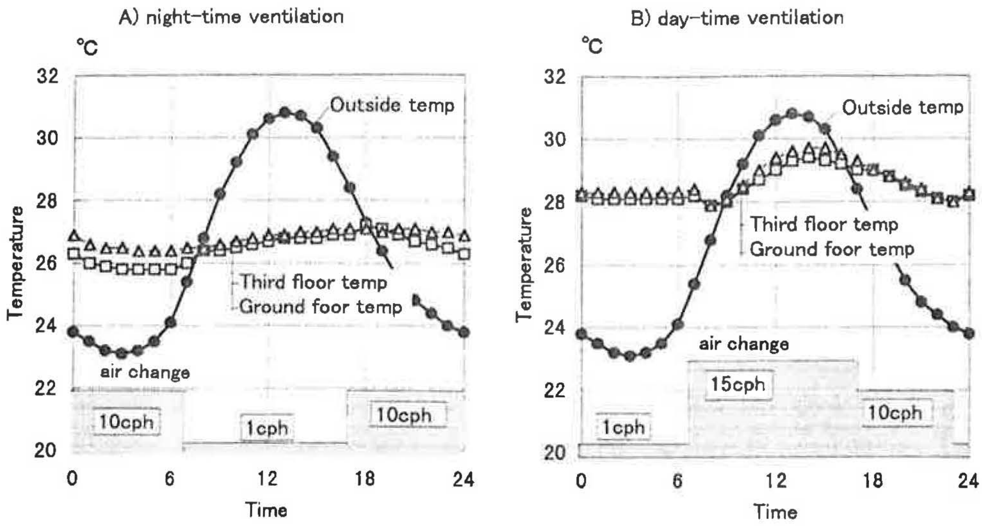

Figure 6 Calculated room temperature in summer

6. CONCLUDING REMARKS

I have designed my house to be simple and practical and want to set an example for other architects. The entire cost of this double block house is estimated to be roughly thirty million yen. It rises more than a ordinary wooden house by about 30%. But substantial saving of the double block wall house on fuel bills has been achieved and summer cooling will be realized. When the other advantages (such as long life, convenience, and no supplement ccoling) are considered, economics of such designs becomes increasingly favorable.

REFERECE

[1] K.Suzuki and N.Aratani (1979),Some aspect of the effective and natural use of solar energy in the design of houses, The third international symposium on the use of computers for environmental engineering related to buildings, national research council of Canada, pp.281-288

THE STRATEGIC
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ABSTRACT The c
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1. INTRODUCTION

Current integrated energy e
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