

Study on Architectural Characteristic and Natural Environment Control System of Japanese Traditional House: Case Study Traditional Houses in Kitakyushu City, Japan

Dian Sekartajii⁽¹⁾, Bart Dewancker⁽²⁾

¹Researcher, Department of Architecture, The University of Kitakyushu, sekartaji.dian@gmail.com

²Professor, Department of Architecture, The University of Kitakyushu, bart@kitayu-u.ac.jp

Abstract — Japanese traditional housing, in its approach to harmony with natural surroundings and environment has formed as unique shape and philosophy which become Japan National property. In the other hand Japan traditional house recently becomes not popular in Japan while Japanese contemporary house has technology method for controlling its environment. However high technology needs more energy to consume and this causes the other problem of environment. This study of traditional houses, located in Kitakyushu City, aims to investigate the architectural characteristic of Japanese traditional house such as structure, plan, material, and natural environment control system. In the beginning, two traditional houses have been selected as target of study; those are Takasaki Old Residence and Shimizu Old Residence in Yahata Nishi Ward. The first section is devoted to the analysis of basic form and structure in three traditional houses. In the following section, the study examines methods used to control the architectural environment in Japanese traditional house which we can call natural environment control system. In conclusion, a preliminary outline of the architectural characteristic and natural environment control system analysis are given. Moreover, the result of this study can be expected become inspiration for recent house construction.

Keywords: traditional housing, architectural characteristic, natural environment control system, Kitakyushu, Japan

1. INTRODUCTION

The Tohoku earthquake, the Greatest East Japan Earthquake and Tsunami which occurred on March 2011, were bad enough caused radioactive leak at the Fukushima nuclear power plant. 11 of Japan's 50 nuclear reactors were closed immediately following the earthquake. Japan nuclear industry supplied a third of the country electricity because the growth of producing energy from nuclear fuel became a way of reducing Japan's dependence on imports while Japan has very little natural resources and become the world's largest importer of LNG and coal. Since the closing many nuclear reactors in Japan after this earthquake, Japan Government limits the energy consumption of electricity with conducting blackout in many industrial, commercial, even in residential areas in several times. This phenomenon becomes a big issue of housing and its environmental adaptation since the housing design influences the capacity to control its environmental adaptation. Controlling the architectural environment in contemporary house of Japan tends to be reliant on scientific technology and a human being's overconfidence in technology. However high technology needs more energy- consuming. Technology cannot be the basic method for solving architectural problems associated with the environment.

Asian traditional houses are known for their capability to control the environment sustainable manner. Reinforcing this, R. Shinta Priya in her paper "Comparing the thermal performance of traditional and modern building in the coastal region of Nagappattinam, Tamil Nadu" in Indian

Journal of Traditional Knowledge (2012) concluded that the traditional residential buildings is thermally comfortable than modern residential building in the same surrounding. Do-Kyoung Kim in his paper “The natural environment control system of Korean traditional architecture: Comparison with Korean contemporary architecture” concluded that Korean traditional architecture has been based on the vision that it should coexist with nature and in contrast, Korean temporary architecture ignores the natural surroundings and relies solely on contemporary technology, which consumes a great deal of energy.

Japan has different climate of India and has its own architecture characteristic of its traditional housing even has the same climate with Korea. This study particularly examines the architectural

characteristic of Japanese traditional house and its methods to control architectural environment which has a natural environment control system. This paper first analyzes the basic form and structure in twotraditional houses which have been selected to understand the basic of architectural characteristic in traditional bearing the whole research that aims to analyze the transformation of Japanese housing. Then in the following section analysis of its natural environment control system is then discussed.

2. Architecture characteristic of Japanese traditional house

Architecture characteristic is studied by analyzing basic form, structure, material futures, spatial organization and details. Two traditional houses in Kitakyushu have been selected for case study. Those are Takasaki Old Residence and Shimizu Old Residence. They were located in Yahatanishi Ward, Kitakyushu City, Fukuoka Prefecture.

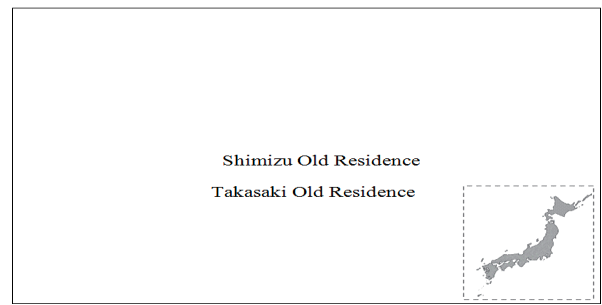


Fig. 1. Kitakyushu Map

2.1 Basic form, structure, material futures of Japanese traditional house

Hierarchy Specified Construction Renovation Total-Total Floor Height classification year - year landar chitectural level of area - area (m2) (m) house Takasaki old residence was constructed in 1835 as a house for merchant. Since it is valuable as post station architecture typical, it was designated as Kitakyushu city cultural property in 1994. Afterwards, this house was reconstructed with a same design and constructed with former main structure yet adding new structures to support this house. Shimizu old residence was built after big fire was occurred in this region in 1836. This house was formerly used for Lord Rest place in their expedition from Nagasaki to

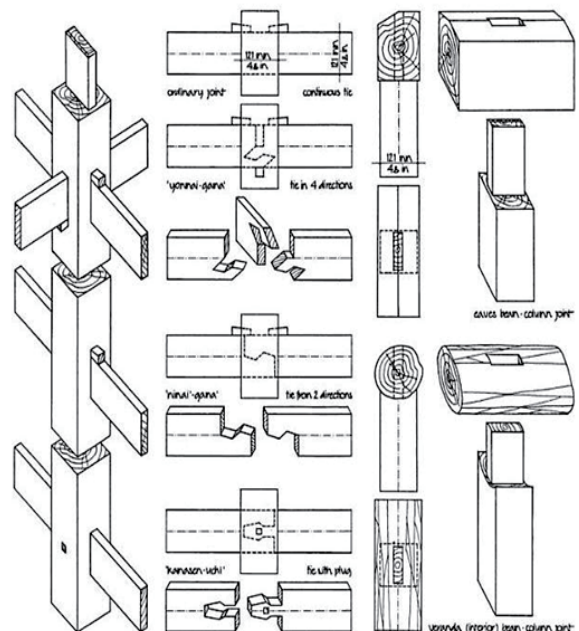


Fig. 2. Column, beam, tie joinings (Source: Measure and Construction of Japanese Home. 1985)

TABLE 1.
BASIC INFORMATION OF HOUSES

	Hierarchy	Specified Classification	Construction Year	Renovation Year	Total Land area (m ²)	Total architectural area (m ²)	Floor level (m)	Height of house (m)
Takasaki Old Residence	Merchant	City cultural property	1835	1995-1997	653,11	429,33	2,65	Roof:12,8 Beam:7,89
Shimizu Old Residence	Tea House	City cultural property	1836	1997-1999	645,02	293,71	2,60	Roof:10,5 Beam:6

passed the road which is the main road of Lord Expedition from Nagasaki to Tokyo.



Fig. 3. Takasaki Old Residence



Fig. 4. Shimizu Old Residence

One of the traditional Japanese house characteristics is the structure of its wall (Fig.5). They made bamboo for the structure, and then covered it with earth which mixed with thatch. For the floor material they usually covered their living space which has raised floor from the ground (Fig.6) with tatami mats which made from rice straw. The size of room is typically measured by the number of tatami mats which are made in standard sizes, with the length exactly twice the width, an aspect ratio of 2:1.

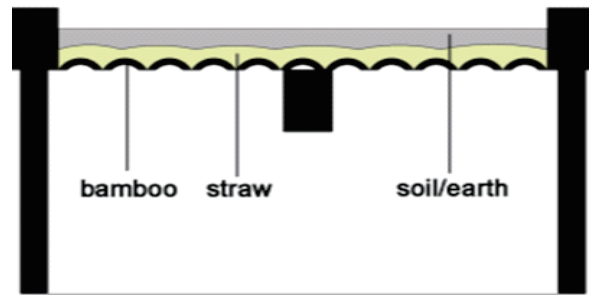


Fig. 5. Detail of wall section

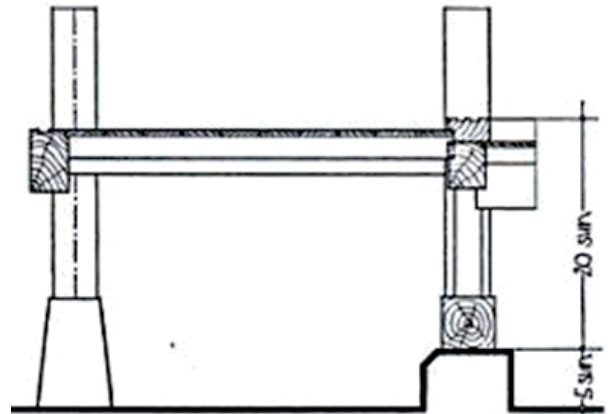


Fig. 6. Raised Floor Construction Detail (Source: Measure and Construction of Japanese Home. 1985)

Foundation in traditional Japanese house was made with no excavation beneath the house, the upright beams rest directly without attachment upon single uncut stones which have been pounded into the earth. The house was perched upon these stones, with the floor elevated at least a foot and a half or two feet above the ground. (Fig.7) (Morse.1885.Japanese homes and their surroundings; page: 15.)

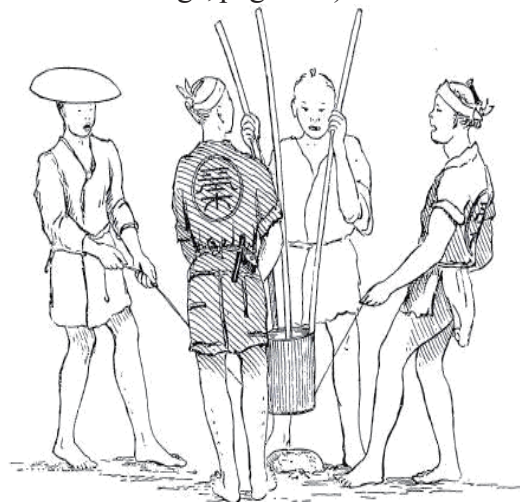

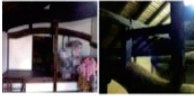



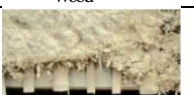
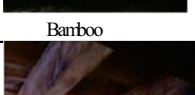
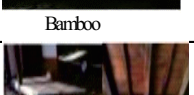

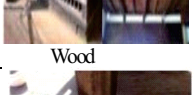









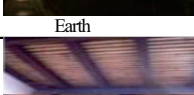
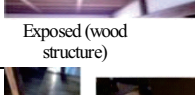
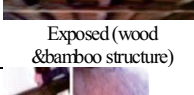
Fig. 7. Pounding down foundation stone. (Source: Japanese Homes and Their Surroundings)

TABLE 2.
STRUCTURAL CHARACTERISTIC

	Takasaki Old Residence	Shimizu Old Residence
Main Structure	 Timber	 Timber
Roof	 Wood	 Wood
Wall	 Bamboo	 Bamboo
Floor	 Wood	 Wood
Foundation	 Stone	 Stone

Material features of both houses were come from local materials, such as cedar wood, stone, bamboo, straw, and earth.

TABLE 3.
MATERIAL FEATURE

	CAKACH Residence	SHIMIZU Residence
Building Envelope	 Wood, Soil, Earth	 Wood, Soil, Earth
Roof	 Kawara	 Kawara
Wall	 Earth	 Earth
Ceiling	 Exposed (wood structure)	 Exposed (wood & bamboo structure)
Floor	 Wood, tatami, cement (after renovated)	 Wood, tatami, earth/soil

2.2 Spatial Organization

Japanese traditional house's spatial organization was consisted of residence spaces and worked place called doma. Doma was un-boarded ground floor while residence spaces were raised higher than the doma and boarded or covered with mattress. It usually used as a workplace, service place, a passageway, kitchen and stable. Residence spaces were for living spaces, such as hall, bedrooms, and veranda. In these spaces users do not wear any footwear because people sit and do activities on the tatami mats.

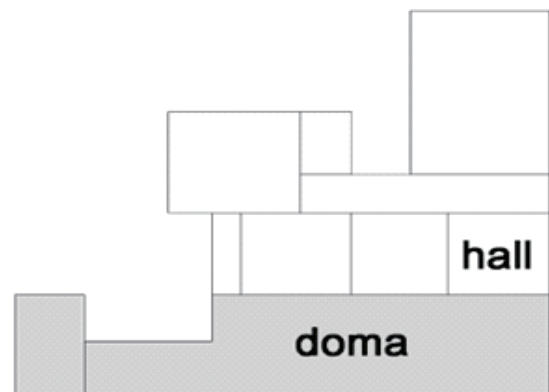


Fig. 8. Typical Plan 1



Fig. 9. Typical Plan 2

The first plan given (Fig.10) is the first floor of Takasaki old residence after it was renovated. The solid black lines represent the wall that cannot be moved. These walls have modular system as tatami mats module. Red lines represent shoji, sliding doors which divides the outer sides and inner sides. It is flexible and made a continuous space between indoor and outdoor space. It made connection between the house and niwa or garden which transformed the

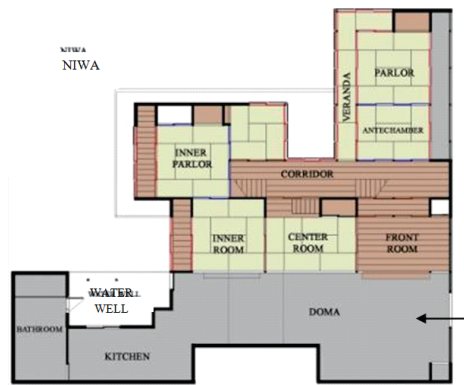


Fig. 10. Takasaki old residence first floor plan



Fig. 11. Shimizu old residence first floor plan

concept building and nature is unite. Blue lines represent *fusuma* (Fig. 12), a movable sliding partition consisting of light frames of wood covered with paper used for dividing the rooms. It runs along the track in upside called *uwabuchi* and bottom called *shitabuchi* (Fig.13). Both of *fusuma* and *shoji* make a room flexible because it can be removed and mounted. The brown lines are also *fusuma* but it was covered by wood panel and paper. Floor material features can be seen by diverse colour in the pictures. *Doma* and kitchen area was covered by cement and has a same level with the ground while living spaces which covered with *tatami* and wood panel has different level (raised floor) with the ground. Parlor and antechamber are the rooms for tea ceremony. The veranda next to parlor is used for expanding space

when tea ceremony guests vastly came that is the reason why veranda in this house also covered by *tatami*.



Fig. 12. *Fusuma*

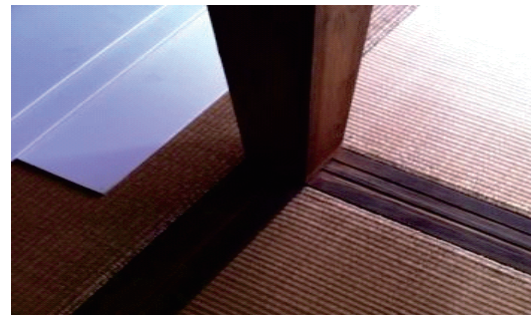


Fig.13. *Shitabuchi*

In Takasaki old residence the hall or front room was used for selling the goods through *suriagedo* (a door can be moved up and down) and the *doma* was used for putting the goods. Formerly, *doma* floor material was made from soil/earth, but it was made from cement after the renovation. There is *tokonoma* in parlor and inner parlor. *Tokonoma* is an alcove that has one or a half *tatami* mat size and a step higher than the rest of the room. It is the place to display *kakiju* (hanging scrolls), *ikebana* (flower arrangement), and other art. The idea that the *tokonoma* is a sacred space was begun by Buddhist priests, and even today it is strictly forbidden to walk into or sit in the *tokonoma*. The seat closest to the *tokonoma* is usually given to the most important guest.

The second plan (Fig.11) is the first floor of Shimizu old residence. Floor material in *doma* of this house is still made by soil/earth even it had been constructed. In Shimizu old residence, *tokonoma* was located in *joudan no ma*, a room with raised floor which used for *daimyo* (territorial lords), *bakufu* (headquarters) or senior officers. In *joudan no ma* (Fig. 14) usually *daimyo* sat and had assembly with his officer or had tea

ceremony. Storage in the back yard has 2 floors, it used for save the stuffs. Both of Takasaki and Shimizu old residence has water well in the back yard and wide niwa or garden.



Fig. 14. Lord/Daimyo in Jyoudan no ma

Both of houses has veranda which formerly sometimes used for expanding seating place for people when they held tea ceremony or party.

3. Natural Environment Control System of Japanese Traditional House

3.1 Double skin of doors

Both of Takasaki and Shimizu old residence have double skin of doors. The outermost of the skin was made from wood that used to protect from strong wind in the winter season. It can be shifted and saved in the distinctive place (Fig.17) when it is not used. This double skin is flexible that can be use in winter season or can be remove in summer season.

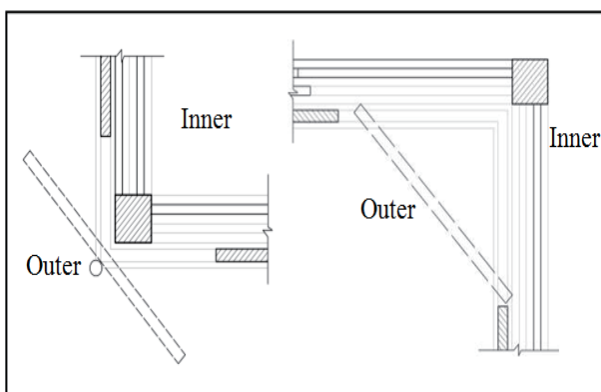


Fig.15. Detail of Double skin door



Fig.16. Double skin door



Fig.17. Space for saving doubles skin door

3.2 Raising Floor

The living space of the both houses have raised floor about 40 cm from the ground. It made wind play free beneath and makes the rooms colder in the summer season. It also decreases the humidity from the ground.

3.3 Tatami mat as floor covered

Tatami mat as a cover in living spaces has many advantages. Besides it absorbs moisture during periods of high humidity and naturally discharge the moisture when the air is dry, these two or three inches in thickness mats act as an insulator as well, keep the rooms cool in the summer and warm in the winter time.

3.4 The Utilization of natural ventilation by cross ventilation

In Japan traditional house, it usually has cross ventilation to flow the wind and make the room colder in the summer season. Cross ventilation is got by opening the *shoji* which separate the indoor space and outdoor space.

Because the house dominantly closed by shoji, it will ease the wind to flow.

3.5 Eaves controlling amount of the sunshine and protecting the heavy rainfall

Japan, as well as Chinese and Korean architecture has deep eaves called hisashi, which can play important role for in controlling the amount of sunshine entering the building. It also protects the heavy rainfall. In Japan both of these traditional houses the angle of the deep eaves is approximately 30° . The angle is related to the highest altitude of the sun according to the seasons. The highest of the sun, in Fukuoka (rising and setting times for the sun in 2012) is $79,8^\circ$ on June 2012 at summer solstice and $32,9^\circ$ on December 2012 at the winter solstice. From these relationships between the depth of the eaves and the highest altitude of the sun, we can see that the eaves block the sunshine in the summers but allow sunshine to enter a building in winter. Accordingly, the eaves can closely control the amount of sunshine that suitable for every season.

In Takasaki old residence, paved space (gravels) under the eaves (Fig.19) made for rainfall which drops from the eaves to prevent splashing soil.



Fig. 18. Eaves in veranda (section)

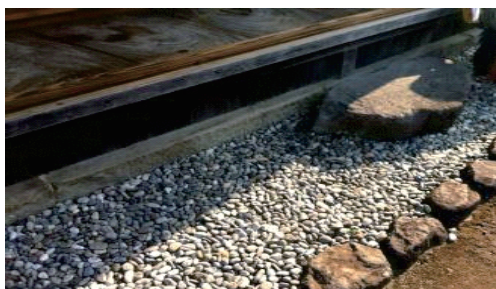


Fig. 19. Paved space (gravels)

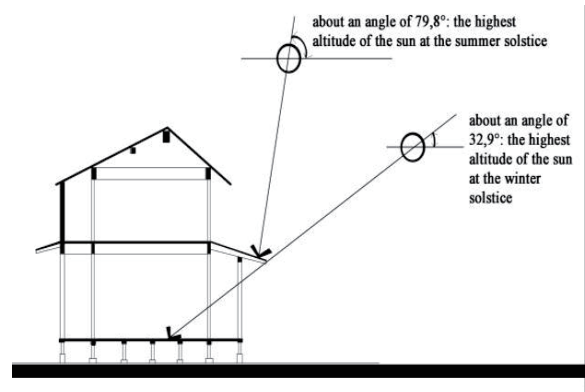


Fig. 20. Function of the eaves in Japanese traditional

4. Conclusion

By examines the architectural characteristic of and natural environment control system of Japanese traditional house, it is concluded that the houses are the carrier for local climate, topography and culture. It has been based on the concept that the architecture should coexist with nature. There are many natural environment control systems that were used in Japan traditional house, including climate responding and using local materials. These systems are all used and improved by hundreds years and suitable for local climate. By this research, the effects of these methods on improving indoor environment and human comfort are confirmed. These methods should be improved by modern technologies and used in modern residence.

By this preliminary outline of the architectural characteristic, natural environment control system analysis, this research will be a basis for next study about the Japanese traditional house and its transformation for adapting to natural environment. It is hoped that this research will be useful to whom aims is to improve the architectural environment.

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