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From Shelters to Long Living Communities

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A Thesis Presented

by

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May 2016

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Stephen Schreiber
Chair, Department of Architecture

DEDICATION

To my mother for her constant care and support.

To my father for his understanding.

To Jun who inspired me, without your help I couldn’t have this done.

ACKNOWLEDGEMENTS

I'd like to thank my thesis committee members Kathleen Lugosch, Alexander C.Schreyer and Naomi Darling, for their constant guidance and support. It has been an impressive experience in my life.

And also I want to express my gratitude to the rest of the UMass faculty who helped me a lot during the past three years: Sigrid Miller Pollin, Ray Kinoshita Mann, Joseph Krupczynski, Caryn Brause, Peggi L.Clouston, Simi T.Hoque, Ajla Aksamija.

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ABSTRACT

FROM SHELTERS TO LONG LIVING COMMUNITIES

MAY 2016

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Disasters happen all the time, attention should be paid to refugees and help them build new homelands. Japan is an earthquake-prone area, every year there is at least 1 earthquake above 6 magnitude happens there. In 2011, Japan suffered from the 9.0 magnitude earthquake, tsunami and meltdown, the triple disasters. About 100 people died in the earthquake itself, and 20,000 people lost their lives in the tsunami, 465,000 people were evacuated after the disaster. Two years later after the triple disaster, more than half refugees still lived in temporary shelters. Efforts should be concentrated on the development of long living communities.

Relying on existing shelters data and the specific Japanese living styles, the research examines a model of continuous living styles. Develop from a basic rapid shelter unit with low cost and limited functional space to a long-term living place. Japan has a long architecture history, its buildings have strong characteristics which shouldn't be abandoned in the modern society. My research here is to develop a series of living types immediately following disasters until 2 years later. Typical and traditional Japanese features will be kept, at the same time combine with new aesthetics and technologies.

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INTRODUCTION

THESIS INTENT

This thesis project aims to explore the design of a continuous living type in Japan. This is important due a high rate of unexpected disasters. The process of how these shelters can change from emergent shelters to long living communities will address the challenges of the structure, culture and the reality of sustainable communities. I select Japan as my design location as it is an earthquake-prone country. According to the long architecture history in Japan, they have excellent structure technology to resist earthquake. This is what I want, based on some parts of their existed structure technology to create new living type.

Besides structure technology, new modern factors are necessary for my project. With time, aesthetics are changing; I will address to satisfy modern people's aesthetic lifestyle requirements. At the same time, how to combine the essential traditional Japanese elements into this project, and how to decide the balance between old and new is important.

In the modern world, we don't have a systematic scheme for refugees' living places. Some design concepts are only focused on shelters, not a continuous program. Which means, after a long period of living in rough shelters, refugees want to move to new communities. This is a disjointed, and a waste of process. My goal is to achieve a continuous living trajectory, to shorten the time living in emergent shelters, and design a path to a long living community with connection medium.

CHAPTER 1

THESIS CONTENT

This thesis project aims to explore the design of a continuous living type in Japan after disasters. How to combine traditional Japanese architecture concepts into it? How to work with modern construction technology and aesthetics? How to apply this concept into real use? How to make the continuous process come true? All these ideas will be addressed through this project.

Research Questions

1. What are traditional Japanese building features? Which one is the most important for Japanese, and which one we should bring into my design? What is my inspiration?
2. What modern ideas will be applied into this design?
3. What is the structure? What materials should I use?
4. Green building will be part of the project, what sustainable strategies will be used in this project?
5. How to make this series of buildings into a real application?

In my opinion, as architects in the future, our responsibility is not to design beautiful buildings, but also importantly sustainable buildings. We should also pay attention to issues of social concern. Our duty is to make that everyone in the world can live in a decent home. Not enough architects do shelter design for people in need, such as refugees and low income families. A private living space is a basic need for people. A challenge in my project, how to design a process to meet immediate needs. Basic physical requirement shelters that can develop into long living home spaces and communities. What was needed was to think from both ends; to know what is really needed the emergency situation and long future needs, and then make this transfer process come true. The process needs to include the very practical consideration, of structure, materials, sustainable systems, transportation etc.

CHAPTER 2

CONTEXT

Japan is an island country in East Asia. Located in the Pacific Ocean, it lies to the east of the Sea of Japan, the East China Sea, China, North Korea, South Korea and Russia stretching from the Sea of Okhotsk in the north to the East China Sea and Taiwan in the south. The kanji that make up Japan's name mean "sun origin", and it is often called the "Land of the Rising Sun".[1]

Figure 1: Map of Japan. Source: Google

Archaeological research indicates that Japan was inhabited as early as the Upper Paleolithic period. Japan has a total of 6,852 islands extending along the Pacific coast of

[1] Japan – Wikipedia, https://en.wikipedia.org/wiki/Japan

East Asia. The country, including all of the islands it controls, lies between latitude 24° and 46°N, and longitudes 122° and 146°E. The main islands, from north to south, are Hokkaido, Honshu, Shikoku and Kyushu. The Ryukyu Islands, which includes Okinawa, are a chain to the south of Kyushu. Together they are often known as the Japanese archipelago.[2]

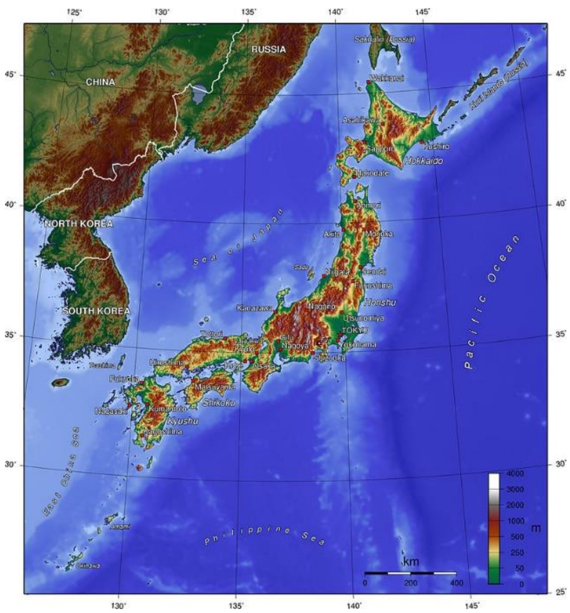

Figure 2: Topographic map of the Japanese archipelago. Source: Wikipedia

About 73 percent of Japan is forested, mountainous, and unsuitable for agricultural, industrial, or residential use. As a result, the habitable zones, mainly located in coastal areas, have extremely high population densities. Japan is one of the most densely populated countries in the world.[3]

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[2] McCargo, Duncan (2000). *Contemporary Japan*. Macmillan. pp. 8–11.ISBN 0-333-71000-2.

[3] "World Population Prospects". UN Department of Economic and Social Affairs. Archived from the original on March 21, 2007. RetrievedMarch 27, 2007.

Climate

The climate of Japan is predominantly temperate, but varies from north to south. Japan's geographical features divide it into six principal climatic zones: Hokkaido, Sea of Japan, Central Highland, Seto Inland Sea, Pacific Ocean, and Ryukyu Islands. The northernmost zone has a humid continental climate with long, cold winters and very warm to cool summers. Precipitation is not heavy, but the islands usually develop deep snowbanks in the winter.[4]

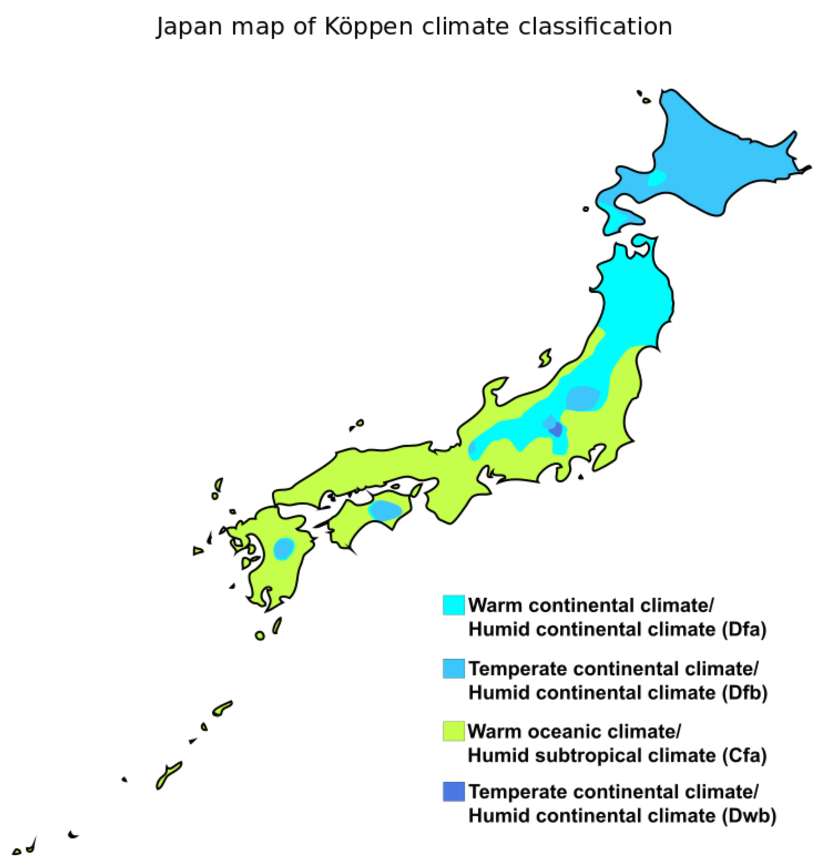

Figure 3: Japan Map of Koppen Climate Classification. Source: Wikipedia

[4] Karan, Pradyumna Prasad; Gilbreath, Dick (2005). *Japan in the 21st century*. University Press of Kentucky. pp. 18–21, 41. ISBN 0-8131-2342-9.

Most of Japan is in the Northern Temperate Zone of the earth and has a humid monsoon climate, with southeasterly winds blowing from the Pacific Ocean during the summer and northwesterly winds blowing from the Eurasian continent in the winter. In the Sea of Japan zone on Honshu's west coast, northwest winter bring heavy snowfall. In the summer, the region is cooler than the Pacific area, though it sometimes experiences extremely hot temperatures because of the foehn wind. The Central Highland has a typical inland humid continental climate, with large temperature differences between summer and winter, and between day and night; precipitation is light, though winters are usually snowy. The mountains of the Chugoku and Shikoku regions shelter the Seto Inland Sea from seasonal winds, bringing mild weather year-round.[4]

The Pacific coast features a humid subtropical climate that experiences milder winter with occasional snowfall and hot, humid summers because of the southeast seasonal wind. The Ryukyu Islands have a subtropical climate, with warm winters and hot summers. Precipitation is very heavy, especially during the rainy season.[4]

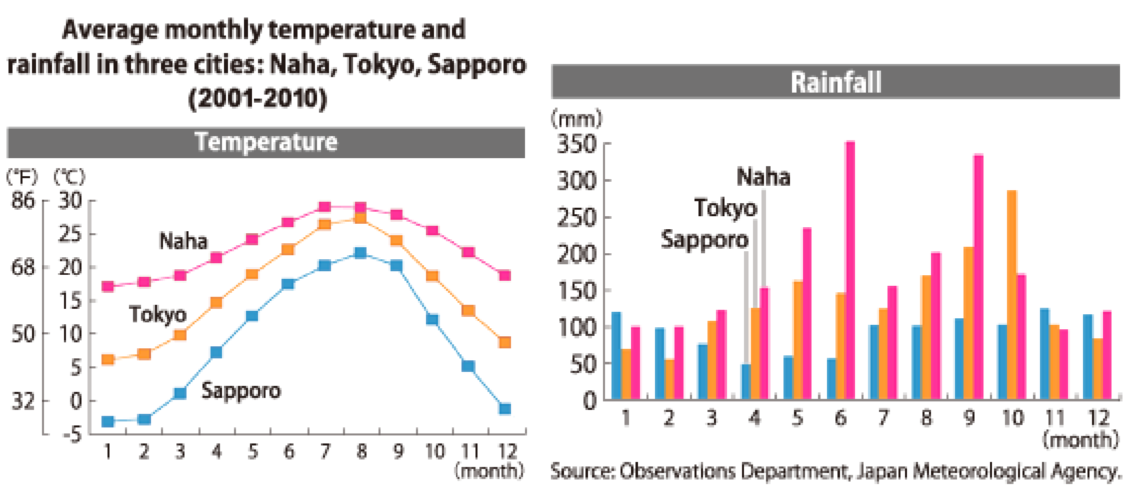

Figure 4: Average monthly temperature and rainfall in three cities. Source: Google

The average winter temperature in Japan is 5.1℃ (41.2°F) and the average summer temperature is 25.2℃ (77.4°F).[5] The highest temperature ever measured in Japan 40.9℃ (105.6°F) was recorded on August 16, 2007.[6] The main rainy season begins in early May in Okinawa, and the rain front gradually moves north until reaching Hokkaido in late July. In most of Honshu, the rainy season begins before the middle of June and lasts about six weeks. In late summer and early autumn, typhoons often bring heavy rain.[7]

Natural Disaster Conditions

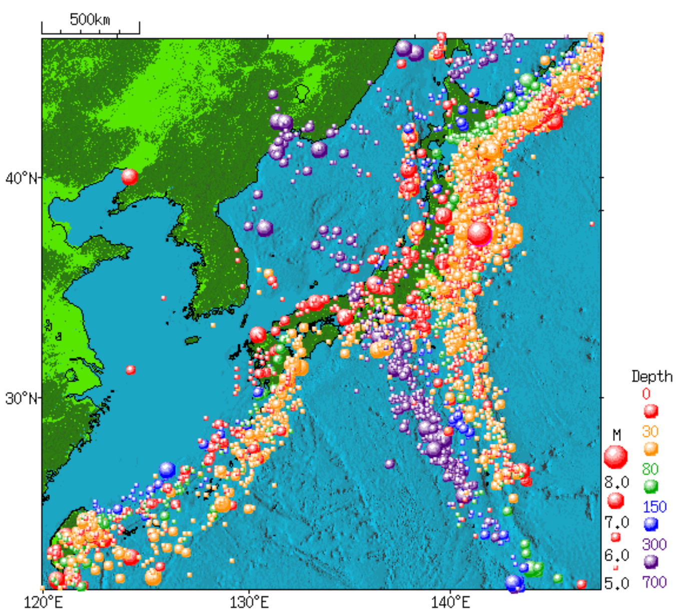

Figure 5: Earthquake Map of Japan. Source: Google

The islands of Japan are located in a volcanic zone on the Pacific Ring of Fire.

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5 "Climate". JNTO. Retrieved March 2, 2011.

6 "Gifu Prefecture sees highest temperature ever recorded in Japan 40.9". Japan News Review Society. August 16, 2007. RetrievedAugust 16, 2007.

7 "Essential Info: Climate". JNTO. Retrieved April 1, 2007.

They are primarily the result of large oceanic movements occurring over hundreds of millions of years.[8] Japan has 108 active volcanoes totally. Destructive earthquakes, often resulting in tsunami, occur several times each century.[9] The 1923 Tokyo earthquake killed over 140,000 people.[10] More recent major quakes are the 1995 Great Hanshin earthquake and the 2011 Tohoku earthquake, a 9.0 magnitude[11] quake which hit Japan on March 11, 2011, and triggered a large tsunami.[12] Due to its location in the Pacific Ring of Fire, Japan is substantially prone to earthquakes and tsunami, having the highest natural disaster risk in the developed world.[13] The Japanese have been working hard for years to minimize their damage. Japan uses state-of-the-art technologies to design quake-resistant structures and to track storms with greater precision.

8 Barnes, Gina L. (2003). "Origins of the Japanese Islands" .University of Durham. Retrieved August 11, 2009.

9 "Tectonics and Volcanoes of Japan". Oregon State University. Archived from the original on February 4, 2007. Retrieved March 27, 2007.

10 James, C.D. (2002). "The 1923 Tokyo Earthquake and Fire" (PDF). University of California Berkeley. Retrieved January 16, 2011.

11 "USGS analysis as of March 12, 2011". Earthquake.usgs.gov. June 23, 2011. Retrieved November 9, 2011.

12 Fackler, Martin; Drew, Kevin (March 11, 2011). "Devastation as Tsunami Crashes Into Japan". *The New York Times*. RetrievedMarch 11, 2011.

13 2013 World Risk Report Archived August 16, 2014, at theWayback Machine.

CHAPTER 3

TRADITIONAL AND MODERN HOUSING IN JAPAN

Housing in Japan includes modern and traditional styles. Two patterns of residences are predominant in contemporary Japan: the single-family detached house and the multiple-unit building, either owned by an individual or corporation and rented as apartments to tenants, or owned by occupants. Additional kinds of housing, especially for unmarried people, include boarding houses (which are popular among college students), dormitories (common in companies), and barracks (for members of the Self-Defense Forces, police and some other public employees).[14]

An unusual feature of Japanese housing is that houses are presumed to have a limited lifespan because of the taxable value, and are generally torn down and rebuilt after a few decades.[14] The taxable value of a house is controlled by its building material. Wooden houses are considered to have a lifespan of twenty years, and concrete ones to have a lifespan of thirty years, and the assessed price depreciates each year contrary to housing markets in other nations. Most real estate agents also use the pricing policy as a rough guided. Although there are still some wooden homes almost 100 years old with thatched roofs and concrete buildings well over the 30 year depreciation price, taxing is based upon the above method.[14]

In most countries, houses get more valuable over time. In Japan, a new buyer will

[14] https://en.wikipedia.org/wiki/Housing_in_Japan

often bulldoze the home. Why? That's the question we try to answer in our latest Freakonomics Radio podcast, "Why Are Japanese Homes Disposable?" [15]

Jiro Yoshida, a professor at Penn State University who specializes in real-estate economics, tells us that, per capita, there are nearly four times as many architects in Japan as in the U.S. (here's data from the International Union of Architects), and more than twice as many construction workers. There is also a huge demand for new homes. When you put all those numbers together, it sounds like a pretty typical housing boom — and yet Japan has a shrinking population and a long-stagnant economy.[15]

It turns out that half of all homes in Japan are demolished within 38 years — compared to 100 years in the U.S. There is virtually no market for pre-owned homes in Japan, and 60 percent of all homes were built after 1980. In Yoshida's estimation, while land continues to hold value, physical homes become worthless within 30 years. Other studies have shown this to happen in as little as 15 years.[15]

Does this make sense? Not according to Alastair Townsend, a British-American architect living in Japan, who is perplexed — and awestruck — by the housing scenario there:

> Townsend: The houses that are built today exceed the quality of just about any other country in the world, at least for timber buildings. So there's really no reason that they should drop in value and be demolished.[15]

In the podcast, we look into several factors that conspire to produce this strange scenario. They include: economics, culture, World War II, and seismic activity.[15]

[15] http://freakonomics.com/podcast/why-are-japanese-homes-disposable-a-new-freakonomics-radio-podcast-3/

Richard Koo, chief economist at the Nomura Research Institute, has argued in a paper called “Obstacles to Affluence: Thoughts on Japanese Housing” that whatever the rationale behind the disposable-home situation, the outcome isn’t desirable:

> Koo: And so you tear down the building, you build another one, then you tear down the building, and you keep on building another one, you’re not building wealth on top of wealth…And it’s a very poor investment. Compared to Americans or Europeans, or even other Asian countries where people are building wealth on top of wealth because your house is a capital good. And if you do a certain amount of maintenance you can expect to sell the house at a higher price. But in the Japanese case once you expect to sell it you expect to sell at a lower price 10 or 15 years later. And that’s no way to build an affluent society.[15]

The reasons for short buildings lifespan are complicated. Part of torn down materials can be recycled, such as wood and metals. But concrete cannot. I don’t know how to solve this problem essentially. The inspiration I achieved is the material selection. Concrete has longer life than wood, but wood is recycled and environment friendly one. What is the balance between lifespan and recycling? I will put much attention on the material selection.

Traditional Housing

Traditional Japanese houses have unique architectural and interior features that are considered an important part of Japan's history and culture. These old features are often included in new homes because many people still find them culturally significant.[16]

Family homes were historically viewed as temporary and were reconstructed approximately every 20 years. They were primarily made of wood and other natural materials such as paper, rice straw and clay.[16]

Figure 6: Traditional Japanese House. Source: Google

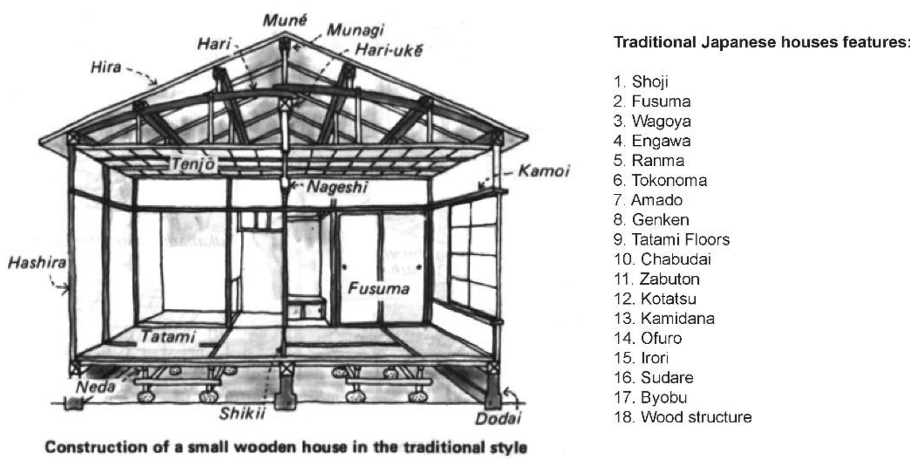


Figure 7: Traditional Japanese House Construction Details. Source: Google

The following are a few common features of traditional Japanese homes:

1. Shoji

Japanese houses didn't use historically use glass, resulting in some interesting methods of natural lighting. A shoji is a sliding panel that is made of translucent paper in a wooden frame. They are used for both interior and exterior walls. They help to give Japanese houses their character by allowing diffuse light and shadows through.[16]

Figure 8: Shoji. Source: Google

2. Fusuma

Fusuma are sliding panels that act as doors and walls. They give Japanese homes many possibilities as rooms can be dynamically reconfigured.[16]

Figure 9: Fusuma. Source: Google

3. Engawa

An engawa is an outer corridor that wraps around a Japanese house. These were traditionally used as a separator between delicate shoji and outer storm shutters. When the storm shutters are shut, engawa feel something like a secret passageway that circles a house and can be extremely narrow. In some cases, large houses have a wide engawa that resembles a wrap-around veranda when the storm shutters are open.[16]

Figure 10: Engawa. Source: Google

4. Genkan

A genkan is the main entrance to a house that has a lower level floor where you remove your shoes. This area is considered extremely dirty. People leave their shoes facing towards the door and take care not to step in the lower part of the floor in their socks. There's usually a shoe closet directly beside the genkan. A spacious genkan is a popular feature of houses since that's where guests are greeted. Wearing shoes into a home in Japan is considered a shocking breach of manners that's akin to splitting on the floor.[16]

Figure 11: Genkan. Source: Google

5. Tatami

Tatami are mat floors traditionally made of rice straw. They are a standard sizethat varies by region. Tatami are so common in Japan that houses andapartments are often measured using the size of a tatami as a unit. They represent a traditional lifestyle that involves siting and sleeping on the floor. Tatami have a soft, natural feel on your feet and have a pleasant smell when they're new. They are associated with a wide range of manners and customs such as sitting seiza.[16]

Figure 12: Tatami. Source: Google

6. Chaibudai

Chabudai are tables with short legs that are used while sitting on the floor. They are most typically used on tatami floors but make appearances on harder floors too. It's common for families to eat at a chabudai while sitting on zabuton.[16]

Figure 13: Chaibudai. Source: Google

7. Ofuro

Ofuro is the Japanese word for bath. In old Japan, homes didn't have baths and people visited communal baths known as sento each evening. By the Meiji-era, baths started to become a more common feature in houses. Japanese baths are usually in a separate room from the toilet. They often have an adjoining dressing room. The baths themselves tend to be deep but short. It's customary to completely clean yourself before entering the bath. A separate shower area sits beside the bath for this purpose. The Japanese see bathing as a leisure activity and tend to take long baths. Baths made of wood are a luxury feature of some homes and ryokan. The earliest home baths were essentially wooden drums and variations of this style remain popular.[16]

[16] http://www.japan-talk.com/jt/new/japanese-houses

Figure 14: Ofuro. Source: Google

The Structure of a Traditional Japanese House

Traditional Japanese houses are built by erecting wooden columns on top of a flat foundation made of packed earth or stones. Wooden houses exist all over the world. What are the particular characteristics of houses in Japan, where there are four distinct seasons, including a hot and humid summer and a cold winter?

In order to avoid moisture from the ground, the floor is elevated several tens of centimeters and is laid across horizontal wooden floor beams. Areas like the kitchen and hallways have wooden flooring, but rooms in which people sit, such as the living room, are covered with mats called tatami that are made from woven rush grass. Japanese generally don't use chairs on top of tatami, so people either sit directly on the tatami or on flat cushions called *zabuton.* This is why people take off their shoes when entering a Japanese house.

The frame of a Japanese house is made of wood, and the weight is supported by vertical columns, horizontal beams, and diagonal braces. Diagonal braces came to be used when the technology of foreign countries was brought to Japan. One characteristic of Japanese houses is that they have a large roof and deep eaves to protect the house from the hot summer sun, and the frame of the house supports the weight of the roof.

In the old days, the walls of houses were made of woven bamboo plastered with earth on both sides. Nowadays, though, many different types of materials have been developed, and plywood is often used. Also, in the past, many houses had columns that were exposed outside the walls. But in the Meiji era (1868-1912), houses came to be made using a method that encases the columns inside the walls in order to reduce the possibility of fire. Many roofs in the past were covered with shingles or straw, but these days most are covered with tiles called *kawara.* The roof is the part of the house most affected by rain, wind, snow, sunlight, and other natural conditions. Although there are a number of differences among the roofs seen in different areas of Japan, they all have one thing in common: They are sloped instead of flat, allowing rainwater to flow off easily.[17]

Modern Housing

For the modern housing in Japan, the traditional features are disappearing gradually. The international style influence Japanese much more than the past. Because of the limited land area, the housing in Japan is very small, so Japanese is good at tight and efficient living space design. With the time development, we have alternative construction

[17] http://web-japan.org/kidsweb/virtual/house/house01.html

technology and materials, some traditional methods and materials are no longer suitable for the modern time. What we should do to transfer the old to be the new ones? This is the key point for our contemporary architects.

Summary of Traditional and Modern Features

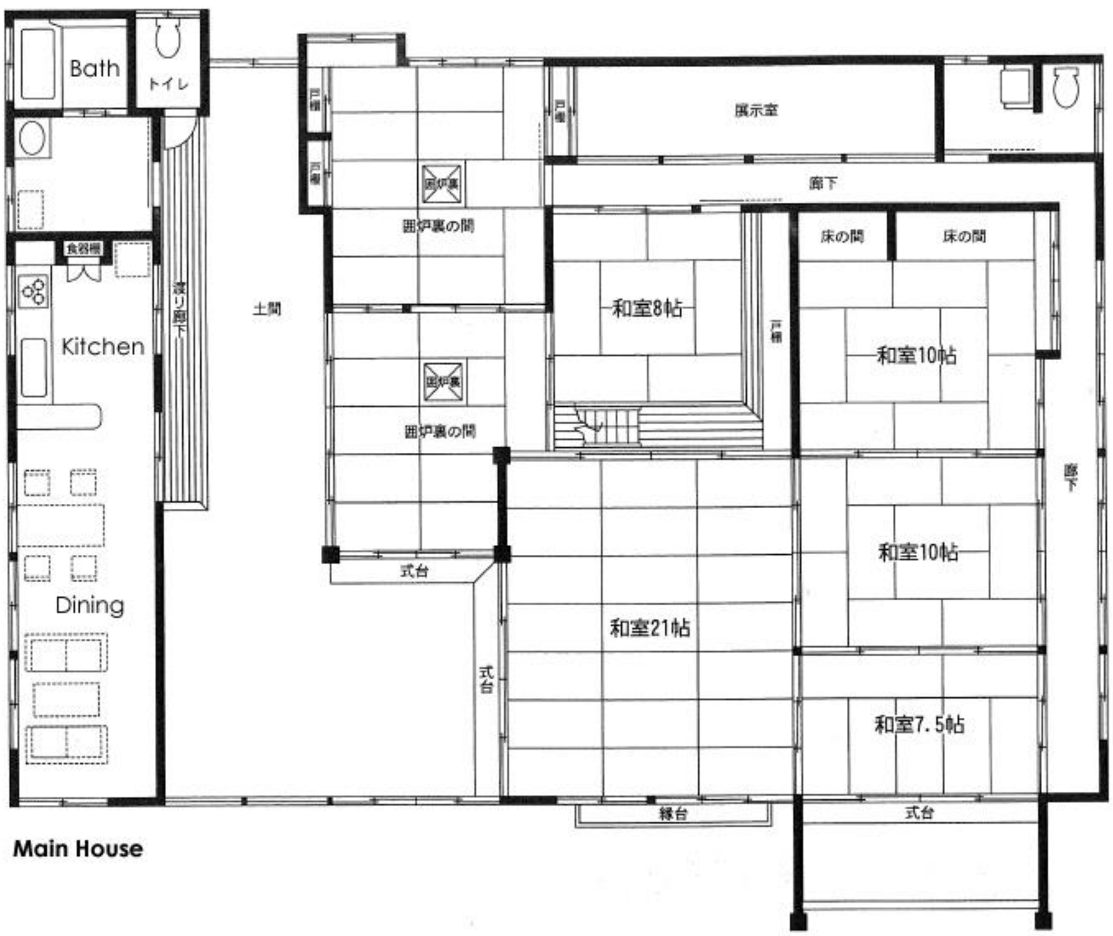


Figure 15: Tatami Layout Plan. Source: Google

Traditional Japanese housing features should be kept for the modern families. The living style has been used hundreds of years must have its existent reasons, it is our duty to inherit and develop them. What I have considered is to in my design is selecting some traditions translated into a modern constructions. Tatami is one of the most influential features for Japanese, so I have selected tatami as a major design factor. Tatami modules can control the room areas and also the height. The tatami layout can be flexible to fit different scale requirements.

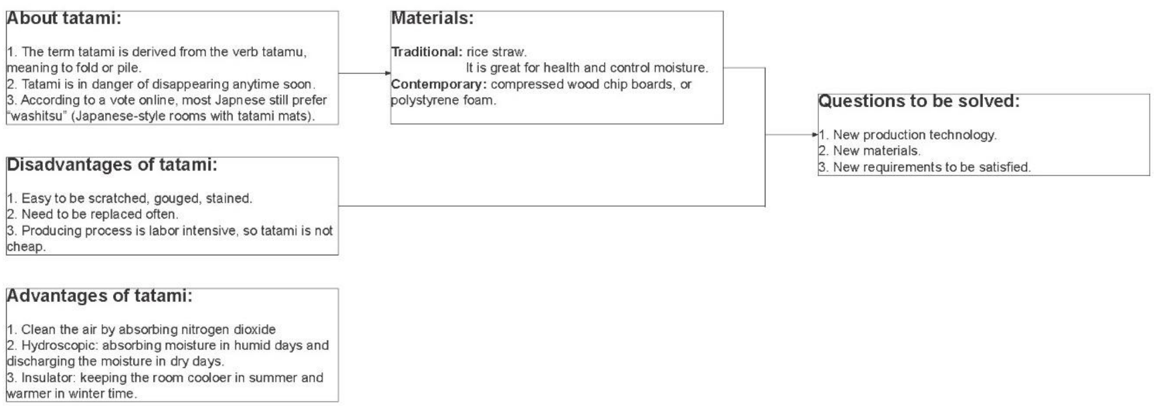


Figure 16: Summary about Tatami. Source: Author

The old tatami tradition cannot be applied to contemporary life at the large scale for different reasons. The old tatami materials cannot be used for long time, and the traditional production process are low efficient and high labor cost. So I need to find a right answer for it, what is the new tatami production technology and materials? How to satisfy the modern people’s requirements? Other features that will also be integrated, include genkan and ofuro.

Genkan is an extremely good transitional spaces between the public and private space. It is a half-private space. From the public avenue to our own home is a transition process. From the public outside space, to the half-public community space, to half-private genkan, to the final private spaces – our home. The strong sequence changing process is necessary both in the past and future. Additionally, it is a space to separate dirty and clean. All dirty shoes and other things like rain coat can be left at this space, so that our living space can be clean.

One of the most important reason for keeping the traditional public bath is the communication. A lot of people cannot recover from huge disasters quickly, a good way to heal that is communication. The public bath create this kind of common space. Shower itself is a relaxing way, in this condition, people can relax themselves totally. Undoubtedly, more communication spaces such as public bath should be built in the long term communities.

CHAPTER 4

SHELTER CONDITIONS IN THE WORLD

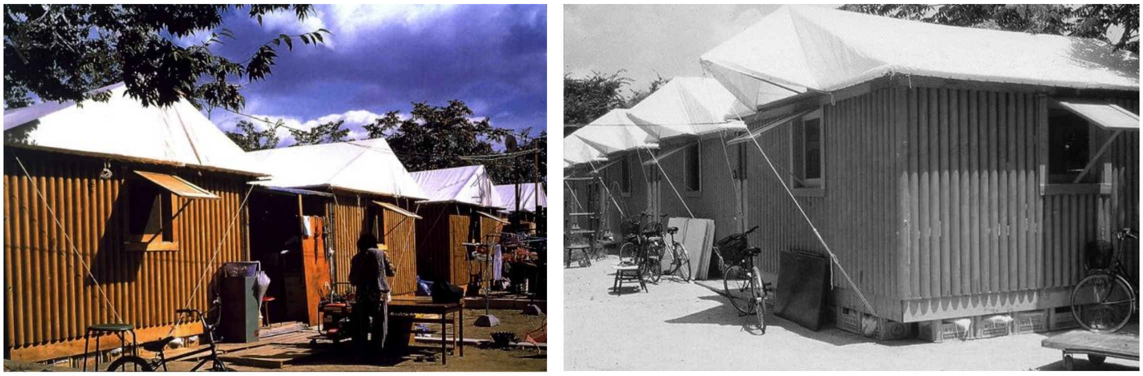


Figure 17: Shelters design 1 by Shigeru Ban. Source: Google

Figure 18: Shelter design 2 by Shigeru Ban, Source: Google

There are not many architects in the world focus on shelter design for refugees. Shigeru Ban is a good role model, he is a leading architect who has applied what his talents into shelter projects. One example, the recycle paper tube can be used into many areas with low cost and fast construction speed all needed. As the picture shows, his paper tube can be used as rapid shelters, adaptable shelters both inside and outside, which can be built by everybody. This is what we really need after huge disasters.

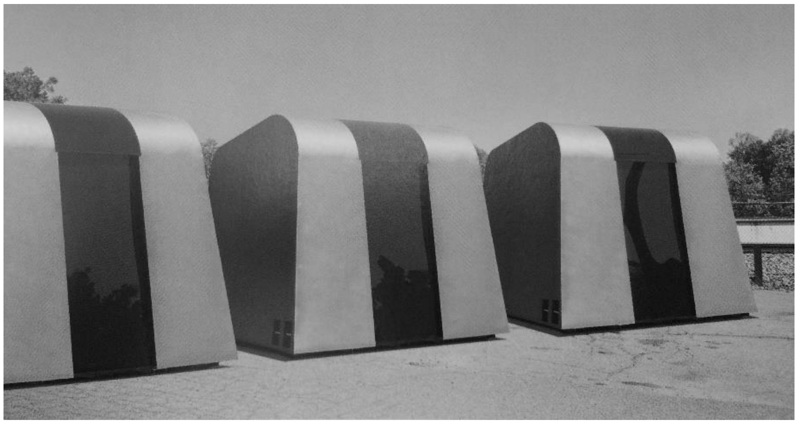


Figure 19: Urgent Shelter 1. Source: *Urgent architecture*

Figure 20: Urgent Shelter 2. Source: *Urgent architecture*

Figure 21: Urgent Shelter 3. Source: *Urgent architecture*

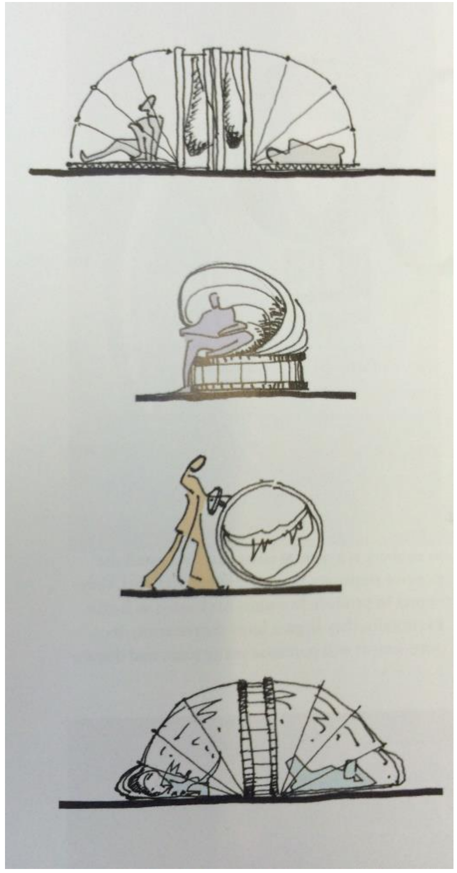


Figure 22: Urgent Shelter 4. Source: *Urgent architecture*

There are some urgent architectures design, there are five categories: rapid shelters, transitional shelters, affordable housing, prefab housing and adaptable housing community. Some consideration for different types includes: deployment, assembly time, skill level and tools, cost, durability, security, reusability, improvements, energy efficiency etc. Various consideration requirements should be done for different process. The pictures I list here illustrate two rapid shelter design. They are prefabricated, light and easy to be moved. However, I cannot find a series design that can become long term communities. The disconnection between these phases is problematic. The rapid shelter is a quick shelter place for people, but they don't have a stable foundation system, and the inside living environment is best for a temporary refuge camp. The adaptable housing and long living housing normally will take long time to be built, which means refugees have to live in a rapid shelter for a long time without a safe and comfortable conditions. The 9.0 magnitude earthquake in Japan 2011, two and a half years later after the triple disaster, there are still over half refugees live in simple rapid shelters.[18] My thesis design strikes to create a series of living types for refugees' immediate and long term post-disaster life. The time line can be extended over 2 years. During this process, based on the phase one design, people will keep receiving better living environment above the original living foundation. Before they can have access to a long living house, they will be offered transitional spaces that will also prove a comfortable housing. Some public space should be added as a plus, after huge disaster, psychological recovery is the key point for them. Additionally considers other community spaces that will contribute to a the final long living community.

[18] http://www.japantoday.com/category/national/view/nearly-290000-people-still-living-in-shelters-2-12-years-after-tohoku-disaster

CHAPTER 5

CASE STUDY

Case One – Nakagin Capsule Tower

Figure 23: Kisho Kurokawa

Kisho Kurokawa (April 8, 1934 – Oct.12, 2007) was a leading Japanese architect and one of the founders of the Metabolist Movement, whose members were known as Metabolists. It was a radical Japanese avant-garde movement pursing the merging and recycling of architecture styles within an Asian context.[19]

Figure 24: Nakagin Capsule Tower. Source: Google

Type: Residential, office

Architectural style: Metabolism

Location: Tokyo, Japan

Construction started: 1970

Completed: 1972

Floor count: 13

Floor area: 33,273.7 sf

Architect: Kisho Kurokawa

The Nakagin Capsule Tower is a mixed-use residential and office tower designed

[19] http://www.archdaily.com/tag/kisho-kurokawa

by architect Kisho Kurokawa and located in Shimbashi, Tokyo, Japan.[20]

Completed in 1972, the building is a rare example of Japanese Metabolism, an architectural movement emblematic of Japan's postwar cultural resurgence. The building was the world's first example of capsule architecture built for permanent and practical use. The building still exists but has fallen into disrepair. As of October 2012, around thirty of the 140 capsules remained in use as apartments, while others were used for storage or office space, or simply abandoned and allowed to deteriorate.[20]

This building is actually composed of two interconnected concrete towers, respectively eleven and thirteen floors, which house 140 prefabricated models (or "capsules") which are each self-contained units. Each capsule measures 7.5ft x 12ft x 6.9ft and functions as a small living or office space. Capsules can be connected and combined to create larger spaces. Each capsule is connected to one of the two main shafts only by four high-tension bolts and is designed to be replaceable. No units have been replaced since the original construction.[20]

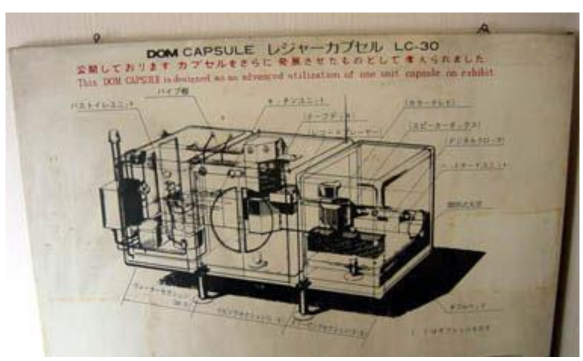


Figure 25: Image for Nakagin Capsule Tower. Source: Google

"Everything need to be repaired regularly, if we can replace the capsule every 25 year, this building can last 200 years." – by Kisho Kurokawa[20]

The capsules were fitted with utilities and interior fittings before being shipped to the building site, where they were attached to the concreted towers. Each capsule is attached independently and cantilevered from the shaft, so that any capsule may be removed easily without affecting the others. The capsules are all-welded lightweight steel-truss boxes clad in galvanized, rib-reinforced steel panels. After processing, the panels were coated with rust-preventative paint and finished with a coat of Kenite glossy spray.[20]

Figure 26: Nakagin Capsule Tower Interior Detail 1

Figure 27: Nakagin Capsule Tower Interior Detail 2

Figure 28: Nakagin Capsule Tower Exterior Detail 3

Figure 29: Nakagin Capsule Tower Model. Source: Google

The cores are rigid-frame, made of a steel frame and reinforced concrete. From the basement to the second floor, ordinary concrete was used; above those levels, lightweight concrete was used. Shuttering consists of large panels the height of a single storey of the tower. In order to make early use of the staircase, precast concrete was used in the floor plates and the elevator shafts. Because of the pattern in which two days of steel-frame work were followed by two days of precast concrete work, the staircase was completely operational by the time the frame was finished. On-site construction of the elevators was shortened by incorporating the 3-D frames, the rails, and anchor indicator boxes in the precast concrete elements and by employing prefabricated cages.[20]

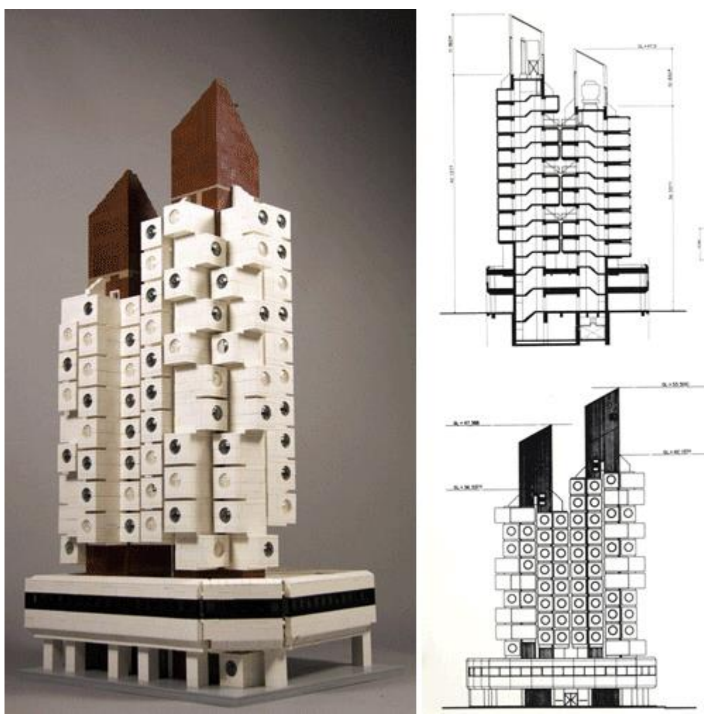


Figure 30: Nakagin Capsule Tower Model and Drawings. Source: Google

The original target demographic were bachelor salarymen. The compact apartments included a wall of appliances and cabinets built into one side, including a kitchen stove, a refrigerator, a television set, and a reel-to-reel tape deck. A bathroom unit, about the size of an aircraft lavatory, is set into an opposite corner. A large circular window over a bed dominates the far end of the room.[20]

Construction occurred on site and off site. On-site work included the two towers and their energy-supply systems and equipment, while the capsule parts were fabricated and the capsules were assembled at a factory.[20]

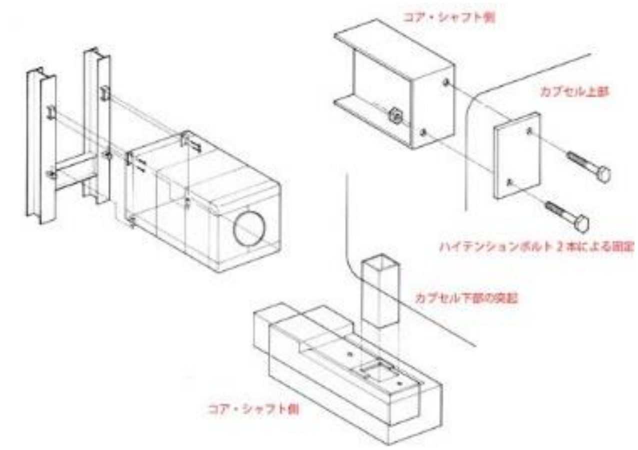


Figure 31: Structure Detail Drawing 4. Source: Google

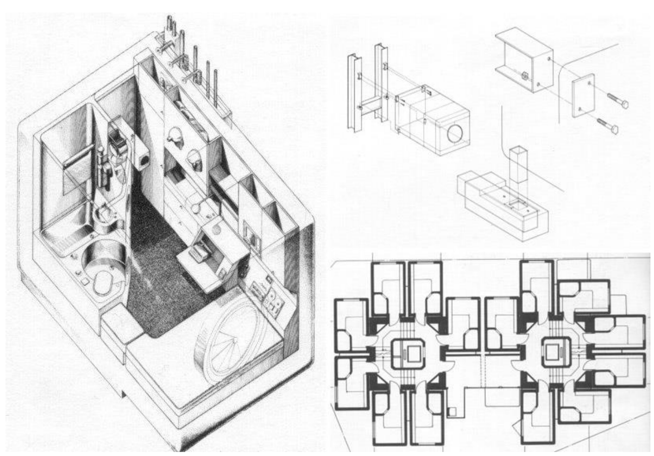


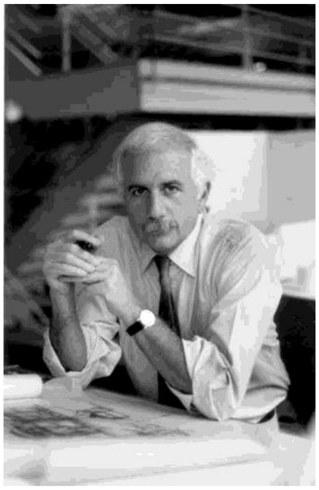
Figure 32: Structure Detail Drawing 5. Source: Google

[20] https://en.wikipedia.org/wiki/Nakagin_Capsule_Tower

Design Flaws:

1. The caplsules' asbestos insulation is deteriorating, so winters are cold, and summer can get very hot.
2. Corroding pipes, water damage
3. Capsule replacement is expensive. So one of the capsule has ever been replaced as the original design thought every 25 years.
4. Narrow spaces, scale problem
5. The fixed double layer window block the natural ventilation.
6. Too many theoretical but not realizable ideas
7. Dull functional space, the capsule fulfils the modern function of a 'machine for living', but not suitable for modern life.
8. No hot water supply.
9. Leakage on rainy days often.
10. Safe requirement cannot satisfy the current codes.

Case Two – Habitat 67



Moshe Safdie, CC, FAIA (born July 14, 1938) is an Israeli/Canadian/American architect, urban designer, educator, theorist, and author. He is most identified with Habitat 67, which paved the way for his international career.[21]

Figure 33: Moshe Safdie. Source: Wikipedia

Figure 34: Habitat 67. Source: Google

Habitat 67, or simply Habitat, is a model community and housing complex in Montreal,Canada, designed by Israeli/Canadian architect Moshe Safdie. It was originally conceived as his master's thesis in architecture at McGill University and then

[21] Dvir, Noam (2012-02-03). "Israeli Architecture With Eastern Promise". *Haaretz*. Retrieved 2016-04-04.

built as a pavilion for Expo 67, the World's Fair held from April to October 1967. It is located at 2600 Avenue Pierre-Dupuy on the Marc-Drouin Quay next to the Saint Lawrence River. Habitat 67 is widely considered an architectural landmark and one of the most recognizable and significant buildings in both Montreal and Canada.[22][23]

Figure 35: Habitat 67 Detail 1. Source: Google

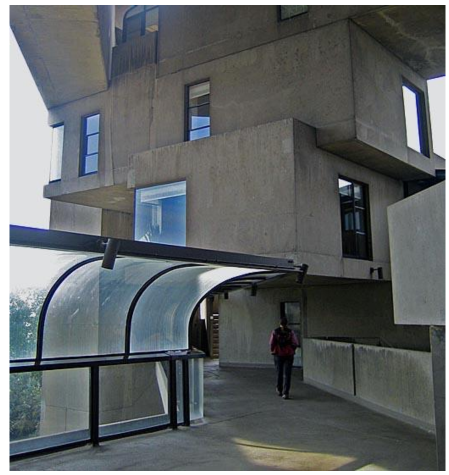


Figure 36: Exterior Detail 2. Source: Google

Habitat 67 comprises 354 identical, prefabricated concrete forms arranged in various combinations, reaching up to 12 stories in height. Together these units create 146 residences of varying sizes and configurations, each formed from one to eight linked concrete units.[24] The complex originally contained 158 apartments,[25] but several apartments have since been joined to create larger units, reducing the total number. Each

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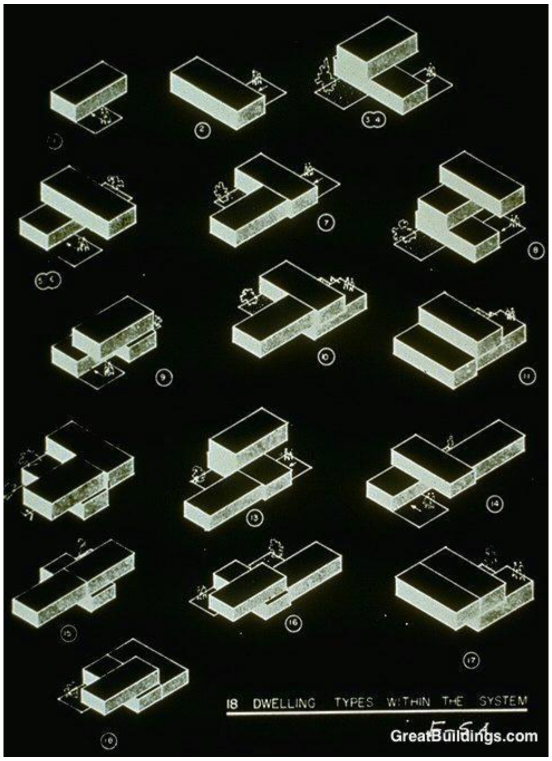
[22] Fox, Matthew (January 4, 1997). "At home in Habitat". *Toronto Star*. p. J1.

[23] Langan, Fred (March 7, 1997). "The homey feeling of living in boxes". *The Christian Science Monitor* (Boston). p. 10.

[24] "Habitat 67". Complexe de la cit é du havre. RetrievedNovember 24, 2011. 354 cubes of a magnificent grey-beige build up one on the other to form 146 residences

[25] Safdie, Moshe (1974). *For Everyone a Garden*. MIT Press.LCCN 73016432.

unit is connected to at least one private terrace, which can range from approximately 20 to 90 square metres (225 to 1,000 sq ft) in size.[22]



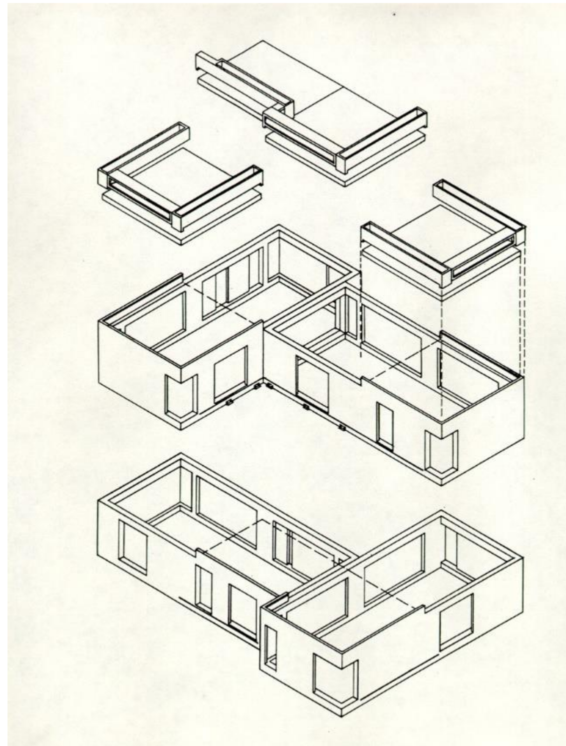


Figure 37: Combining Form. Source: Google   Figure 38: Explosive View. Source: Google

The development was designed to integrate the benefits of suburban homes, namely gardens, fresh air, privacy, and multilevelled environments, with the economics and density of a modern urban apartment building.[20] It was believed to illustrate the new lifestyle people would live in increasingly crowded cities around the world.[26] Safdie's goal for the project to be affordable housing largely failed: demand for the building's units has made them more expensive than originally envisioned.[20] In addition, the existing structure

[26] Rémillard, François; Merrett, Brian (1990). *Montreal architecture : a guide to styles and buildings*. Montreal: Meridian Press. p. 195.

was originally meant to only be the first phase of a much larger complex, but the high per-unit cost of approximately C$140,000 prevented that possibility.[27]

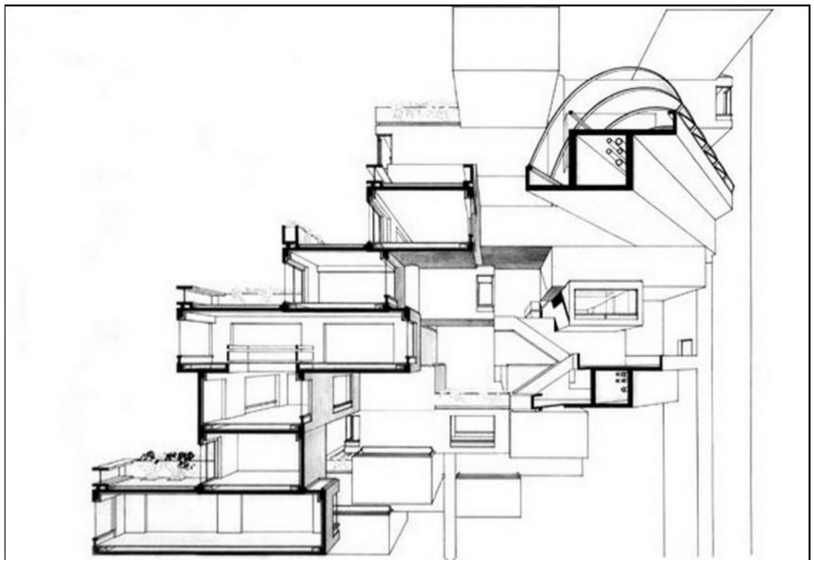


Figure 39: Section Perspective. Source: Google

Figure 40: Site Construction. Source: Google

As one of the major symbols[28] of Expo 67, which was attended by over 50 million

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[27] Penketh, Anne (October 17, 1980). "Habitat, 13 years later". *Globe and Mail*.

[28] Safdie, Moshe (June 27, 1997). *Safdie/Stevens/Walker*. Interview with Charlie Rose. *Charlie Rose*. Retrieved November 25, 2011.

people during the year it was open, Habitat 67 gained world-wide acclaim as a "fantastic experiment"[29] and "architectural wonder".[21] This experiment was and is regarded as both a success and failure—it "redefined urban living"[30] and has since become "a very successful co-op",[20] but at the same time ultimately failed to revolutionize affordable housing or launch a wave of prefabricated, modular development as Safdie had envisioned.[20] Despite its problems, however, Habitat's fame and success "made [Safdie's] reputation"[26] and helped launch his career; Safdie has now designed over 75 buildings and master plans around the world.[28]

Even now, more than 40 years after Habitat, much of Safdie's work still holds to the concepts that were so fundamental to its design, especially the themes of reimagining high-density housing and improving social integration through architecture that have become "synonymous" with his work.[31]

Summary about Case Studies

Habitat 67 is the original one to apply this concept, after it there are a lot of buildings copy or transfer this concept, Nakagin Capsule Tower is one of them. They are not shelters design, but I am interested in the starting point. This prefabricated unit is my

[29] Weder, Adele (January–February 2008). "For Everyone a Garden".*The Walrus* **5** (1): 88–93. Retrieved November 25, 2011.

[30] Safdie, Moshe (August 22, 2011). *Moshe Safdie; NFL team Owners Jerry Richardson & Jerry Jones*. Interview with Charlie Rose. *Charlie Rose*. Retrieved November 25, 2011.

[31] Makary, Martin (February 1, 2007). "A Life Less Ordinary".*designbuild-network.com*. Retrieved November 25, 2011.

inspiration, can I design a rapid shelter in this way? Habitat 67 is successful until right now, but Nakagin Capsule Tower is failed. Compare these two, we can find that the installation process is good, but the unit is the key to determine success and fail. The unit module is tiny, not comfortable to use, no natural ventilation, no fresh air input, and high cost for renovation. So the Nakagin Tower face to be torn down right now, which is so bad. It is a new attempt in that time, but not successful. Both of these two cases plan to change the unit after 10-20 years. But that is unreal, it takes a large sum of money to change only one unit. With that cost, most people will prefer a new building instead of renovate the old one. That is one of the failed point. So what I need to do is to be inspired by the module unit concept, and transfer this unit into a long living form. With the time changing, the unit's life span as longer as the permanent house. This is the 1st job for me.

And then the 2nd task is the unit design part. A comfortable, sustainable and flexible module is what I want. The limited interior makes Nakagin Capsule Tower to be not an ideal living space. So what is people really need? How to decide the scale? How to layout and decide the interior functional space? With the help of these two cases, I begin my project design.

CHAPTER 6

SITE SELECTION AND ANALYSIS

I have focused on rural site communities to develop my proposal. In order to make this project clear, I select Sendai as an example site. In the 9.0 magnitude earthquake 2011, it was strongly suffered from the triple disasters.

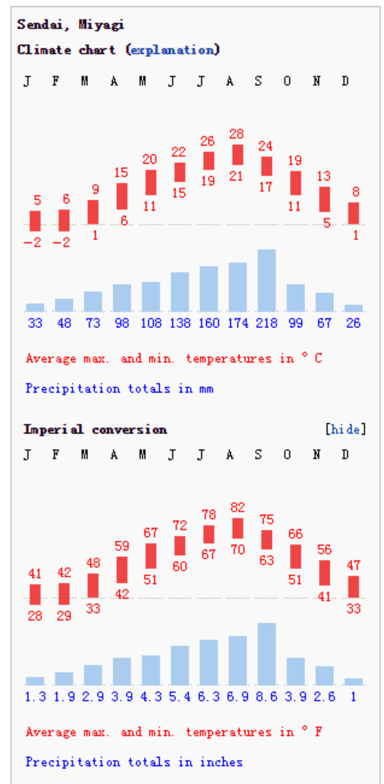

Figure 41: Location of Sendai. Source: Author Figure 42: Climate of Sendai. Source: Wikipedia

Climate data for Sendai, Miyagi (1971-2000) [hide]

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Average high °C (°F)	5.2 (41.4)	5.5 (41.9)	8.8 (47.8)	14.8 (58.6)	19.5 (67.1)	22.0 (71.6)	25.7 (78.3)	27.9 (82.2)	24.1 (75.4)	19.1 (66.4)	13.4 (56.1)	8.3 (46.9)	16.2 (61.2)
Daily mean °C (°F)	1.5 (34.7)	1.7 (35.1)	4.5 (40.1)	10.1 (50.2)	14.9 (58.8)	18.3 (64.9)	22.1 (71.8)	24.1 (75.4)	20.4 (68.7)	14.8 (58.6)	9.1 (48.4)	4.3 (39.7)	12.1 (53.8)
Average low °C (°F)	−2 (28)	−1.8 (28.8)	0.5 (32.9)	5.7 (42.3)	10.8 (51.4)	15.3 (59.5)	19.3 (66.7)	21.2 (70.2)	17.2 (63)	10.8 (51.4)	4.9 (40.8)	0.6 (33.1)	8.5 (47.3)
Average precipitation mm (inches)	33.1 (1.303)	48.4 (1.906)	73.0 (2.874)	98.1 (3.862)	107.9 (4.248)	137.9 (5.429)	159.7 (6.287)	174.2 (6.858)	218.4 (8.598)	99.2 (3.906)	66.8 (2.63)	26.4 (1.039)	1,241.8 (48.89)
Average snowfall cm (inches)	29 (11.4)	31 (12.2)	15 (5.9)	1 (0.4)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (0.4)	14 (5.5)	90 (35.4)
Average snowy days	19.5	17.4	11.6	1.7	0.1	0.0	0.0	0.0	0.0	0.0	2.5	11.9	64.7
Average relative humidity (%)	65	64	62	64	70	80	83	81	78	71	67	65	70.8
Mean monthly sunshine hours	151.3	151.9	182.3	190.9	198.7	127.9	127.7	155.4	119.8	151.8	140.2	144.7	1,842.6

Source: [10]

Figure 43: Temperature in Sendai. Source: Wikipedia

Urban Site Analysis

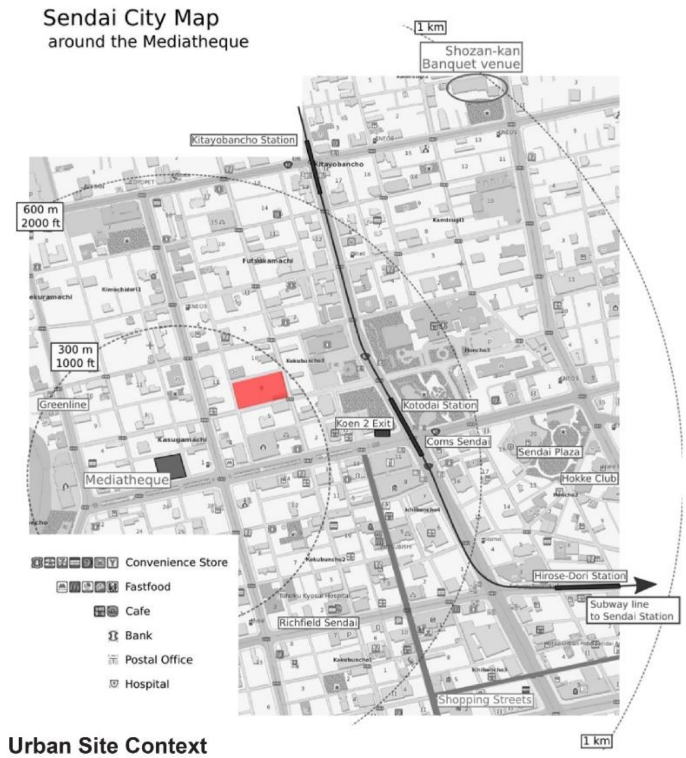

Figure 44: Urban Site. Source: Author

The site I select in Sendai urban regions is only 1000ft from Sendai Mediatheque. It is a typical urban block, 360ft long by 200ft wide. It is located at the heart of Sendai. The Sendai city office is located on the next block. In front of the Sendai city office, there is large open area available for the public. It is a city garden for the residents. Which is perfect for an urban site. After a huge disaster, we assume everything is destroyed, buildings become ruins. So at this time an existed open area is essential for refugees. The rapid shelters can be built on it in high density. And then another 7 days later, rapid shelters can be transported to other block, such as the site we selected.

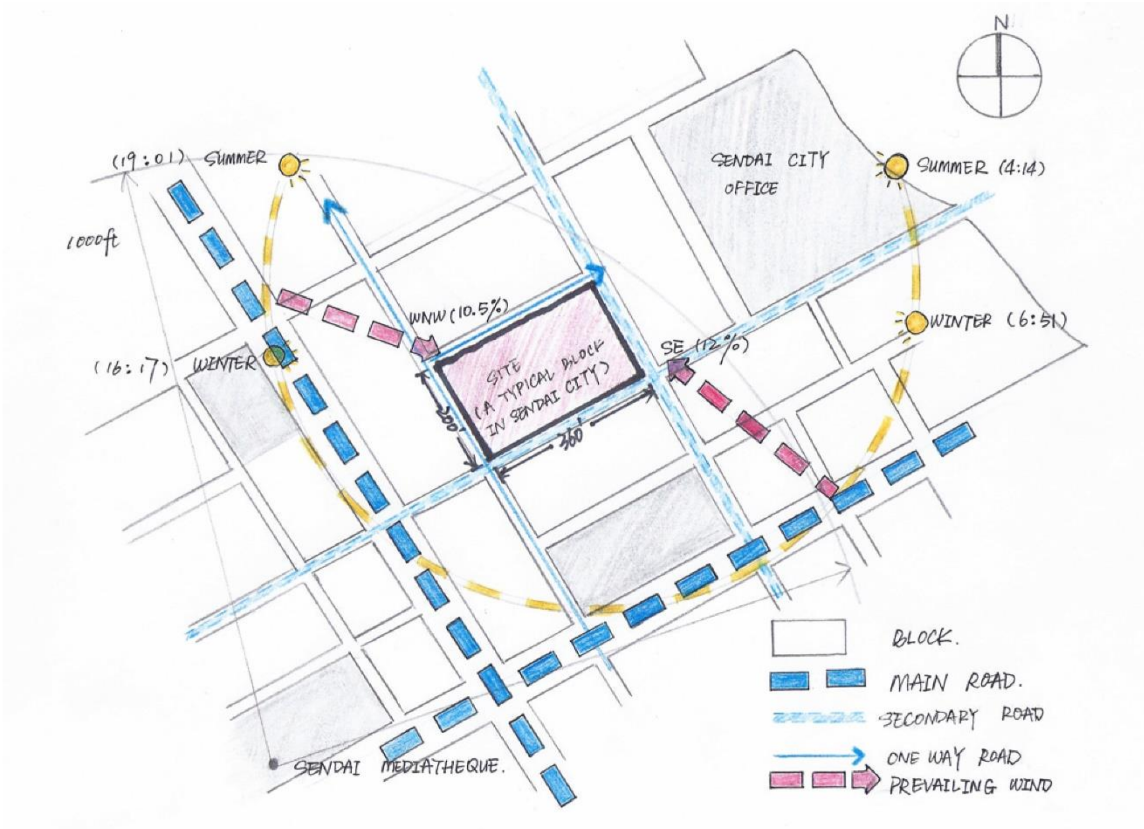

Figure 45: Urban Site Analysis. Source: Author.

The prevailing wind directions are southeast and westnorthwest. And the site can receive very good sunshine. The convenient road system is the other necessary factor for the site selection. Developed transportation system can deliver daily goods easily and the rapid shelter also can be moved to the site.

Rural Site Analysis

The typical block size is 250ft by 125ft, located at the urban region in Sendai. On the west side, it is a public park, next to it is a hospital. Swimming pool is located on the north side. Transportation system is convenient here. Both the park and the swimming pool is very good region for the initial shelter construction. At the beginning, the park can be used as the farm land for refugees' daily life.

Figure 46: Rural Site. Source: Author

The sun path diagram and prevailing wind directions are the same as the urban one. The factors I illustrate here are necessary keys for a long living community development process, but not only limited to be this kind of area. For the north and south place in Japan, climate is largely different, based on different location, site selection concept can be adjusted at the same time.

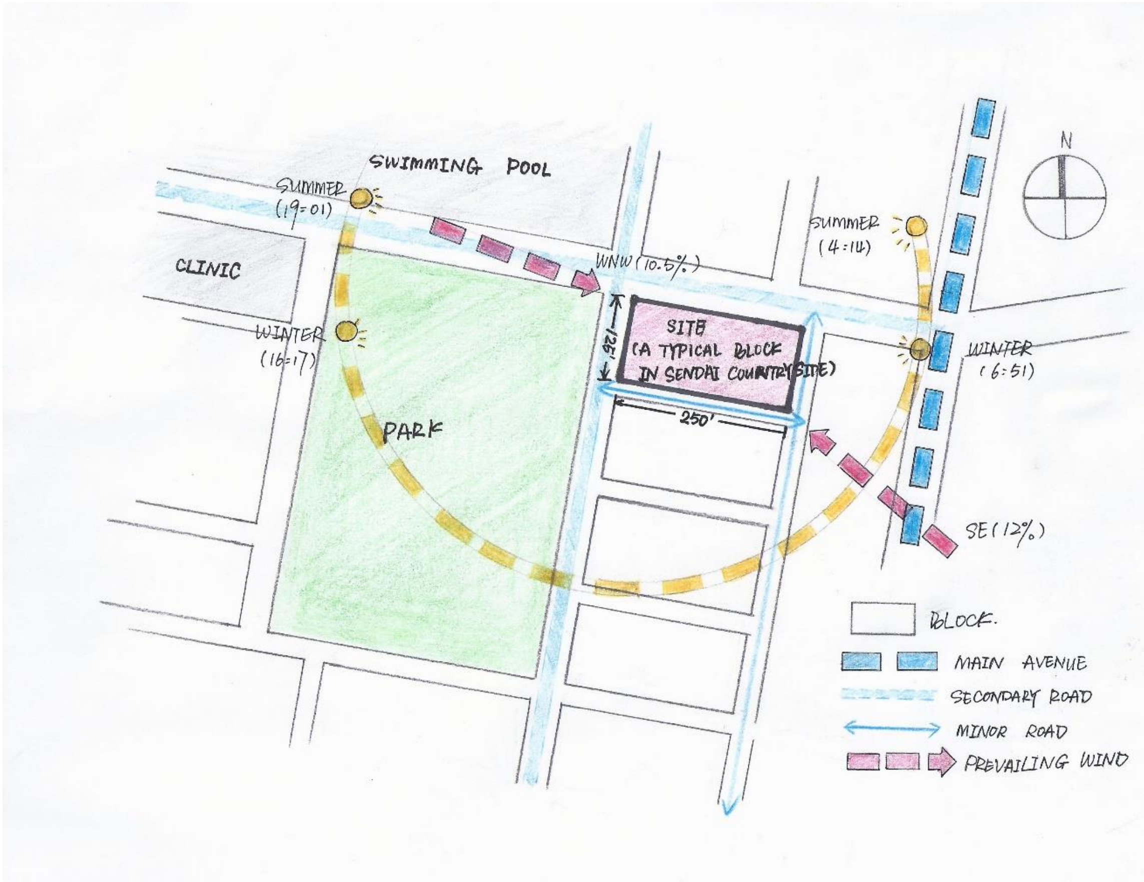

Figure 47: Rural Site Analysis. Source: Author

CHAPTER 7

DESIGN

I am inspired by the two precedent study: Habitat 67 and Nakagin Capsule Tower for some points, so the module unit is my start point. The concept for it should be a tiny and high efficient space design with traditional Japanese features, combined with sustainable systems. Two proposals: horizontal development for rural regions, vertical generation for urban regions.

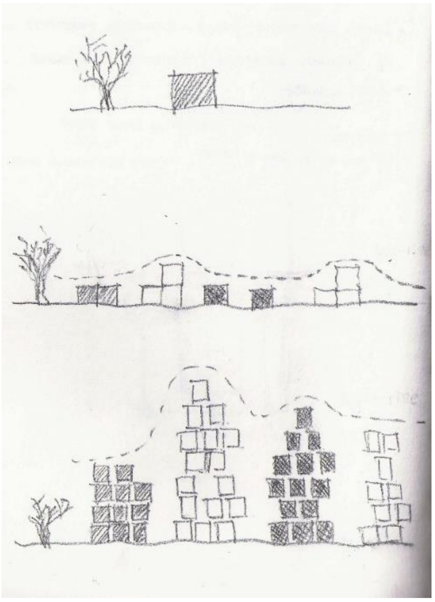

Figure 48: Concept Sketch Drawing. Source: Author

The entire project is divided into 4 phase, considering from both end. What are refugees' really needed at the beginning after the disaster? What do people want to achieve for a long living community? How to transfer these phases? What is the connections between each phase? The time line is spread from the first day after the disaster to 2 years later.

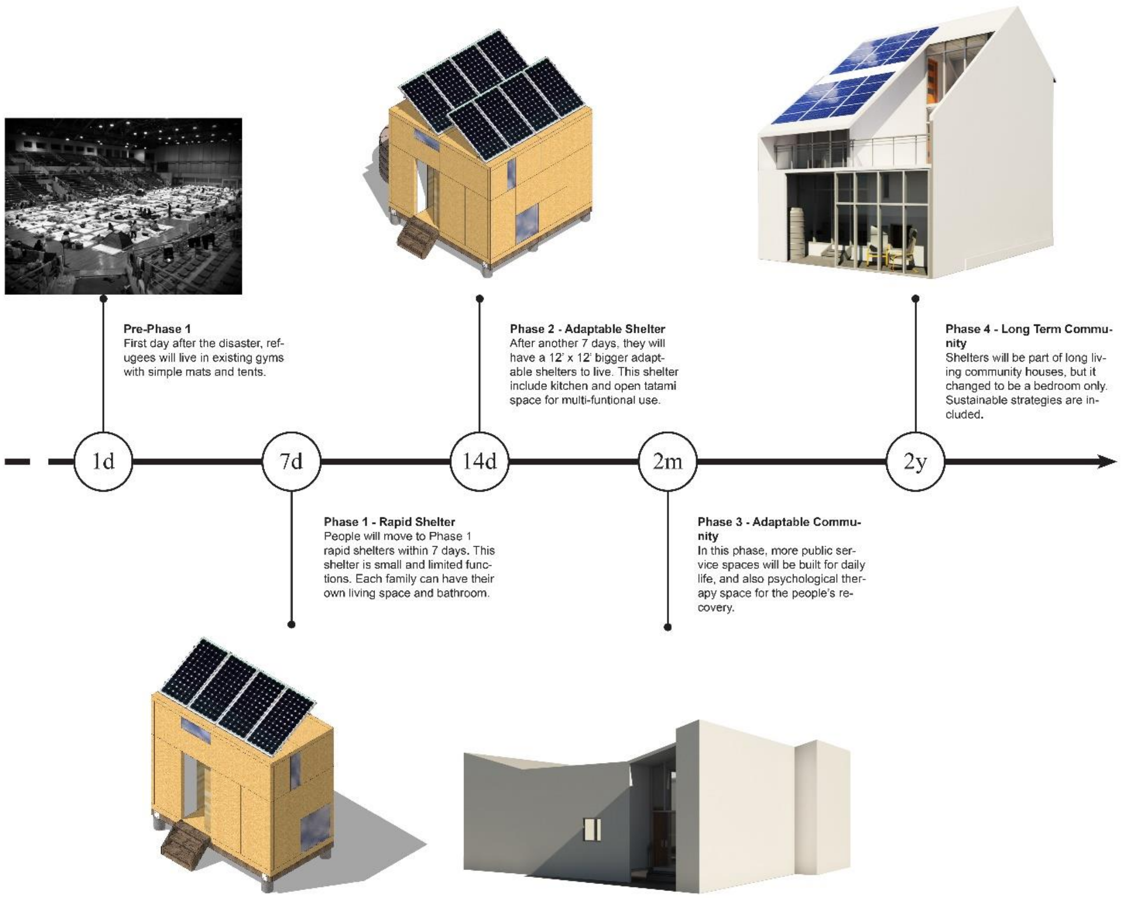

Figure 49: Time Line. Source: Author

Pre-Phase 1 is not part of my design. Refugees will move to an existed large interior space, such as gym, with simple mats or tents. Seven days are the proposed days to live here. Seven days later phase 1, the rapid shelter, will be completed. 12’ by 6’ space for each unit, and private toilet and living space only. Solar panels also will be installed at the same time. After another 7 days phase 2, adaptable shelter, will be done. The size is 12’ by 12’, a kitchen and closet are added. Large open interior areas for multiple use, and it is a traditional Japanese style. Two month later, an adaptable community can be applied into use. A community center is completed, residents will enjoy more common spaces.

And then in the end, they will live in a long living community with comfortable house.

Phase 1 – Rapid Shelters

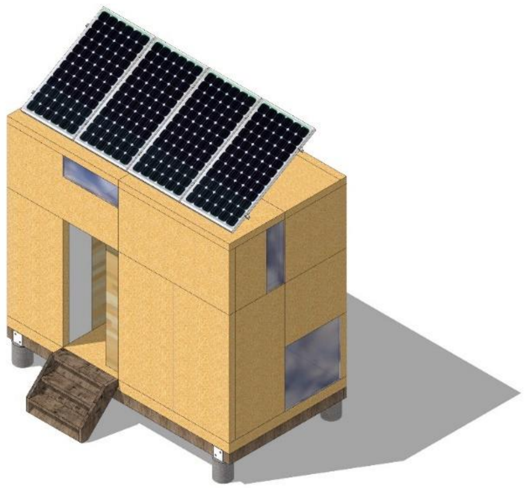

Figure 50: Perspective of Rapid Shelter. Source: Author

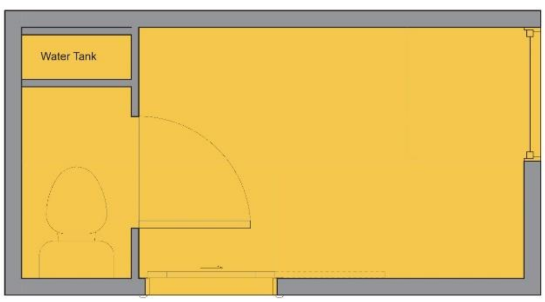

Figure 51: Phase One Plan. Source: Author

We can assume that there are 340 refugees live in the gym on the disaster day, each rapid shelter is design for up to 4 people, so we need about 85 rapid shelters. All 85 rapid shelters are built next to the gym or close open spaces with temporary foundation. There is no specific facing direction for it, the shelter can be built wherever they want. This is necessary for the real condition. Normally after disaster, we cannot find a good site, such as crack, collapsed buildings and trees. The flexible rapid shelter can fit this kind of site better. In the rapid shelter, there is a sliding door, 4 tatami mats, living space, toilet, custom size water tank and solar panels. Some people will ask what is the difference between pre-phase 1 and phase 1, refugees still live in tiny spaces? My answer is the privacy. Each family has their own shelter and toilet, the privacy is the basic need for the home.

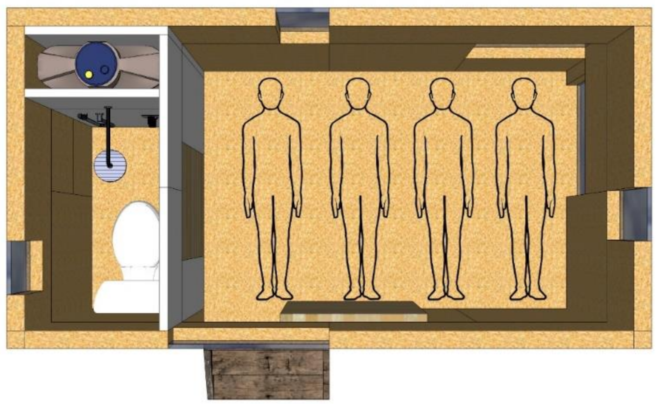

Figure 52: Phase One Perspective Plan. Source: Author

After huge disaster, we assume all plumbing systems are destroyed, there is no clean fresh water supply. A water tank is necessary, limited to the tatami module space, a 160 gallon custom size water tank can fit in it. Sliding door is a traditional Japanese type of door, and the higher and lower windows can provide natural ventilation.

For the foundation system I select sauna tubes because of its fast and easy features. The foundation system is built on the ground as the temporary use, so the entire construction process will be easier. Above sauna tubes there is a beam system for the reason that the SIPs panel is not strong enough to support the entire load.

SIPs panel is the material for floor, walls and roof. It is not a finish material, so more wall and roof layers are needed. But for phase one, it only lasts for 7 days, SIPs panel can survive within short time. Above the floor panel, a 4 mats tatami is installed on it. Traditional Japanese housing size is controlled by tatami, each tatami is 6’ by 3’. Four tatami make up of a 12’ x 6’ floor mats. And the height of the shelter is 1.5 tatami mats, which equals to 9 ft. All data is decided by tatami, the window sizes are 1’ x 3’, 3’ x 3’. The only specific one is in the toilet, 1’ x 2’. Considered about people’s visual height 5’7”. In order to have a private toilet space, I higher the sill height to be 6’ + 6” foundation height.

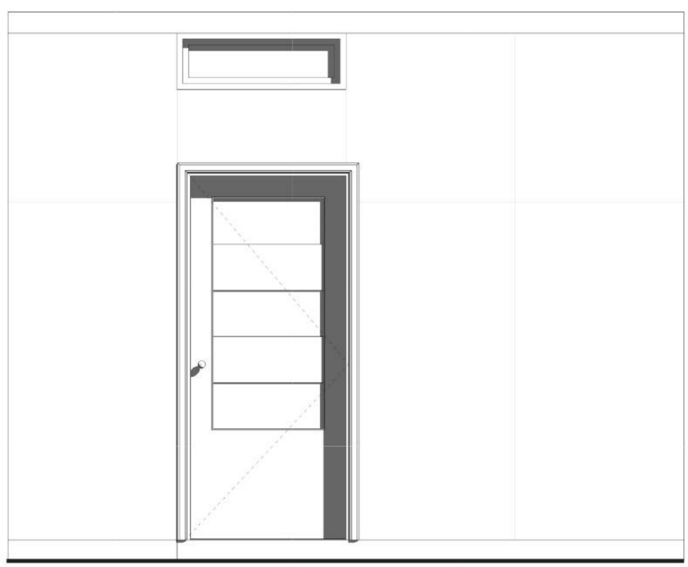

Figure 53: Phase One Front Elevation. Source: Author

In order to satisfy residents’ daily use, solar panels are needed to be installed. The flat roof can provide more facing options for solar panels, but still with slightly slope for water collection. Some quick and folded solar panels are good choice for the rapid shelter.

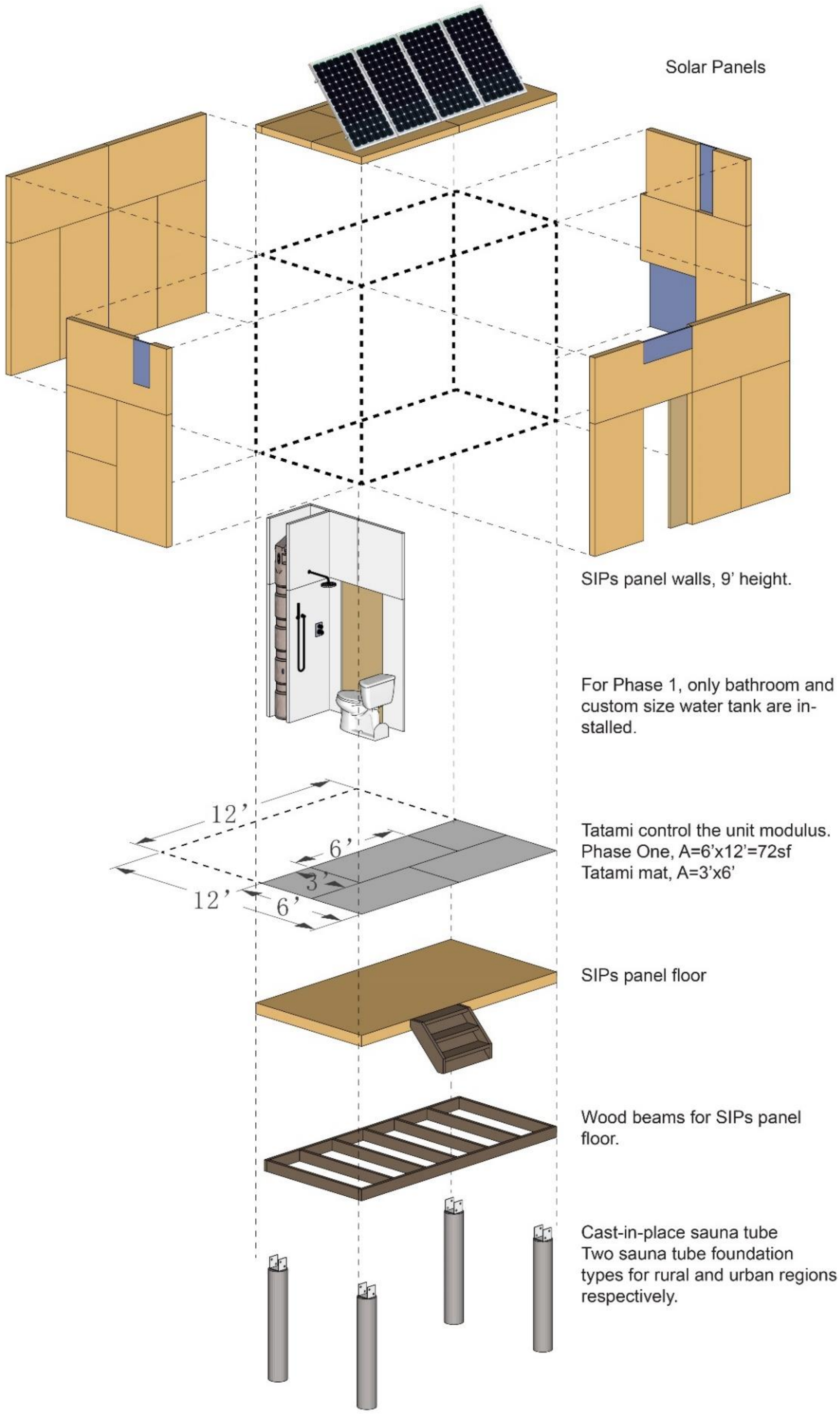

Figure 54: Explosive View of Phase One. Source: Author

Phase 2 – Adaptable Shelter

Figure 55: Perspective View of Phase Two. Source: Author

Figure 56: Phase Two Plan. Source: Author

The 85 rapid shelters will be transported into 5 different site in the local rural areas and become part of the long term community. 17 shelters are a group. In this phase, people have a larger living spaces, it is 8 tatami mats unit and the entire size is 12’ x 12’. Private kitchen, tiny genkan, wardrobe and larger interior living spaces are built in this phase.

There is no too many fixed furniture so that the limited space can satisfy more functional requirement.

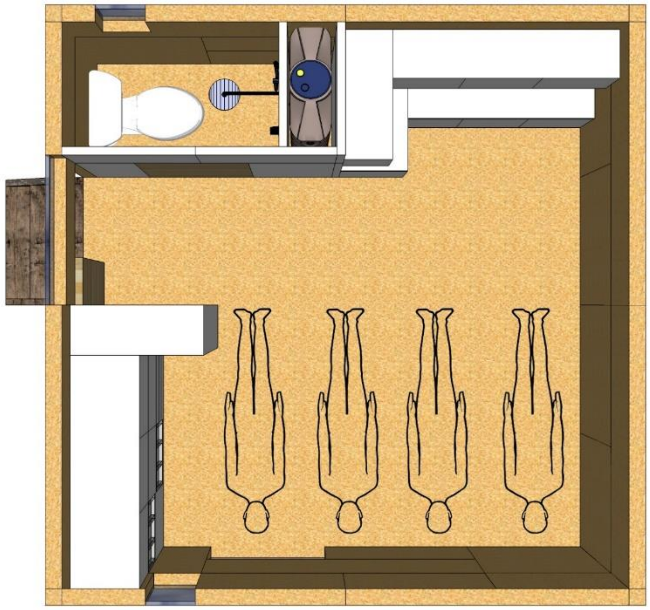

Figure 57: Perspective Plan of Phase Two. Source: Author

Phase 2 is the continuous step for phase 1, so it is still design for up to 4 peoples. The foundation system is permanent sauna tubes, and the facing is designated. The east wall is the original wall in phase 1 and moved 6’ to the east side. A shoes closet can separate genkan from the living space. I also design a folding clothes hanger which is installed on the wardrobe. It can be folded back and hidden in the wardrobe. When we want to use it, just rotate it 90 degrees.

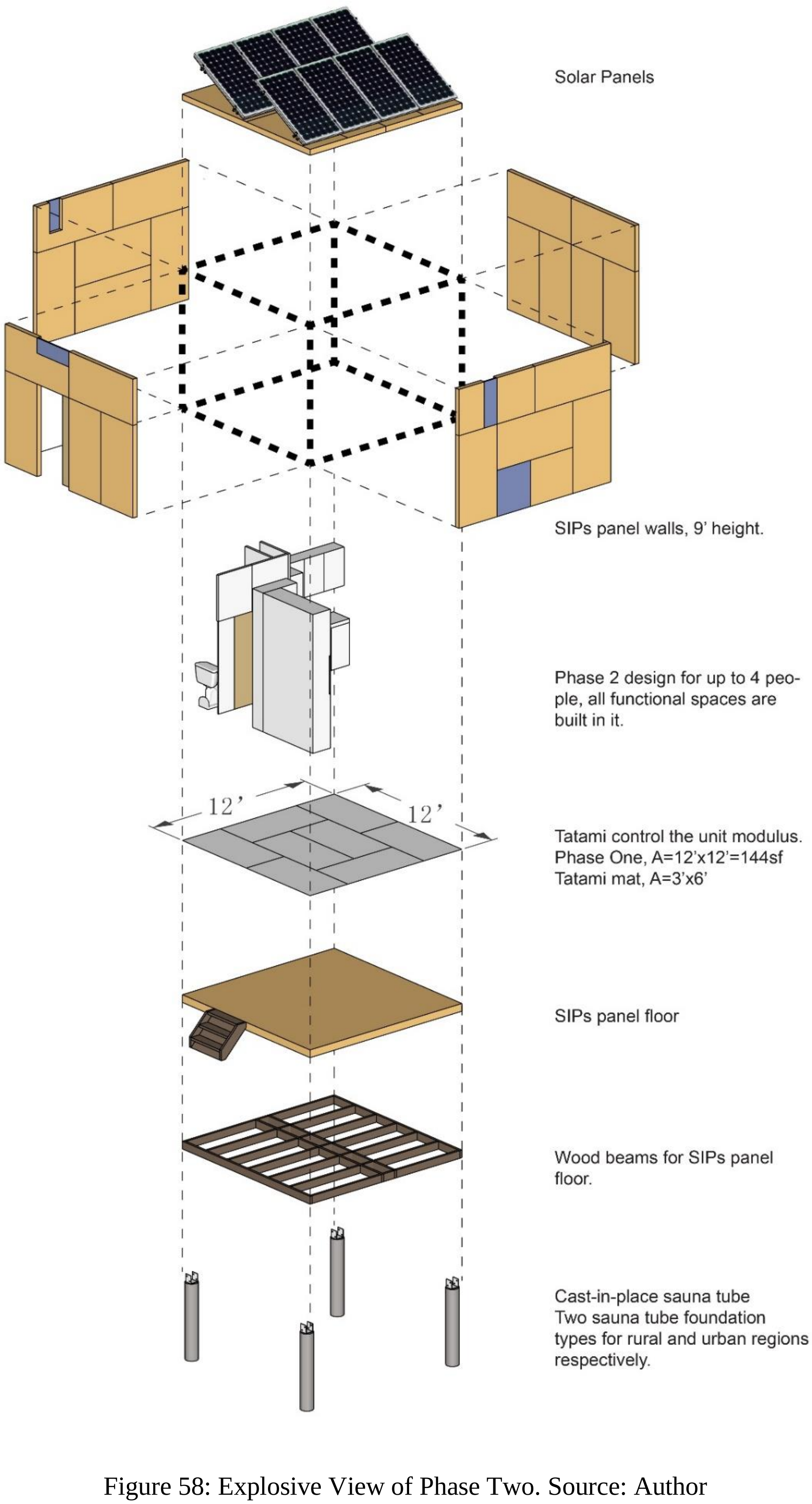

Figure 58: Explosive View of Phase Two. Source: Author

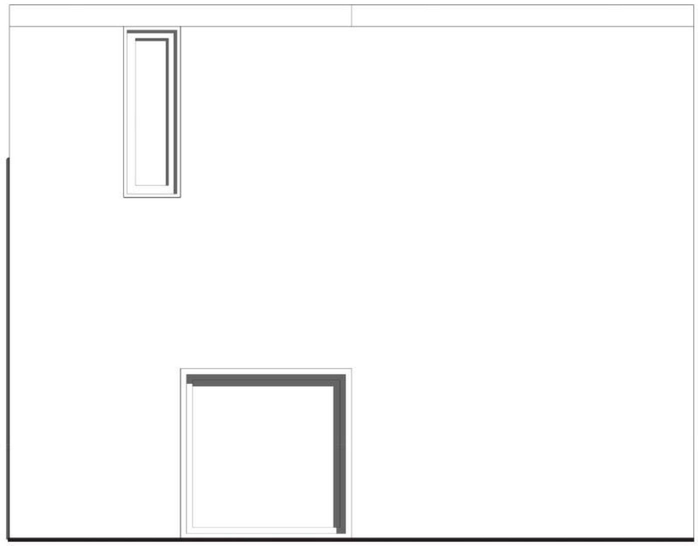

Figure 59: South Elevation of Phase Two. Source: Author

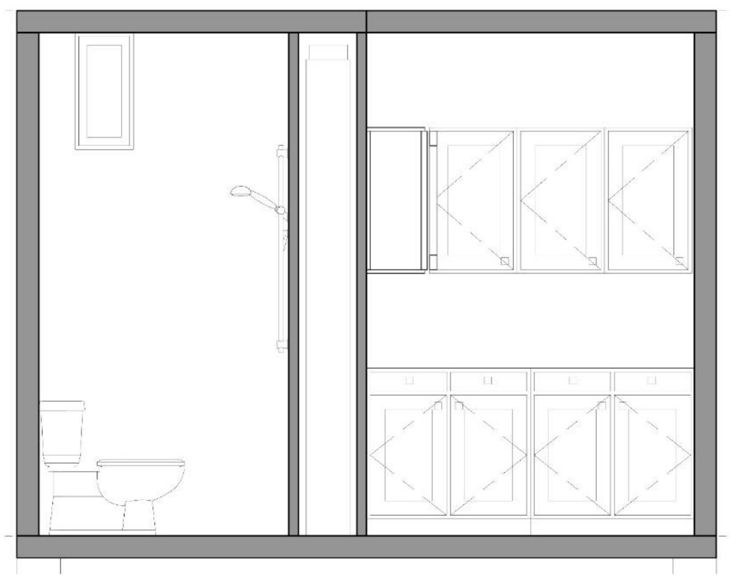

Figure 60: Section of Phase Two. Source: Author

One more row of solar panels are installed in this phase. And keep the flat roof so that the future house will not be blocked by the sloped roof. This adaptable shelter is a multifunctional living space.

Figure 61: Multifunction – Sleeping. Source: Author

Figure 62: Multifunction – Sitting and Dining. Source: Author

Figure 63: Multifunction – Folding Clothes Hanger. Source: Author

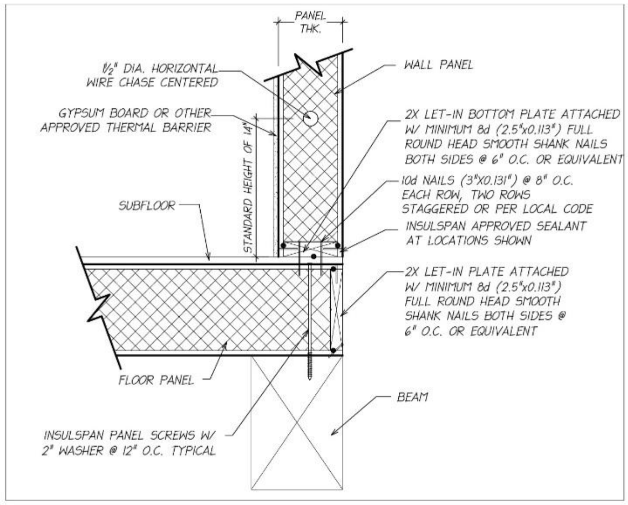

Figure: 64: SIP Wall and SIP Floor Connection. Source: Insulspan

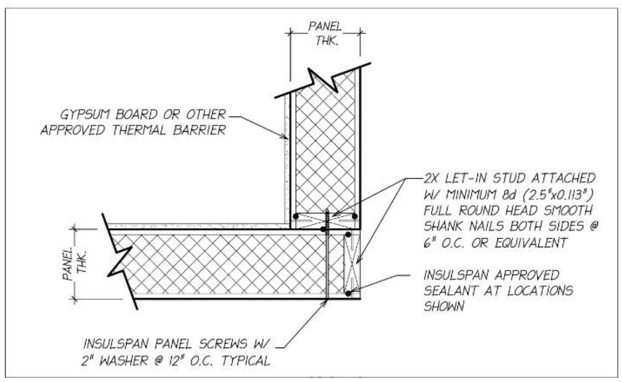

Figure 65: SIP Wall Corner Detail. Source: Insulspan

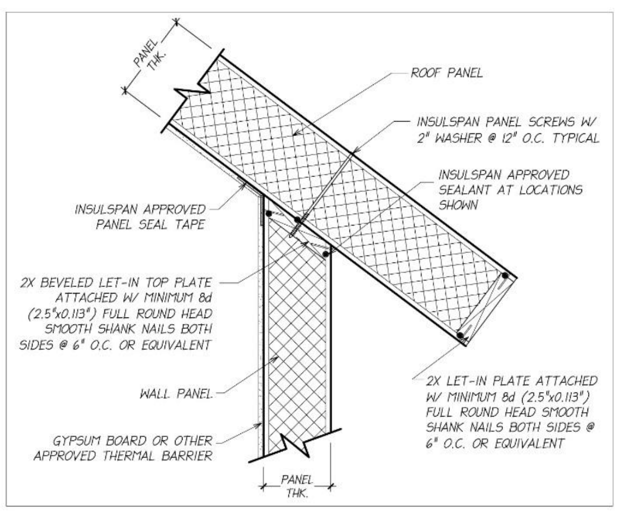

Figure 66: SIP Wall and SIP Roof Connection. Source: Insulspan

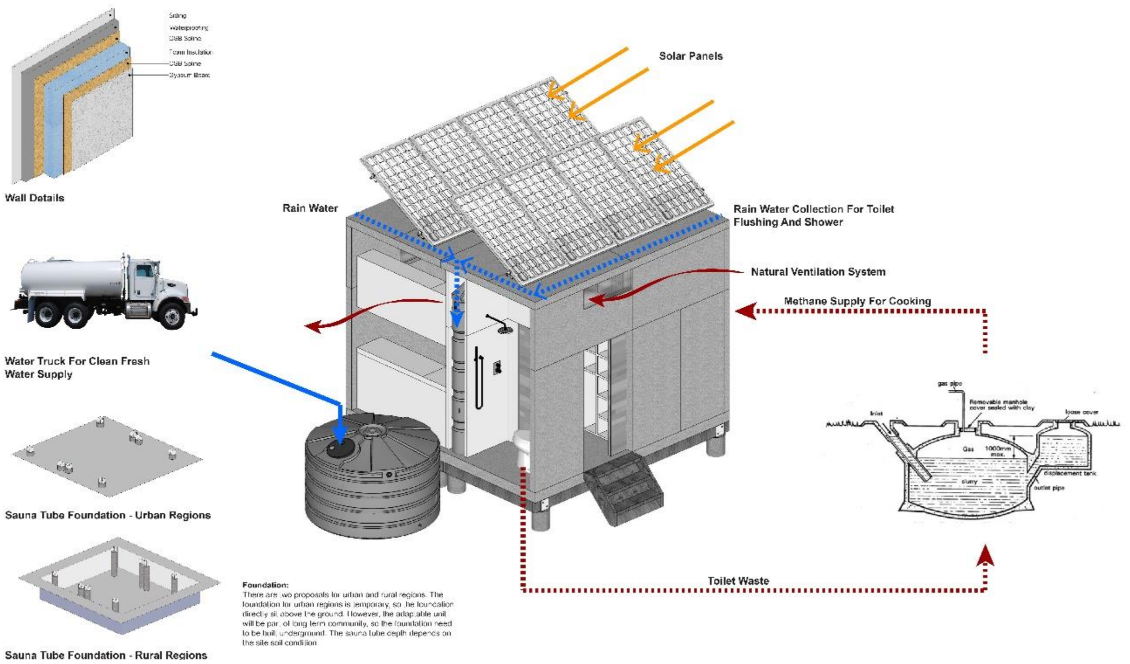

Figure 67: Various System Diagram. Source: Author

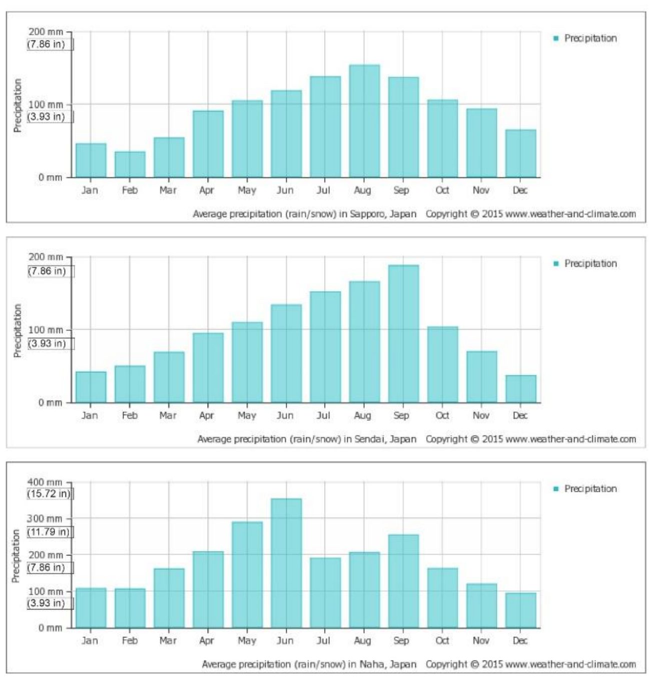

Figure 68: Precipitation in Three Different Locations. Source: Google

From the north to the south, I select three different site to do the precipitation research. The roof area for phase 1 and 2 are 72sf and 144sf respectively.

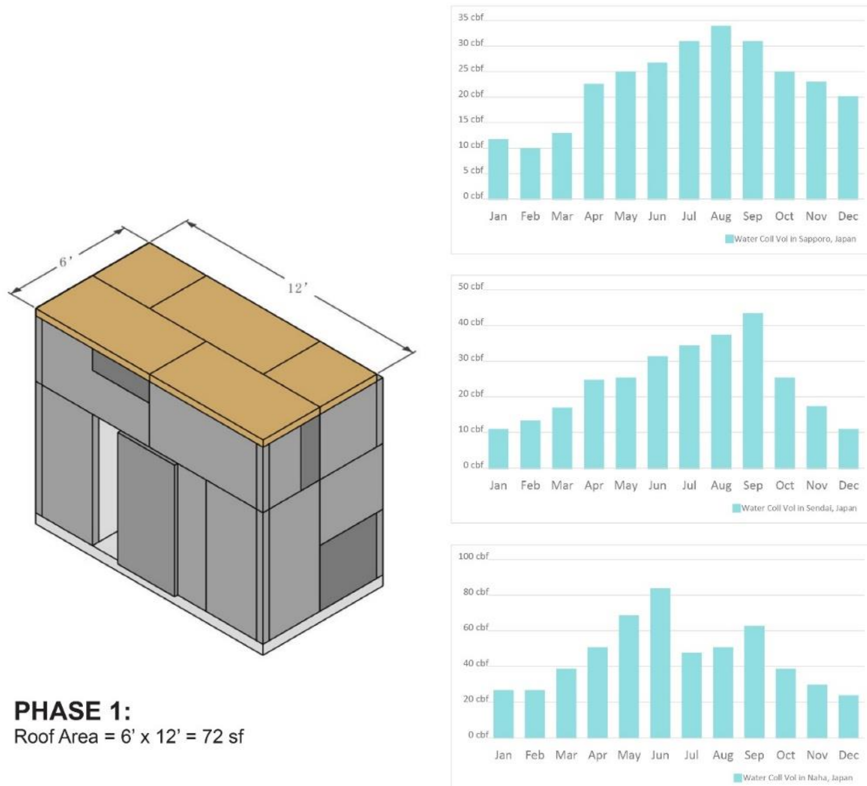

Figure 69: Precipitation of Phase One. Source: Author

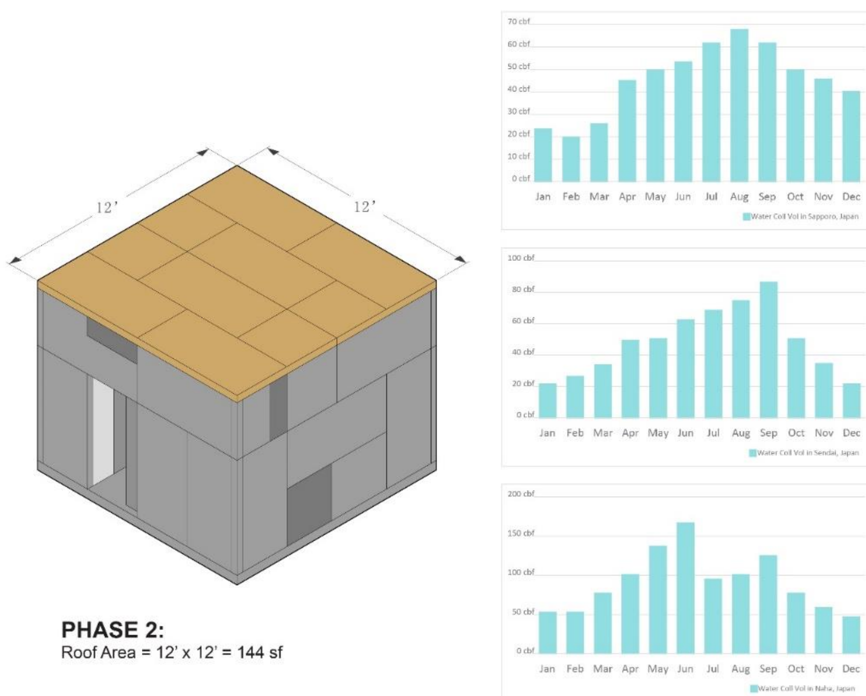

Figure 70: Precipitation of Phase Two. Source: Author

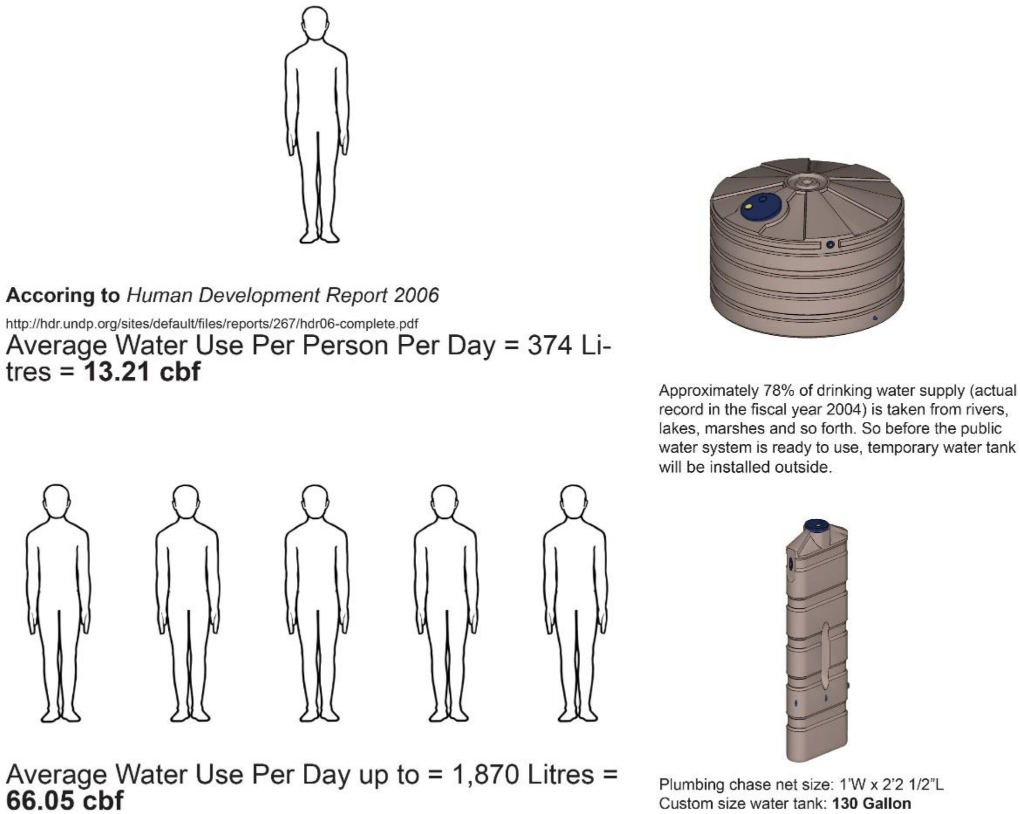

Figure 71: Water Consumption and Water Tank. Source: Author

Based on the diagram we can find that even though phase two double the water collection volume from phase one, but it still far from enough to satisfy the daily use. Each people use 13.21cbf water per day, for 5 people 66.05cbf is needed. Before clean fresh water supply done, a temporary 660 gallon water tank is needed. This tank is located at the exterior space next to the 160 gallon interior water tank. Water truck transport fresh water to fill this tank every day.

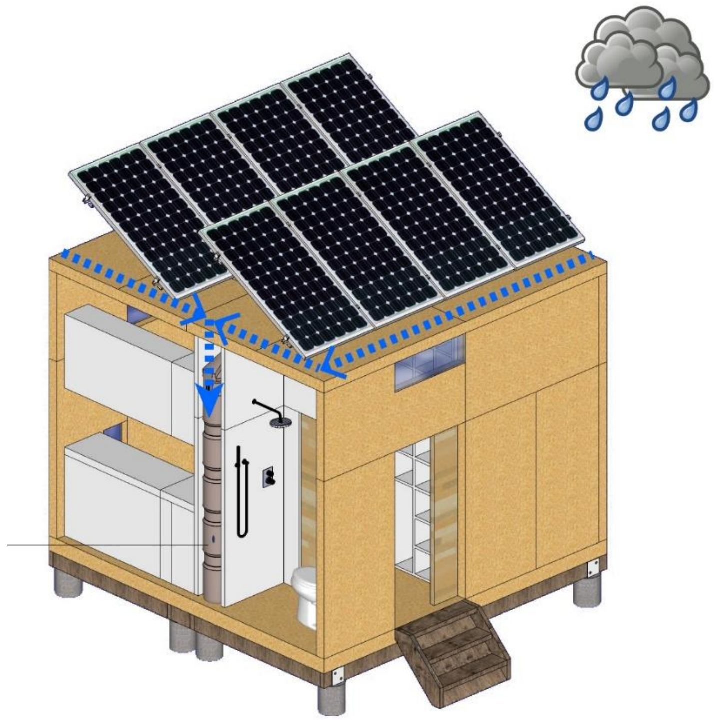

Figure 72: Phase Two Water Collection. Source: Author

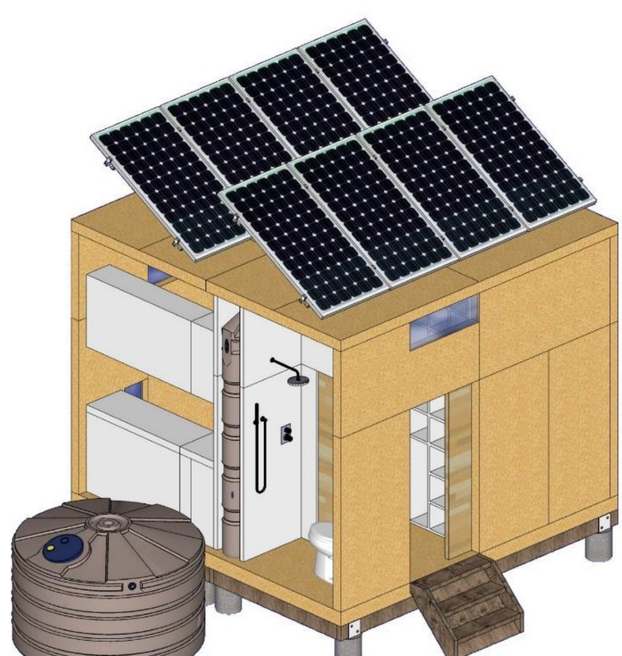

Figure 73: Temporary Water Tank. Source: Author

Phase 3 - Adaptable Community

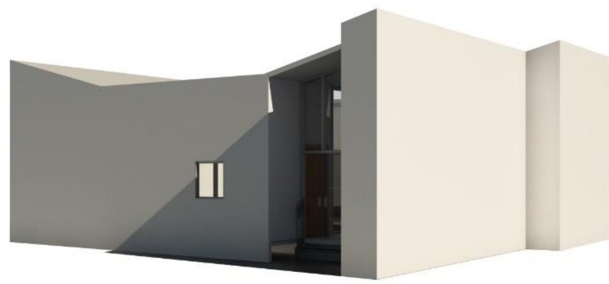

Figure 74: Community Center. Source: Author

Figure 75: Phase Three Adaptable Community Plan. Source: Author

This phase is an adaptable community. I select a typical block in Sendai rural region, the size is 250’ x 125’. It is one of the 5 sites, all other four sites construct in the same way. All adaptable shelters are built on the designated places, so that the long living houses can be built around them.

New building for this phase is the community center. I consider the traditional courtyard preference for Japanese, which is surrounded by gym, public bath, psychotherapy room and management office.

All other community spaces are used as farm land at this time. This is people's basic requirements. But the housing construction spaces should be retained. For the future development, farm land will disappear. Instead, activity court, landscape and parking will take this room.

Phase 4 – Long Living Community

Figure 76: Phase Four Perspective One. Source: Author

Figure 77: Phase Four Perspective Two: Source: Author

It is a long time for the permanent community construction, 1.6 years to 2 years is my schedule period. In the long living community, adaptable shelters become part of permanent housings. It becomes a grandparents bedroom. The solar panels on the shelter roof are moved to the large housing slope roof. All entrances face to the middle, so residents have higher chance to communicate.

Figure 78: Phase Four Perspective Three. Source: Author

Figure 79: Long-term Housing Perspective. Source: Author

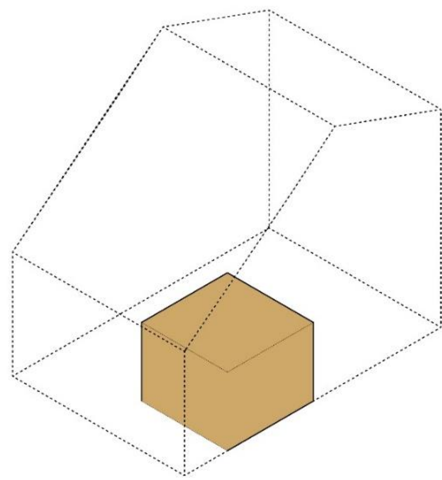

Figure 80: Long-term Housing Diagram One. Source: Author

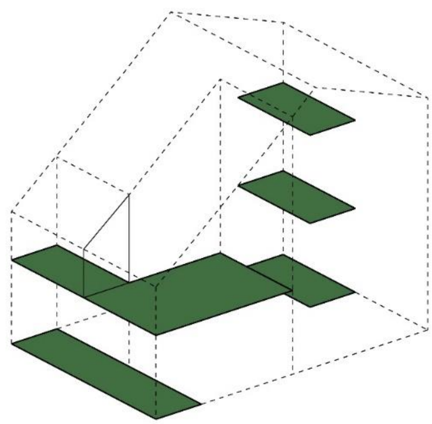

Figure 81: Long-term Housing Diagram Two. Source: Author

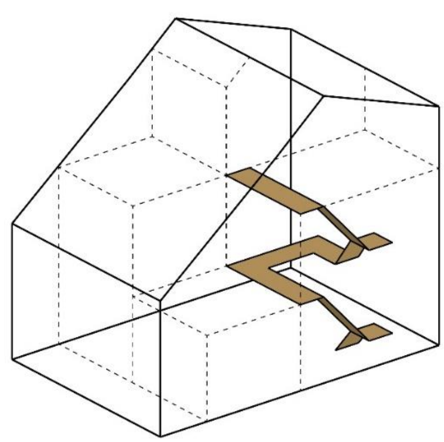

Figure 82: Long-term Housing Diagram Three. Source: Author

Figure 83: Phase Four Plan. Source: Author

Parking lot is located in the middle part of the community. There are totally 17 families live here. Main landscape axis through east and west, badminton court on the left part, fountain and table tennis areas on the right. All entrance face to these activity spaces and face to each other. On the other hand, according to Jane Jacob's idea, "street eyes" can improve the community safety. Both sides of each house have garden spaces which are very good transitional part.

The permanent housing foundation is different from the shelter, it use foundation wall. The housing is built surround the shelter part. Housing is made up of SIPs panels, from inside to outside is gypsum board, sips panels, water proofing layer and siding panels.

The toilet waste can be recycled as resource, and return it back as methane form for cooking. Alternately it can be discharged to the public waste system. Custom size water tanks are kept for the water collection from the shelter roof. The other water tank in the garden collect water from the large slope roof.

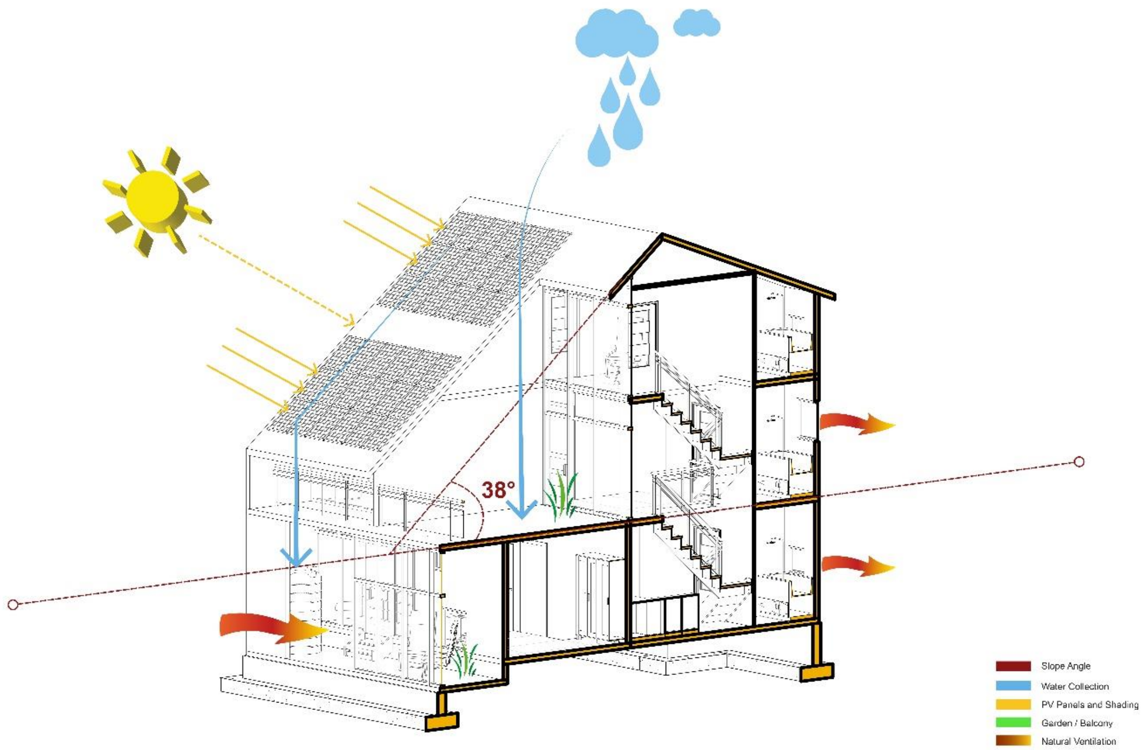

Figure 84: Long-term Housing Sustainable System. Source: Author

The latitude is Sendai is 38 degree, so the slope angle I set is also 38. So that solar panels can be installed on the roof without any extra supporting. The slope roof acts as multiple roles: supporting for solar panels, shading system and water collection system. Opposite windows make sure natural ventilation happen. Two water collection systems. I really put much attention on the transitional spaces design. From the community to the house, entrance garden is the first transition. And then set back on the second floor, so that the shelter roof can be a balcony. Visual connection can happen on 1st, 2nd and 3rd. No matter which level residents live, they can observe the community garden all the time. It is a good way to improve neighborhood.

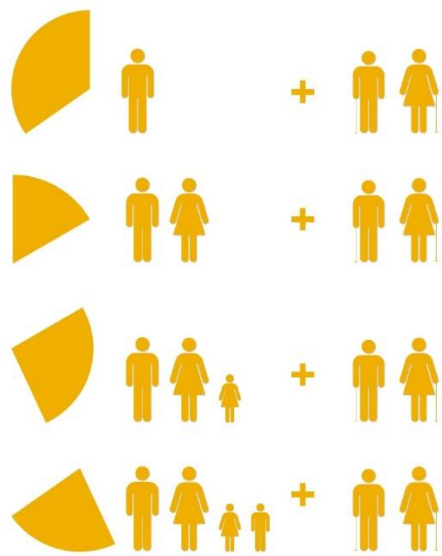

Figure 85: Household Types in Japan. Source: Author

To correspond to the household types, I design 4 different housing from 2 bedrooms to 4 bedrooms. And mix all houses together. And the Two families house have their own common space, it is private but also public. Even though the second floor don't have a garden entrance, but the common space can be a good transitional space.

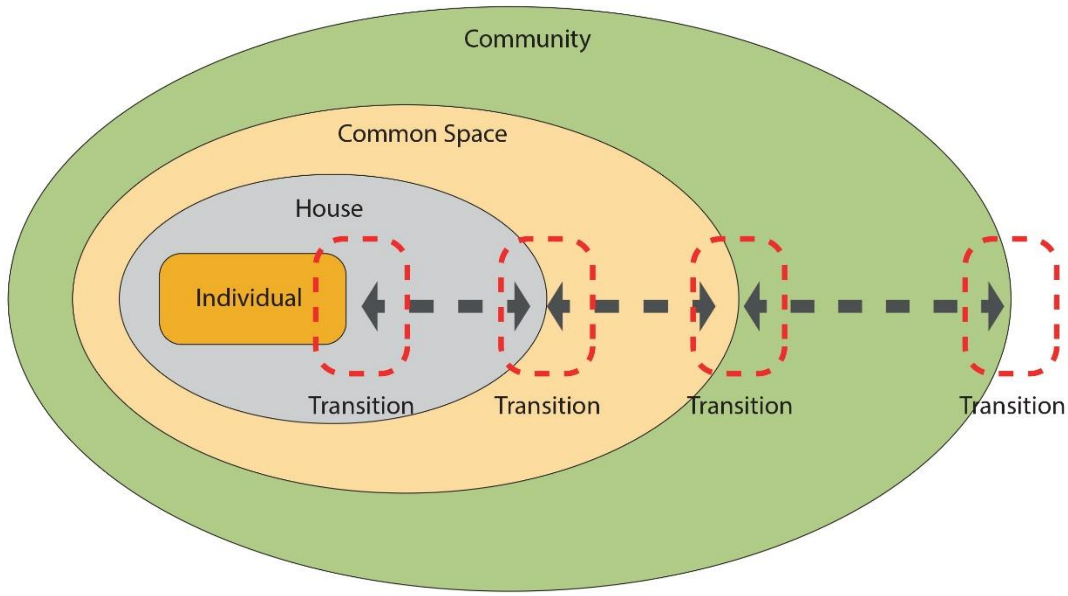

Figure 86: Concept Diagram One. Source: Author

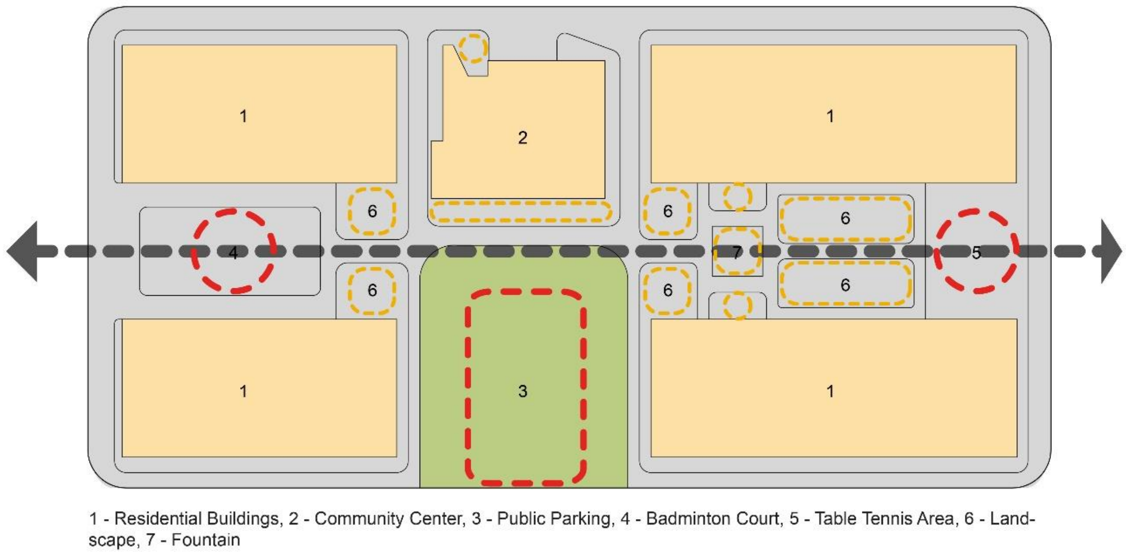

Figure 87: Concept Diagram Two. Source: Author

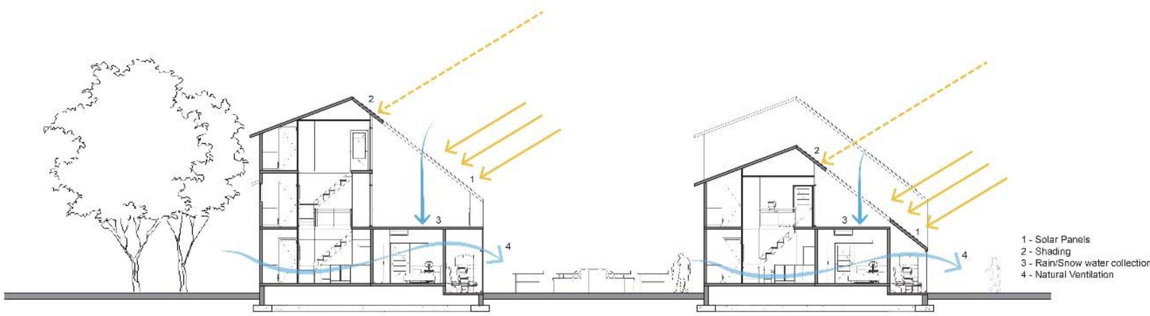

Figure 88: Phase Four Section View. Source: Author

Except 3 bedroom house, others are three floor height. Three bedroom type is a two floor single-family house. I put most two floor height houses on the south side, so the north housing can receive more sun light.

Japanese usually live with their parents, so every type of housing I design a bedroom for parents. Elevator is optional for the second floor entrance units. If they need it, the elevation can be installed next to the stairs.

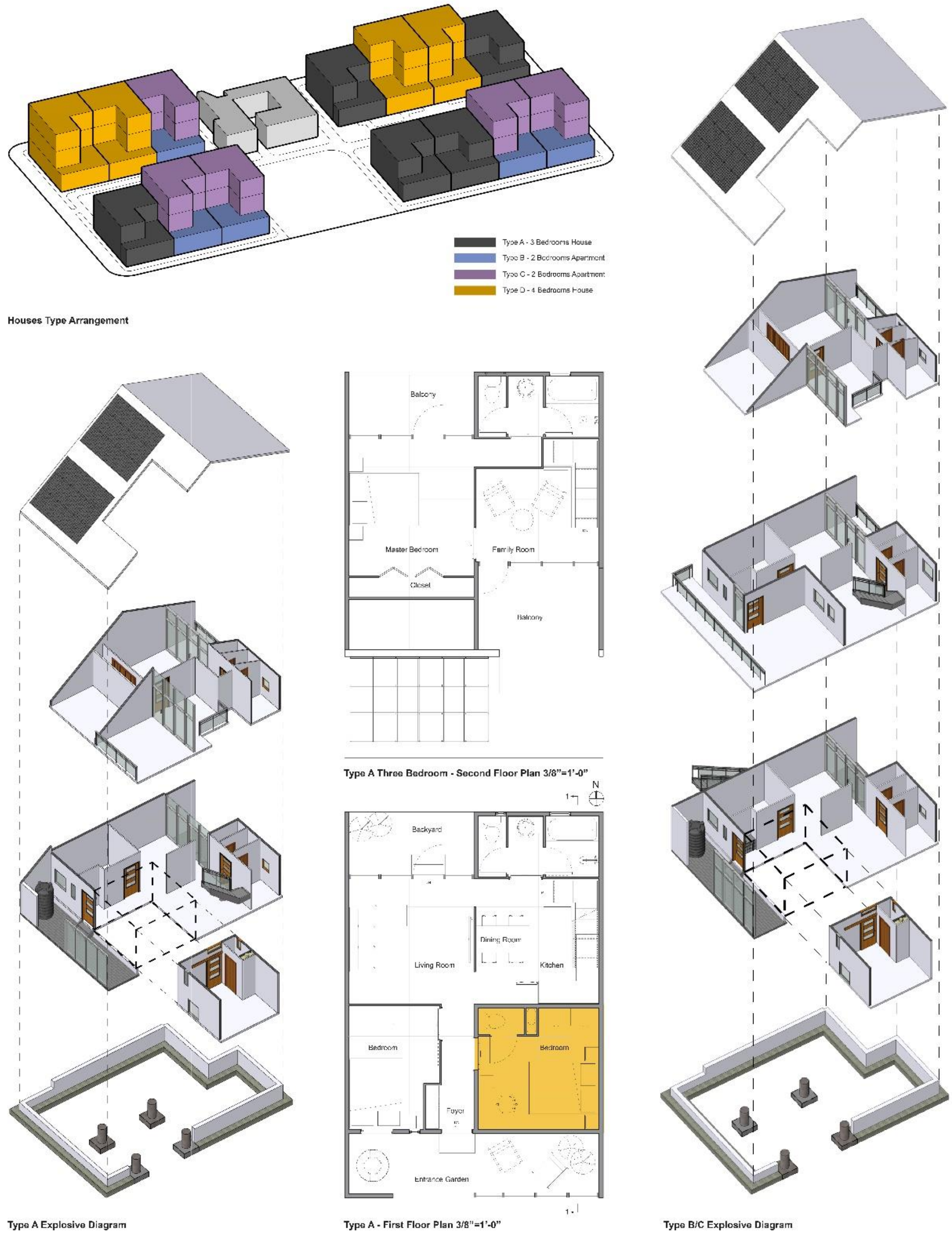

Figure 89: Housing Type A, B and C. Source: Author

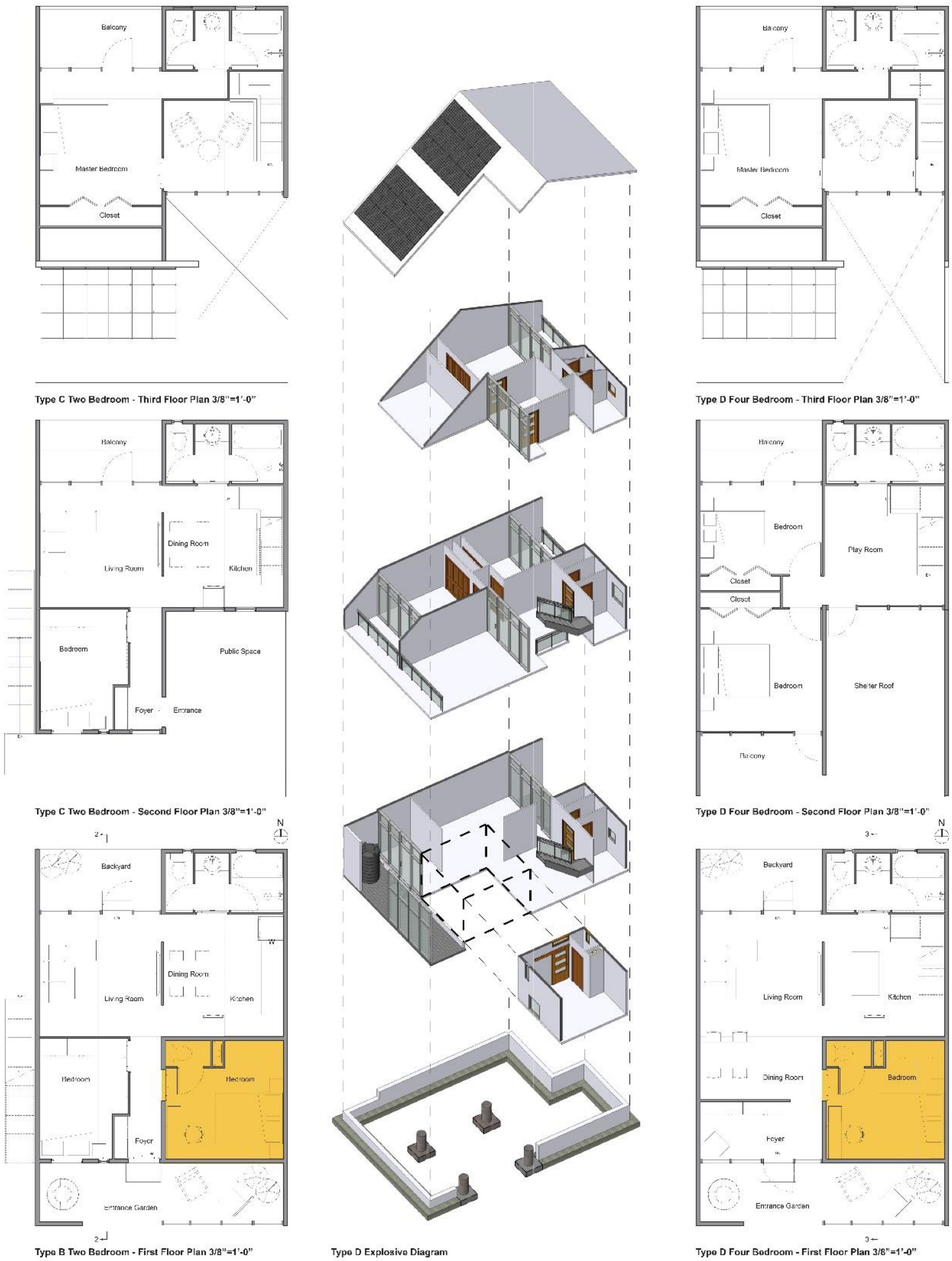

Figure 90: Housing Type B, C and D. Source: Author

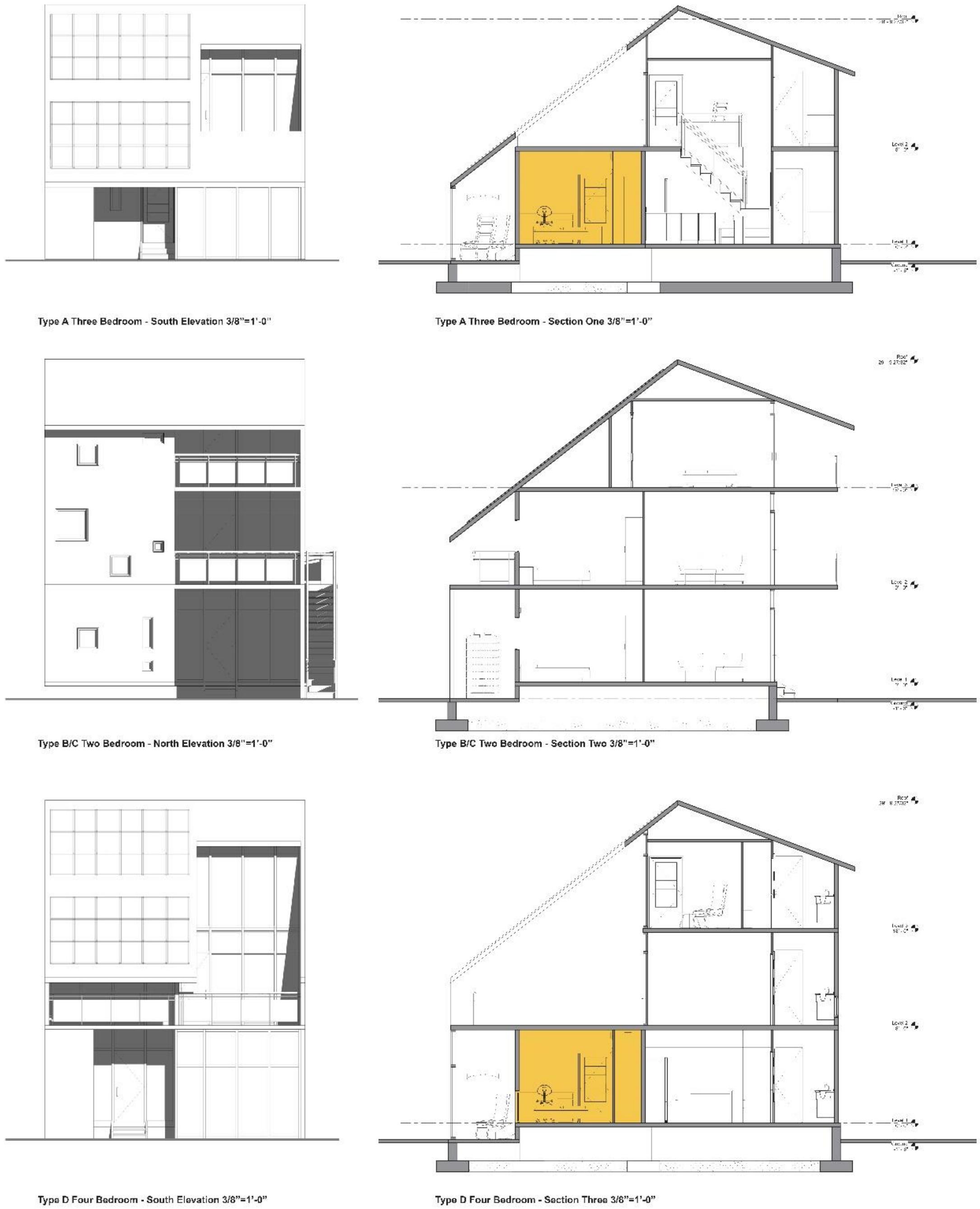

Figure 91: Housing Elevation and Section. Source: Author

CHAPTER 8

CONCLUSION

The concept is very important for this project. I have to think about from both ends, and then how to make this changing process come true. From the rapid shelter to the long living community is long construction period, during this process everything is changing. I need to figure out if the shelter can be used as a long-term one. Normally shelters use low cost, recyclable and unsubstantial materials without foundation. But for my design, people will live in the shelters for a long period of time. It is impossible to use the normal shelter concepts. I have to find out a quick, stable, less expensive materials and foundation types. In the end, I think that SIPs panel is a good choice. Based on some research, SIPs panel buildings are stronger than others. And it is a prefabricated material, we can store them in warehouses. And the shelter module is 6’ x 3’ which is tatami size is easily to be transported to the site. After figure out all materials, foundation and transportation problems. More real questions come out, how to supply water, how to collect water, how to install electricity system, how to deal with waste etc. It is a very reality project.

Transfer from phase to phase is not an easy topic. Every detailed thing need to be considered. Such as the east wall of phase 2, reinstall it from phase 1 that is a cheap and reality way. From shelter to shelter is a problem, from shelter to community is a different problem. All starting points of shelter design are quick and low cost, but some of them are not suitable for long living communities. Such as the foundation systems are totally different, wall materials, design concepts etc.

For the long living community, we have to consider all factors into it. But we cannot get rid of the shelter shadow. It is hard to do everything right for the long-term life but also remain the original temporary sign. This is a hard topic, but I learn a lot from it. It is different from most studio project we did, it is very real design. Every detailed piece should be considered again and again. This is a series living type design, it is a very real and sustainable strategy.

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