Rebuilding the Past, Sustaining the Future

Christian Michael Donato

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Masters of Architecture

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ABSTRACT (Academic)

By researching natural disaster displacement and the process in which we rebuild, I have found that by creating a modular prefabricate unit that is both cost efficient and easy to construct, we can significantly reduce the rebuild time, reduce people from leaving, as well as encourage new residents to move to the effected area.

It is important as an architect and designer to use our skills to better help humanity. By focusing on the effects of Hurricane Harvey in the Houston Area, I have developed a unit design, and infrastructure plan that can be used universally around the world to help effected cities and people survive after a natural disaster.

These findings are useful in the fact that the United State has no universal plan when dealing with disaster events. By creating a plan to provide single and multi family units, and incorporating them within close distance to necessary needs and infrastructure, this plan has the potential to reduce rebuild time, and encourage economy growth.

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ABSTRACT (Public)

The value in which this thesis will bring to humanity is the implementation of a modular disaster relief structure that anyone can build. It will be able to be constructed in four days, by two people with no previous construction experience.

Implementing this plan will help speed up the rebuild process after a natural disaster. This will create one universal unit and infrastructure implementation plan to provide residents of an affected are the resources needed to survive in the case of an event such as a hurricane or flooding.

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DEDICATION

I am dedicating this book to my parents, Steven and Patricia Donato. They have supported me my entire academic career, and have made me the person I am today. This thesis would not have been completed without their support.

I would also like to give my mom an additional shout out as she celebrated both her birthday and Mother's Day during the same weekend as my graduation.

Thank you, Mom and Dad.

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Rethinking the planning and implementation of disaster relief structures

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01 Introduction

1.1

Natural disasters take place every year. They can range from minor to severe. The summer of 2017 has a series of hurricanes that came through and devastated Houston Texas, Florida, and Puerto Rico. As seen in recent disasters, the rebuild process can be very long and strenuous on a community. It not only stops the entire city, but it forces people to move to new locations, businesses to close, and the entire identity of the area to change. The rebuild process needs to change in order to prevent people from moving, and to get the economy back on track. There needs to be a quicker, cost efficient solution to rebuilding a destroyed city while keeping the Identity and history of the area intact. For this thesis, I am focusing on rebuilding a destroyed city in the form of modular prefabricated construction, and by doing so, keeping the history and culture of the area intact and alive.

I will focus on two major aspects of rebuilding; one being master planning, and the other consisting of the individual units. The master plan will be a proposed idea on where and how to layout the location of the new construction. After a natural disaster, the current area is usually in a condition in which construction cannot take place, or there is a possibility of a repeat natural disaster. The idea with the master plan would be to find a location in the area which is safe from flooding, or new damage, and to relocate people and families here to keep them local, and safe from the aftermath of the destruction. The area would be open to constructing commercial buildings such as grocery stores, libraries, and restaurants to make the new neighborhood livable. With the prefabricated construction, homes will become a permanent place to live while original homes or businesses are being reconstructed. If the owner decides to move back to their original home, new residents can take over the existing prefabricated building, and have the ability to modify it to meet their needs.

The final product will be 100% prefabricated and assembled on site. It will be a flexible design allowing for the owner to customize their home to meet their needs. The construction system will allow for unique placement of exterior wall panels which consist of solid, translucent, and screened members. Each panel has the ability to be placed in any location on the exterior allowing total control of privacy, open areas, and natural light. The interior will consist of movable partitions, allowing for total control of room organization and placements. The owner would be able to pick from a series of pre designed floor plans, or have the option to design his/her own layout. The floor system will have tracks built in which will allow wall panels to be “clipped” into place. When the tracks are not being used, they will be covered with a cap to create and even surface. Total construction time will be less than two days per residential unit.

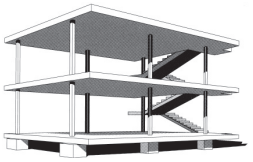
02 Precedents

Modular design has been traced back to about 400,000 B.C. to the Nomads and settled dwellers. The idea is clearly not a new concept. In the early stages of prefabricated modular design, it was more of a way of life, but as the years go on, it has become a regular option of construction. It was important for me to research other modular prefabricated buildings to learn more about why they were being built, and to learn from the new ways of construction being introduced. I also thought it was important to study cities and towns to get a better understanding of master planning, and to see how I could potentially develop and design a neighborhood for a destroyed city. I decided to look at buildings and master plans from around the world in order to understand the differences and similarities in design when it comes to different cultures and ways of life.

I focused on seven total precedent studies. Five of which are modular prefabricated buildings, and two which focus on the master planing and organization of cities. The seven precedents are research on the shotgun style home which originated in Haiti, the Dom-Ino house designed by Le Corbusier, the Packaged House designed by Konrad Wachsman, the Central Column House designed by Jean Prouve, the IBM Traveling Pavilion designed by Renzo Piano, Savannah, Georgia designed by James Oglethorpe, and Vancouver, BC one of the most livable cities in terms of quality of life.

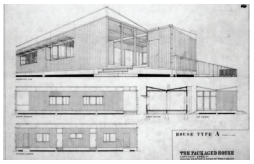
Shotgun House

Image 1: Shotgun Houses



Dom-Ino House

Image 2: Over Here, Over there



Packaged House

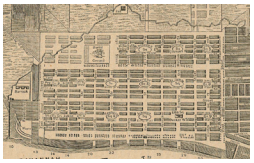
Image 3: The Dream of the Factory-Made House

Central Column House

Image 4: Chamberlain

IBM Traveling Pavilion

Image 5: Components and Systems



Savannah, GA

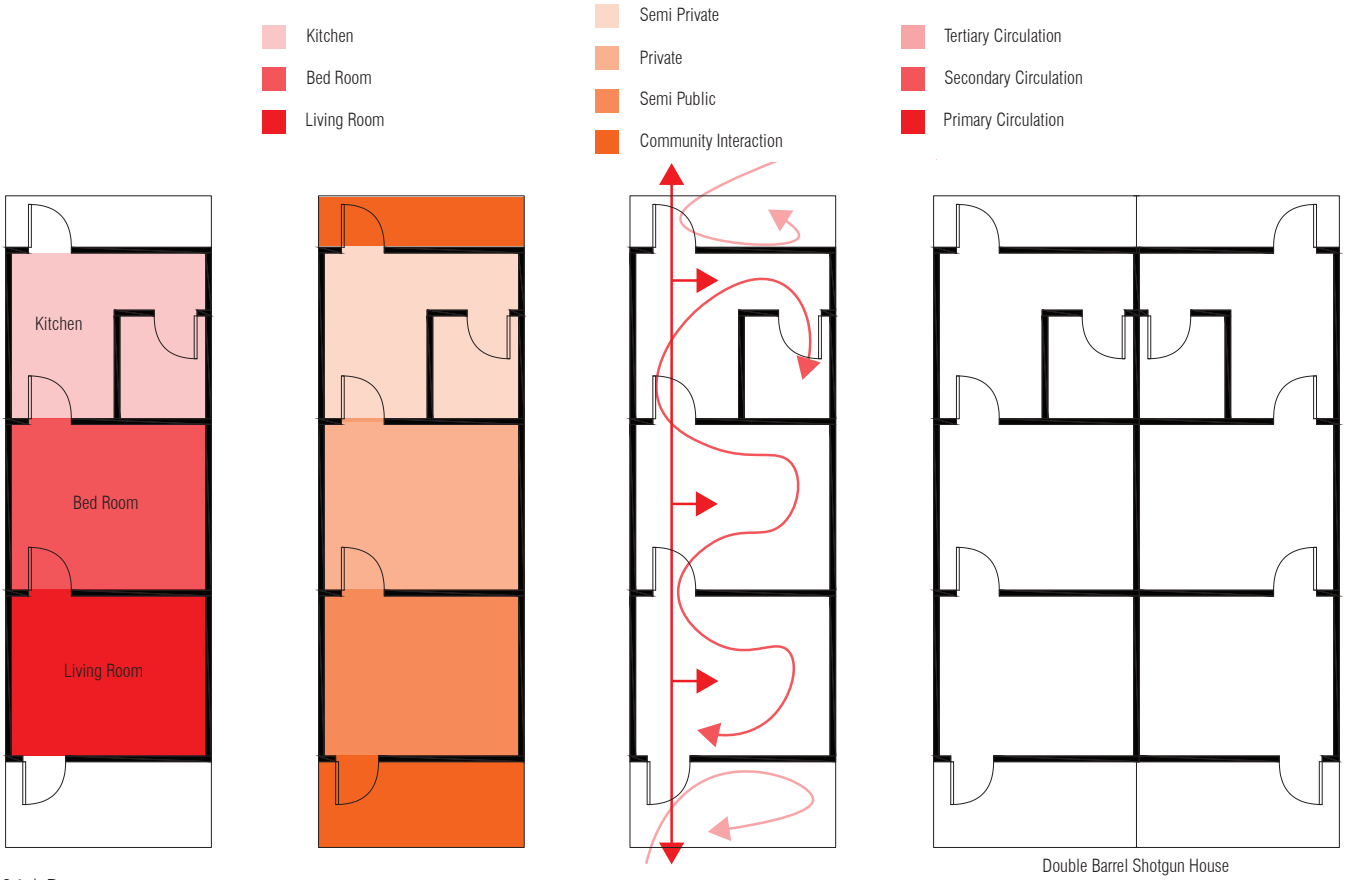
Image 6: Terracotta Savannah

Vancouver, BC

Image 7: Francesc Zamora

Shotgun House

Shotgun houses were a popular form of housing in the southern united states from the civil war until the 1920's when it became a sign of poverty. They consist of 3-4 rooms lined up back to back with no hallways. There are entrance doors on either side of the house. Shotgun houses can be traced back to African or Haitian influences. The typical layout of a shotgun house is that you enter in living room or common space, proceed into a bedroom, and the last room would be a kitchen. Most houses did not have plumbing, bathrooms were a common addition to homes.

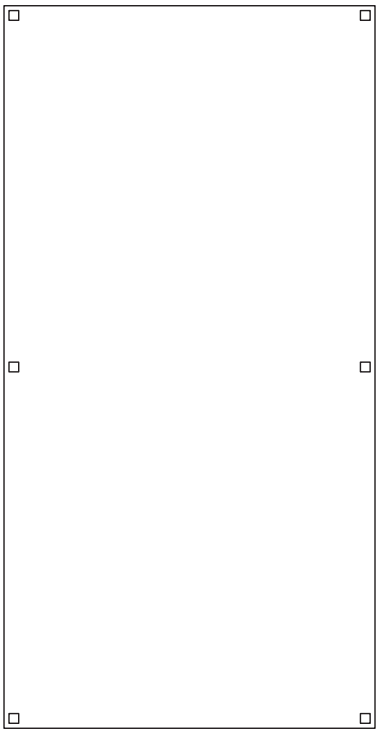


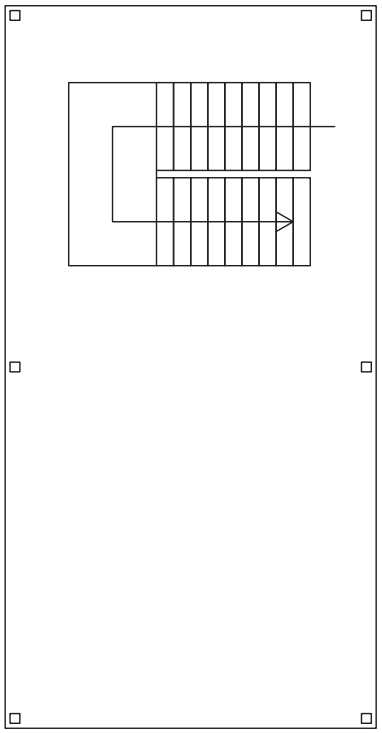
Double Barrel Shotgun House

Image 8: Shotgun Houses

Dom-Ino House
Le Corbusier
1914-1915

The Dom-ino house was designed by Le Corbusier in 1914-1915. This was designed with the idea of rebuilding destroyed city's after the war. The intention was to create mass produced housing. The design consists of three concrete slabs held together with minimum concrete columns. The frame was independent from the plan to allow for freedom of design. It also eliminated load bearing walls and support beams. The design take son the name "dom-ino" because it can be combined at the ends and line up like dominos.





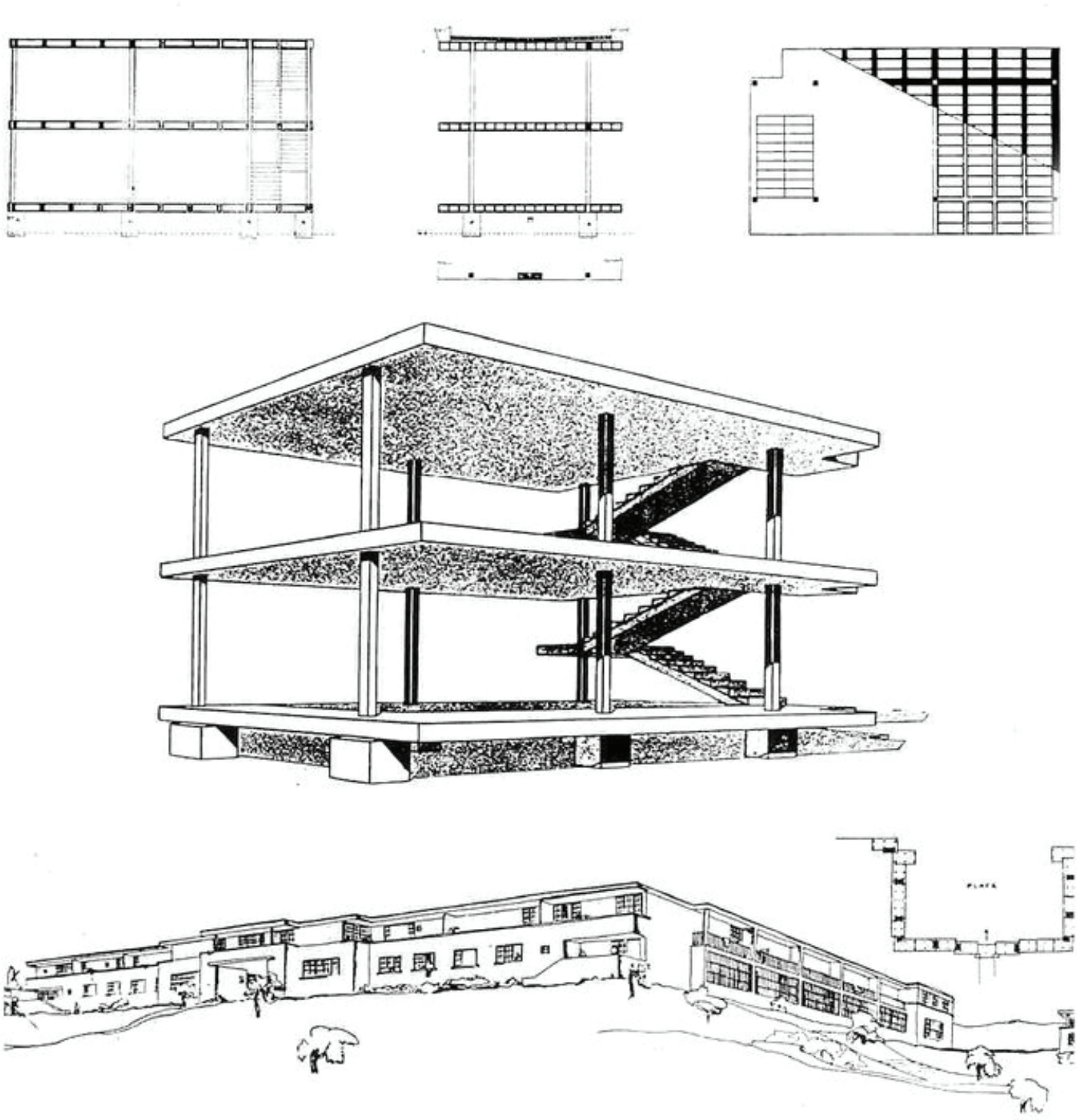
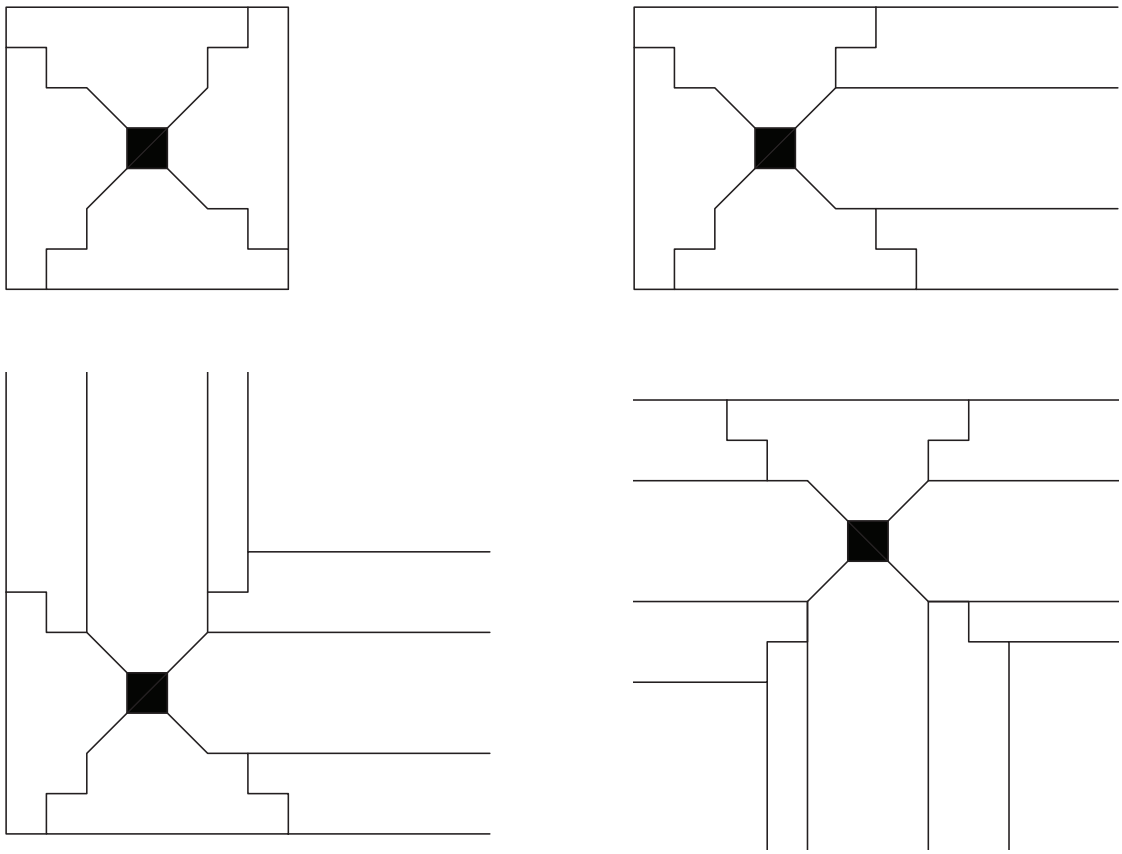


Image 9: Overe Here, Over There

Packaged House
Konrad Wachsman
1944

Designed in 1944, the Packaged house was designed by Konrad Wachsmann in collaboration with Walter Gropius. It was based on his previous work of load bearing panel construction. This was a timber framed prefabricated building that was put together with hooks and cotters in less than 36 hours. It was able to be constructed by untrained workers with no previous skills in construction. This design later turned into the General Panel System which improved the connections with fewer pieces. Each panel was pre-wired with electrical wiring, it was designed to become the most complete form of prefabricate construction.



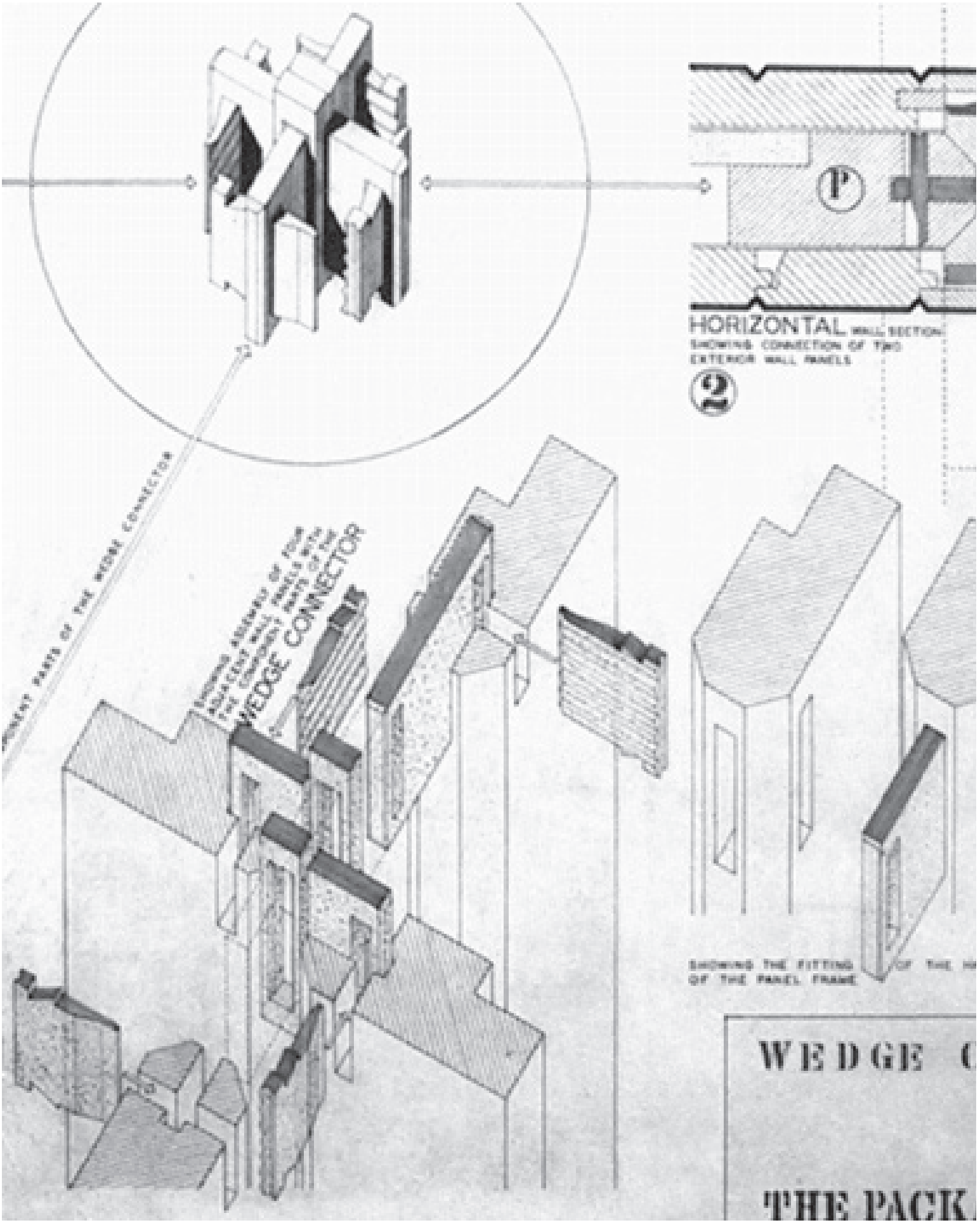


Image 10: The Dream of the Factory-Made House

Central Column House
Jean Prouve
1946

Jean Prouve was fascinated by aircrafts, ships, and automobiles, which lead to his fascinations with the materials of metal sheeting, aluminum, and plastic. Prouve played a key role in the 20th century with prefabricated construction and inspired architects such as Renzo Piano, and Le Corbusier. The Central Column House was a design that Prouve designed that held influence in a lot of his future designs. It was a model of a house that had one centralized column with a beam placed on top. The beam would span the length of the house, and wall panels would attach to the frame keeping it stable. The frame of the house was primarily made from bent sheet metal.

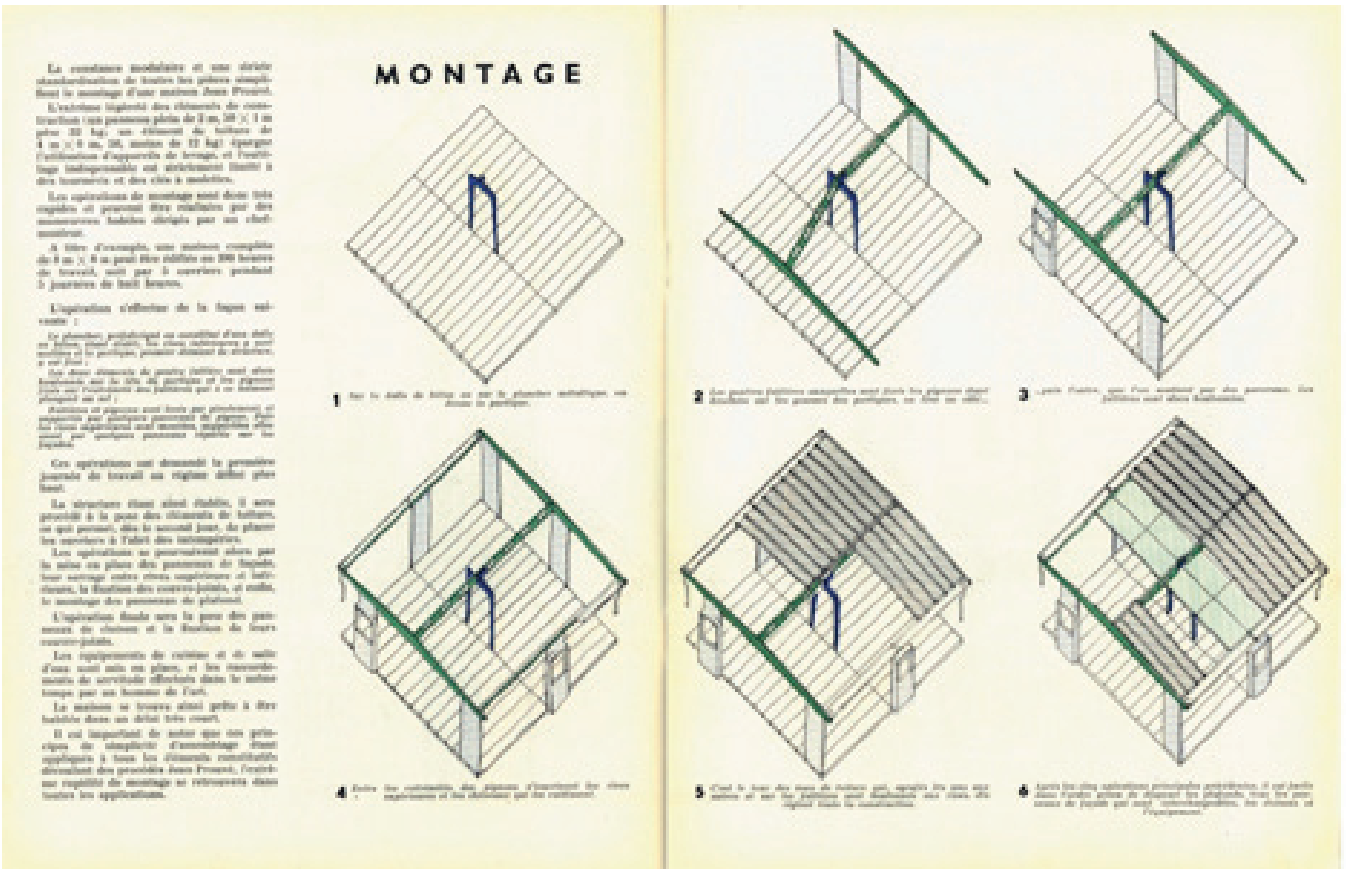


Image 11: Chamberlain

Image 12: Chamberlain

IBM Traveling Pavilion
Renzo Piano
1984

With the IBM Traveling Pavilion, Renzo Piano showed how a system of materials that are different but complementary to each other can create a structure that is both pleasing to look at, and structurally sound. This was a design that was supposed to house the new world of computers, so Piano took his influenced from the Crystal Palace, and demountable greenhouses. This design consists of 34 arched segments of laminated timber, aluminum connections, and triangular translucent windows. It took approximately fifteen days to assemble.

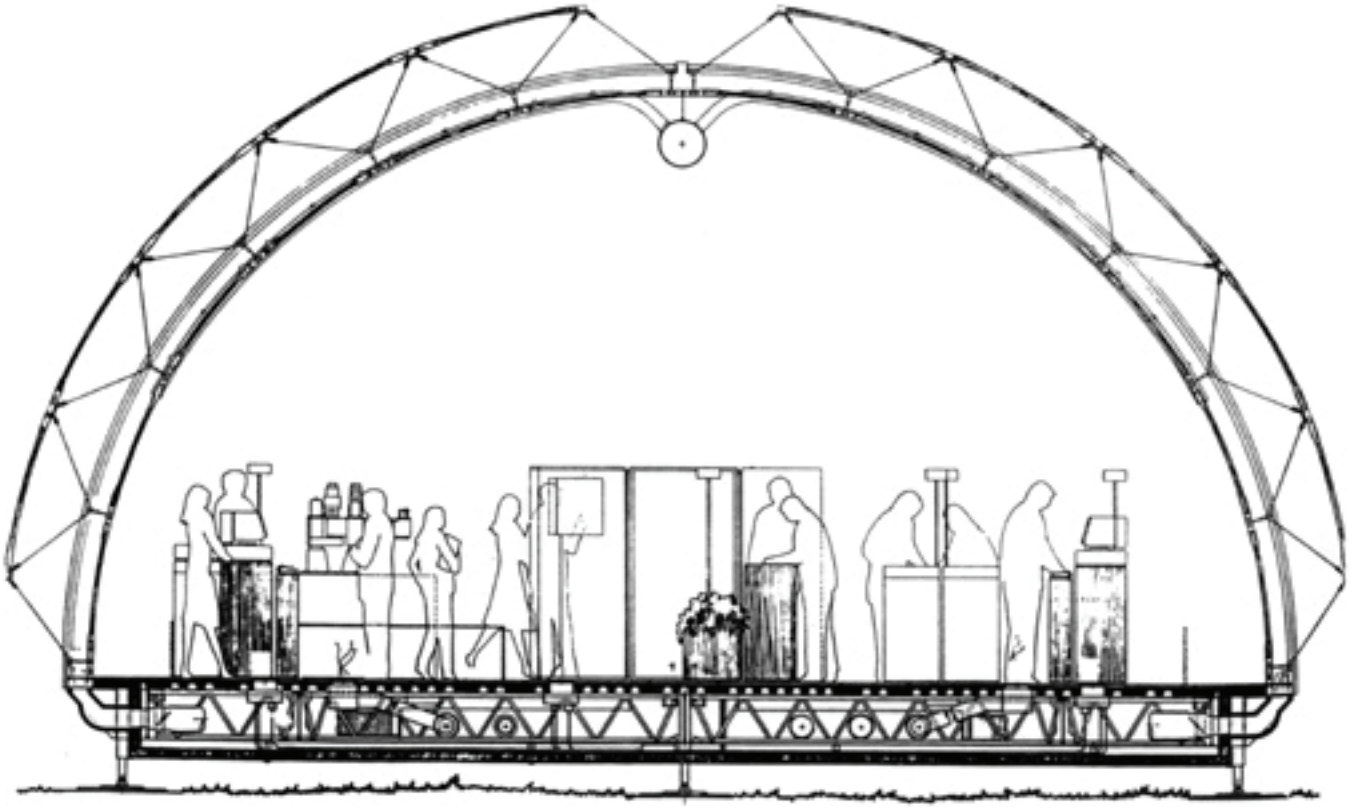


Image 13: Components and Systems

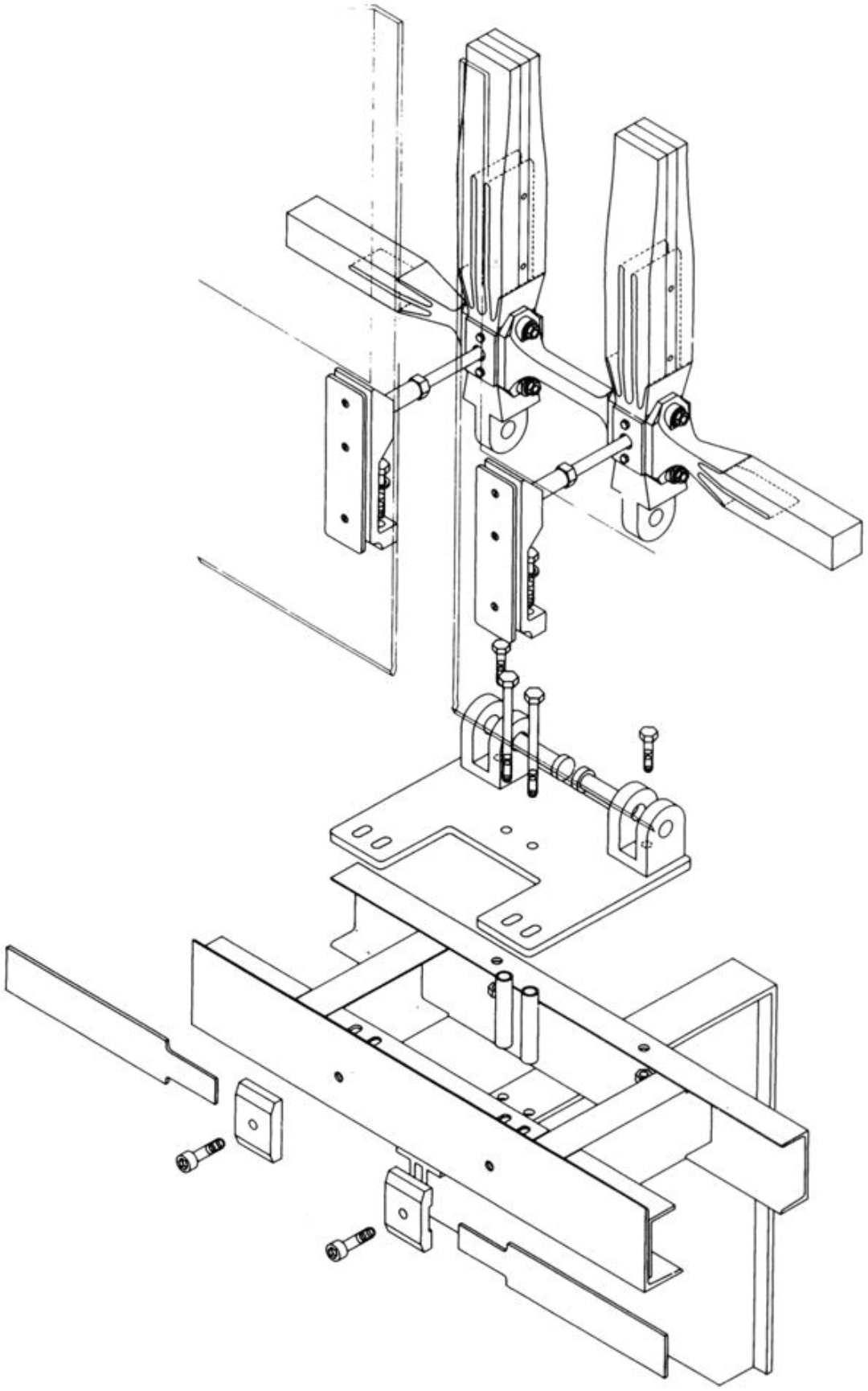


Image 14: Components and Systems

Savannah, Georgia
James Oglethorpe
Founded 1733

Savannah, Georgia was founded in 1733, and was designed and organized by James Oglethorpe. Savannah overlooks the Savannah River and is about 18 miles from the Atlantic Ocean. It was the last colonial capital to be established in American by Britain. The basic layout of the city is a series of wards roughly 600 feet by 540-600 feet. In the ward, there are eight blocks. Streets and lots are organized around a central green space. This organization allows for uninterrupted movement of vehicles as well as safe pedestrian traffic.

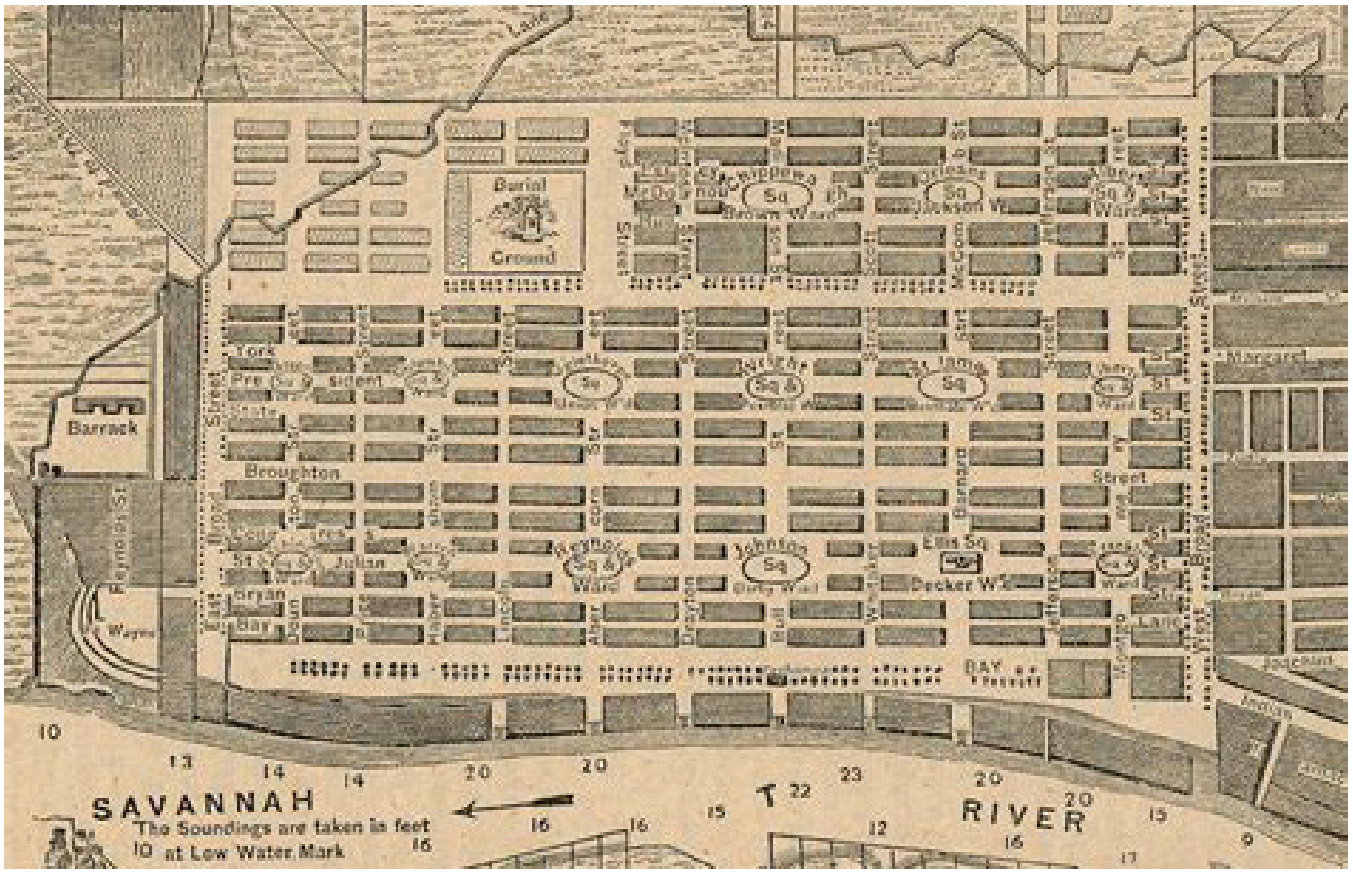


Image 15: Terracotta Savannah

Image 16: Terracotta Savannah

Vancouver, BC
Established 1886

Vancouver was established in 1886. It is located in the lower mainland region of British Columbia. With a population of 2,463,431 in 2016, it is the third largest city in Canada but the most dense. Vancouver is in the top five cities for quality of life. They have taken the initiative to create green space throughout the city, and to decrease food deserts. In the 1950's regulations were set to build high-rise residential buildings that do not take away from away green spaces or sight lines. This resulted in dense livable neighborhoods.

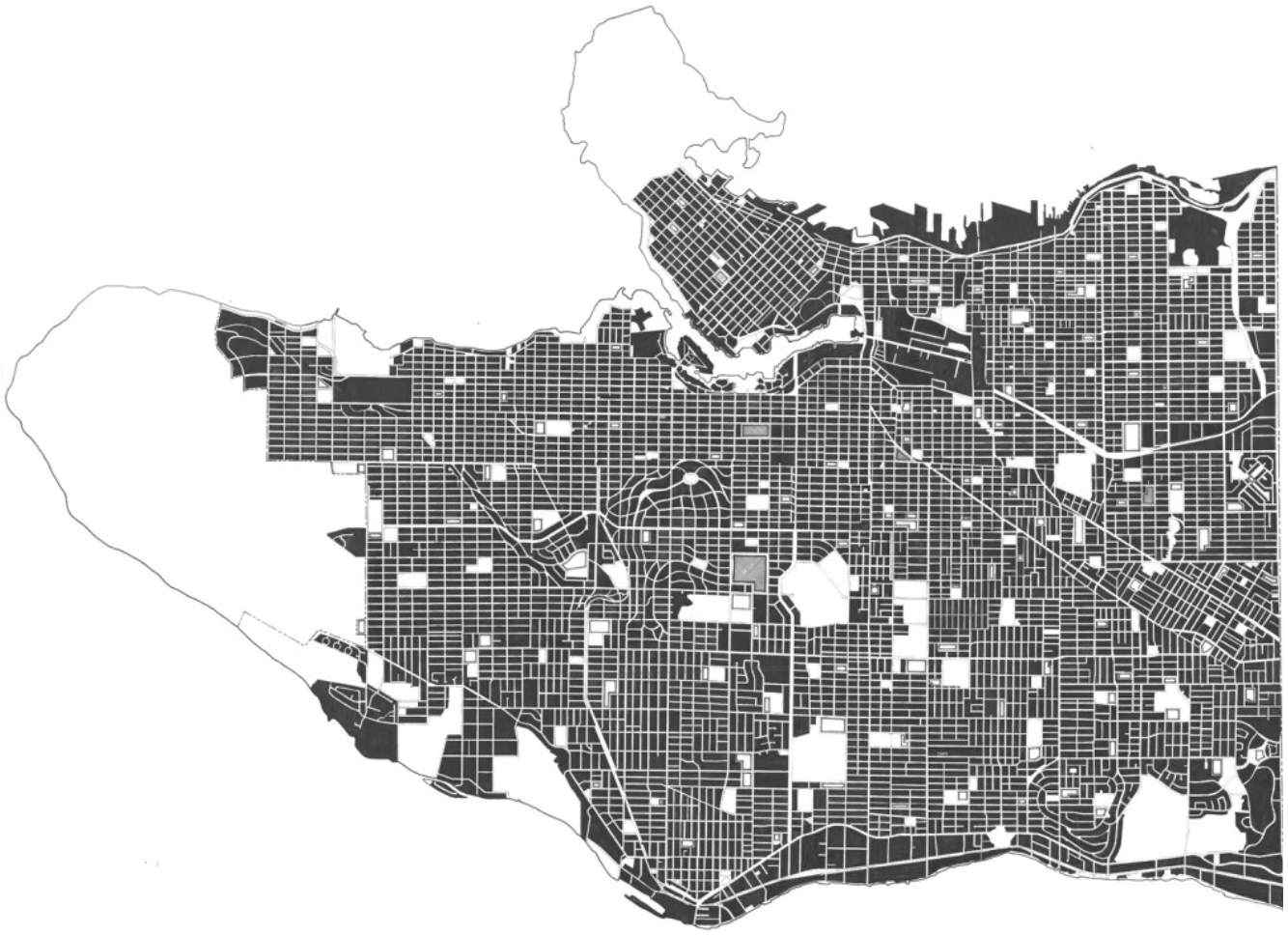


Image 17: Francesc Zamora

Image 18: Francesc Zamora

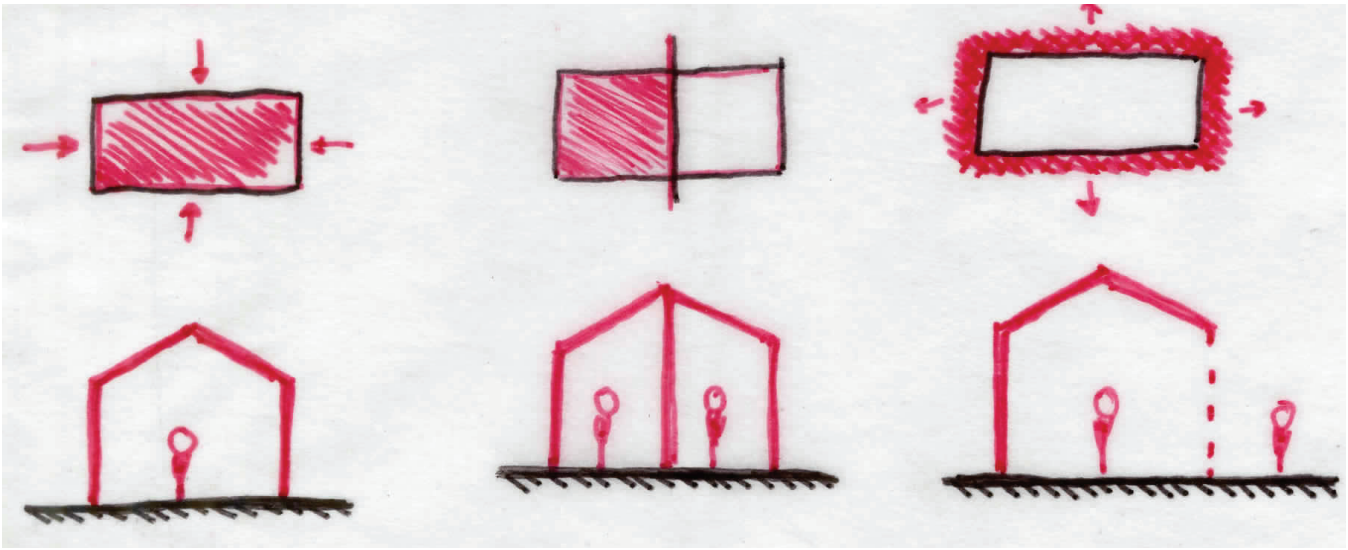
03 Preliminary Design Research

3.1

When starting the initial design research, the question of what makes a home, and what makes a community was the initial driving force. The three main ideas that answer these questions are *ENCLOSURE, DIVISION, and COMMUNITY.* The basic principle of a home is represented by *ENCLOSURE*. Four walls and a roof. This idea comes from the idea of the primitive hut. You cannot have a home unless you are protected from the elements. Once there is that protection and the inhabitant feels safe, then the idea of home can come into play.

The idea of *DIVISION* follows. When the inhabitant feels safe and the shelter can become a home, different rooms can be added such as bedrooms, kitchens, living rooms, and bathrooms. The initial necessity of shelter is not longer the priority. Comfort takes over and the inhabitant will modify the shelter into a home.

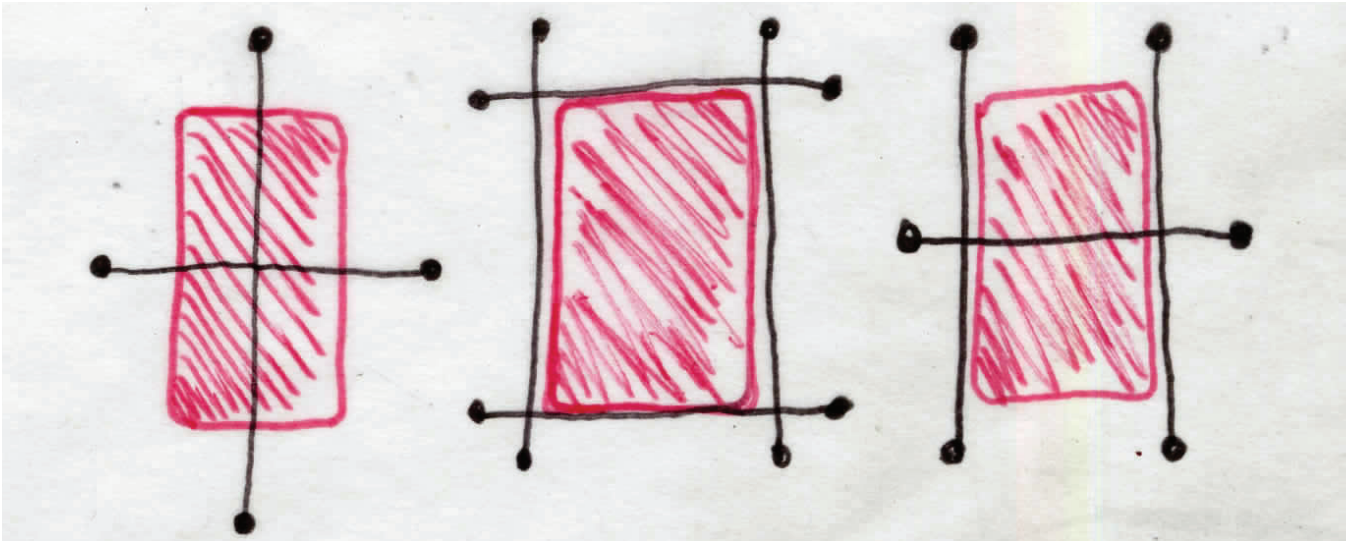
The third aspect is *COMMUNITY*, once a home is establish, the inhabitant can start looking outward. The idea of a neighborhood or a community is put into play by a series of homes. The inhabitants feel comfortable enough to invite people into their homes and area to the point where the location becomes a settlement. All three ideas work off one another to create a home.

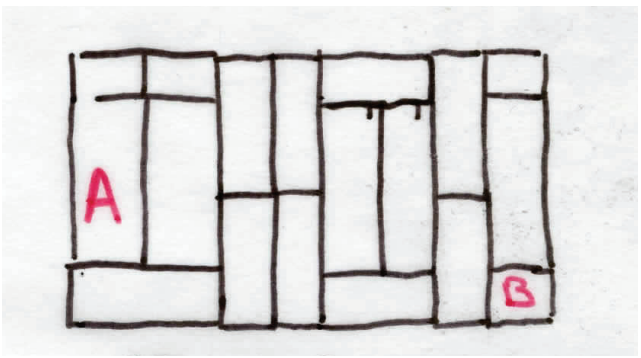


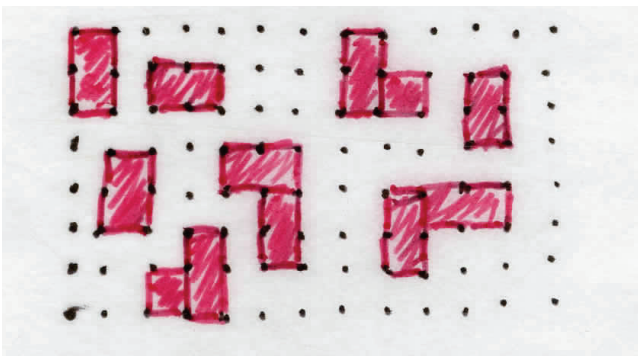
In terms of designing homes and communities after a natural disaster, there needs to be a sense of order and exactness to be efficient with the rebuild process. The idea of a grid is the most logical way to have quick and cost efficient construction. The images below represent three diagrams of grid patterns. The first represent three organized grid patterns; the axial grid, the modular grid, and the combination grid. The axial grid can be used to divide up a pre-existing space by splitting it into section. The modular grid can be used in a form of modular design. Using a specific repeated dimensional pattern to form the design. The combination grid uses both the axial and the modular grid. It uses a set modular dimension that is then broken down into sub sections.

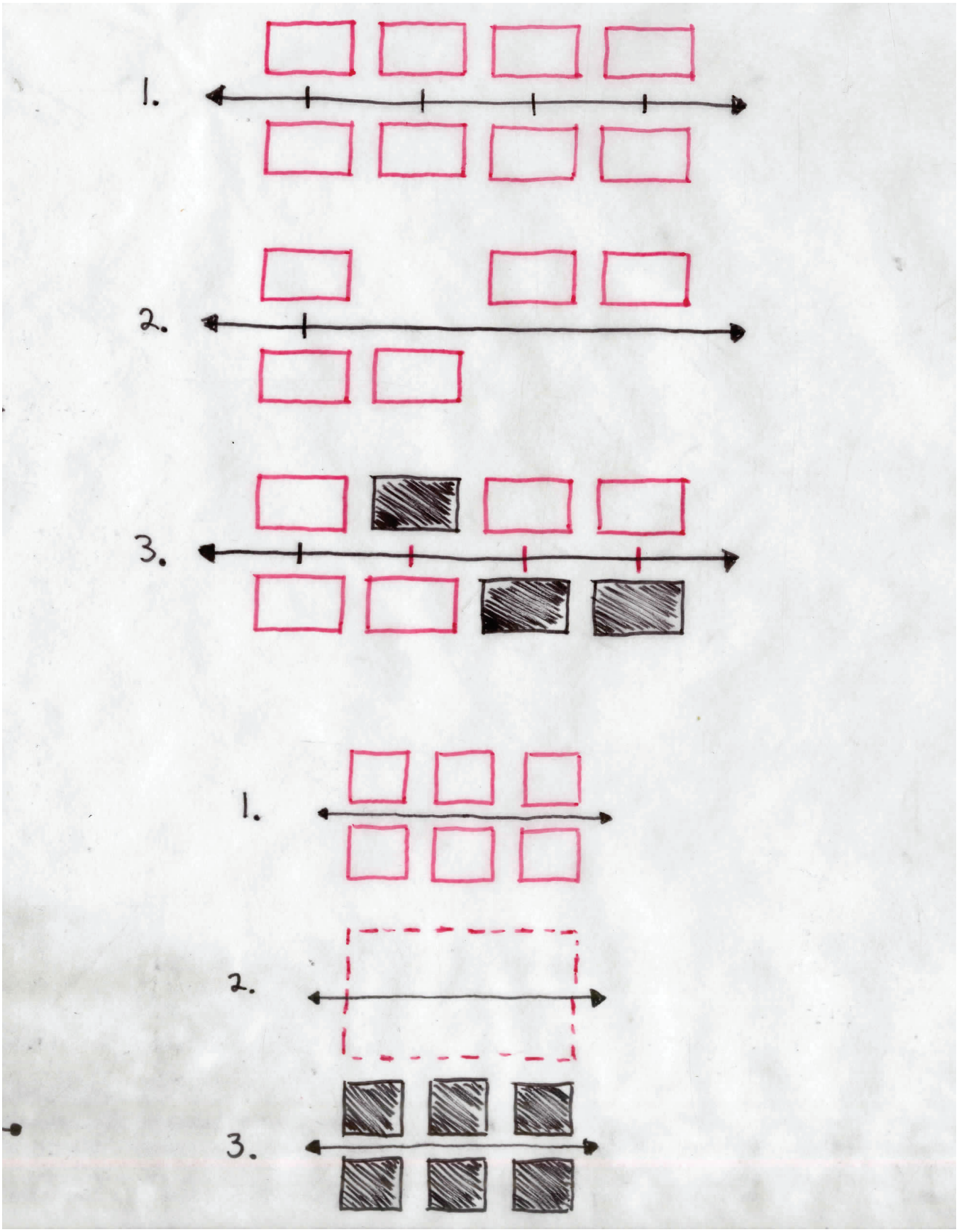
The traditional Japanese style home is unique in the sense that it uses basic dimensional order that is shown in the modular grid. They use a module called “shaku” which is about the same length as a foot. The shaku determines the size of the rooms and walls. The modular arrangement of the traditional Japanese home seen in the lower left diagram creates a sense of order, as well as makes the construction more organized and precise. This style home is one of the first modularly designed buildings that uses prefabricated elements.

By understanding the basic elements of modularity, the next step was to narrow down the idea of rebuilding a city. The diagram to the right shows my process of understanding a rebuild. In the case of a neighborhood that has partial damage to residential and commercial buildings, it would make sense to rebuild using the existing layout of the neighborhood. Taking the lots of the destroyed building and using





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them for new construction. In the case of a neighborhood that has total destruction, the rebuild becomes different. It gives the designer the option to replicate what was once there, or to completely redesign the area.

3.2

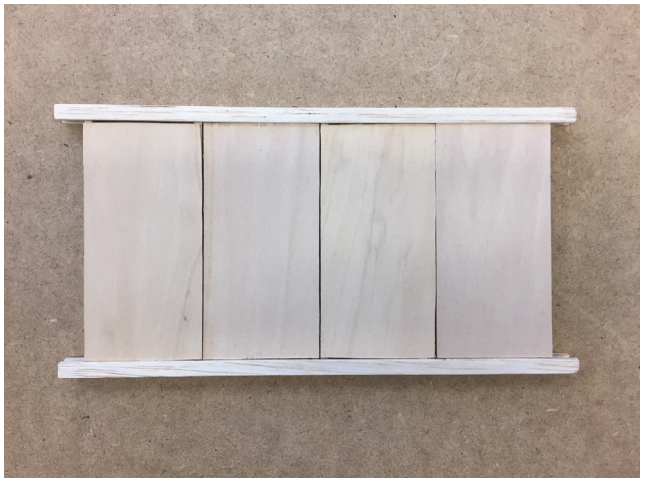
With the idea of a two part thesis focusing on both the master planning as well as the modular prefabricated structures, the next initial step in the preliminary research was to focus on the structural aspect of the modular construction. There were three initial concepts that I wanted to focus on. They were, customization, prefabrication, and assembly.

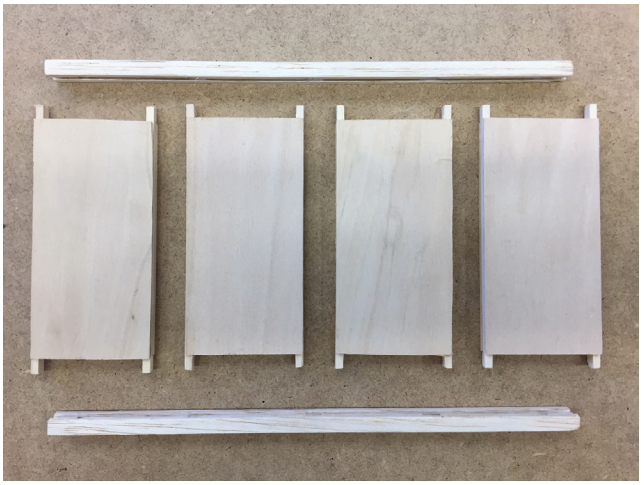
With the customization, I wanted to design in a way that gave the owner the ability to customize their home in the way they wanted. The initial design research that I focused on for this idea was the exterior wall. I wanted the owner to have the ability to choose where wall opening were placed without changing the materials or time frame of construction. The prefabricated element of this research was easy to comprehend due to the fact it is the main driving force of the thesis. The goal is to design a building that no more than two people are needed to assemble. Each prefabricated element would be able to be lifted by two people, and installed on the job site. This leads into the assembly. The prefabricated elements would be delivered by truck to the job site where a group of 2-3 people would assemble the building. The owner will have the ability to customize their home with the delivered materials.

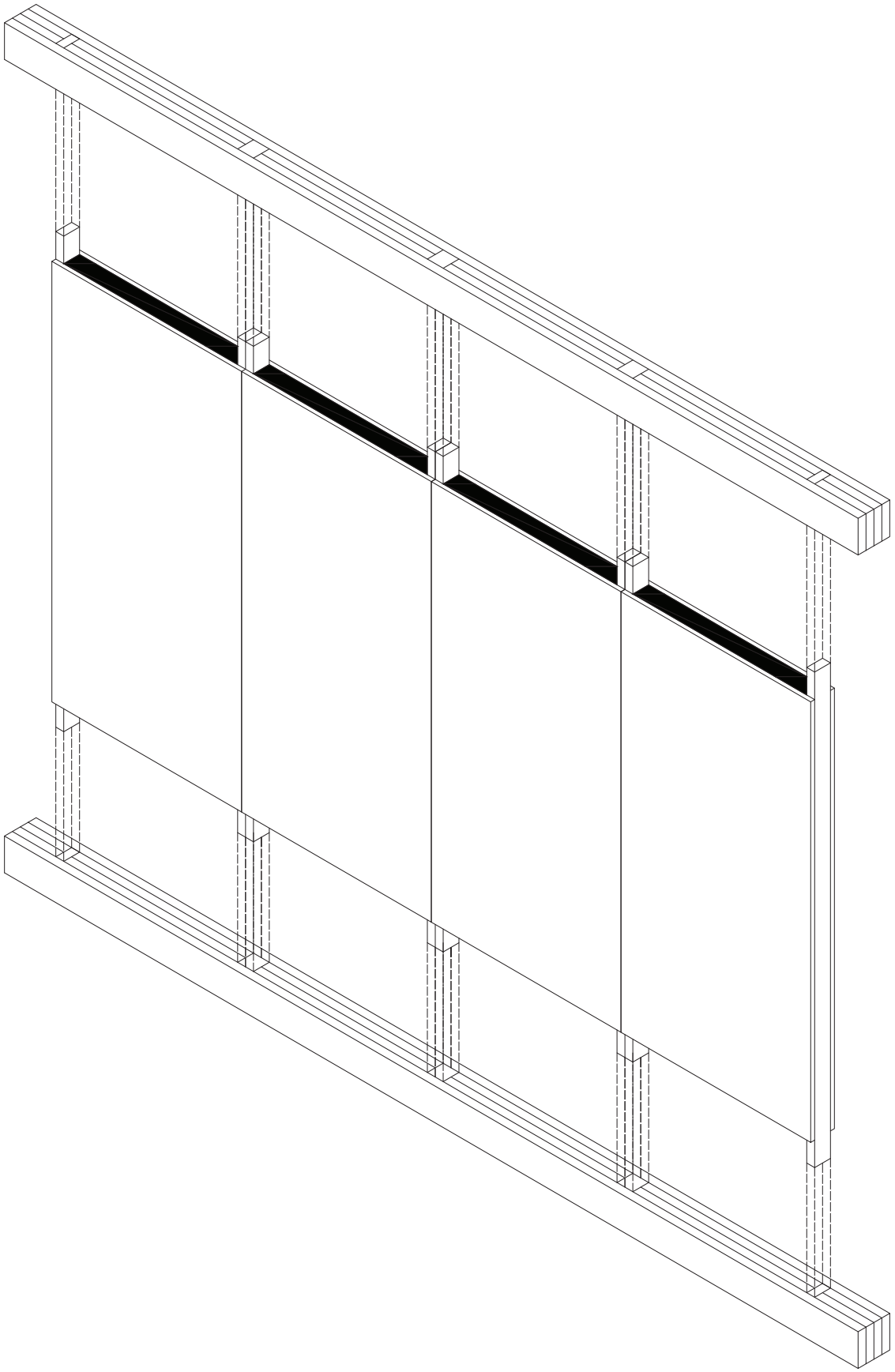
3.3

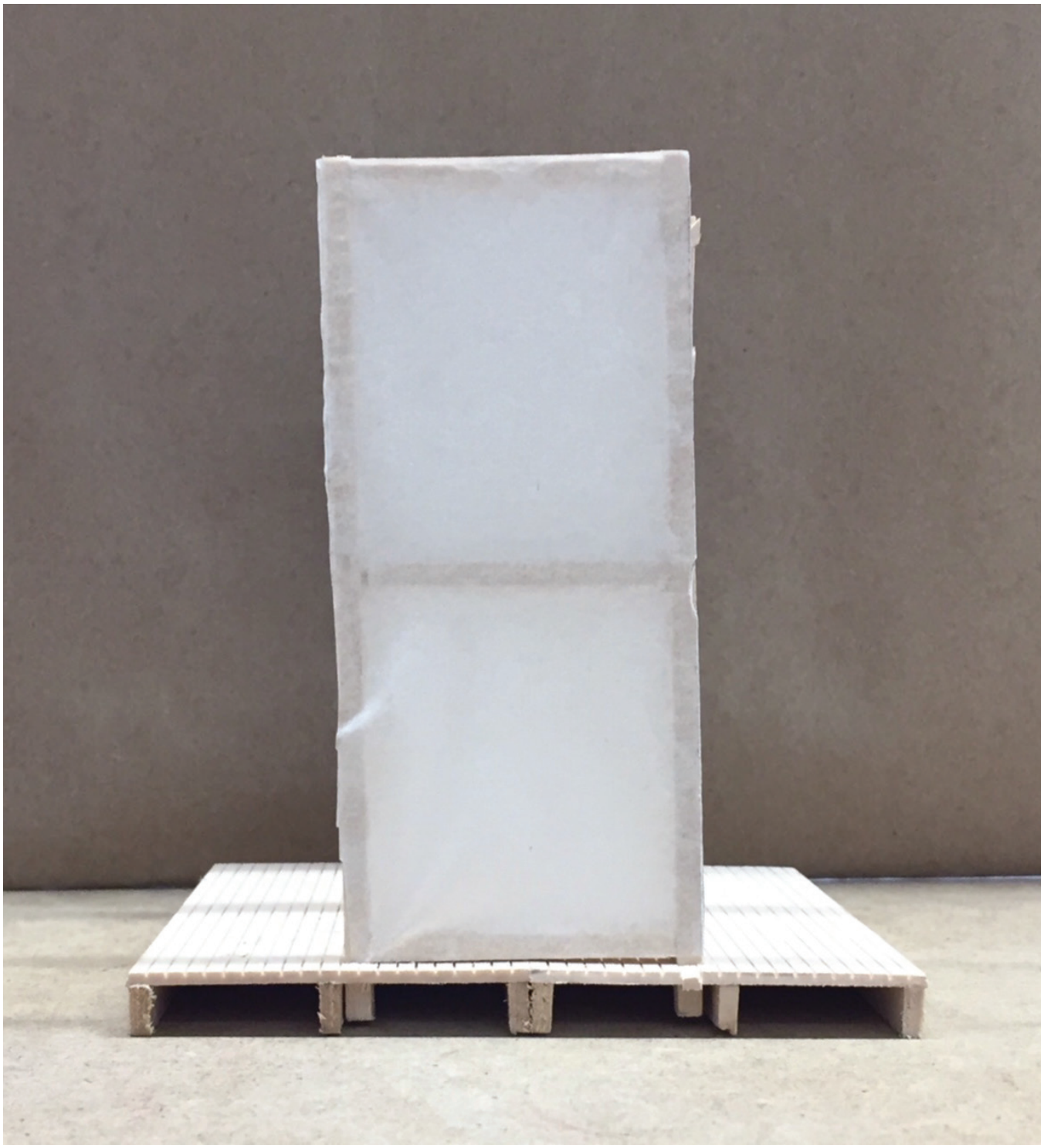
These three ideas lead me to the design of the structure and wall panels shown in the following pictures. The wall panels will be inserted into a glue laminated footer and sandwiched between a glue laminated header to tie them together. There are three types of wall panels; solid, screened, and translucent. Each panel would be the same size giving the owner the ability to drop the individual panels wherever they pleased.

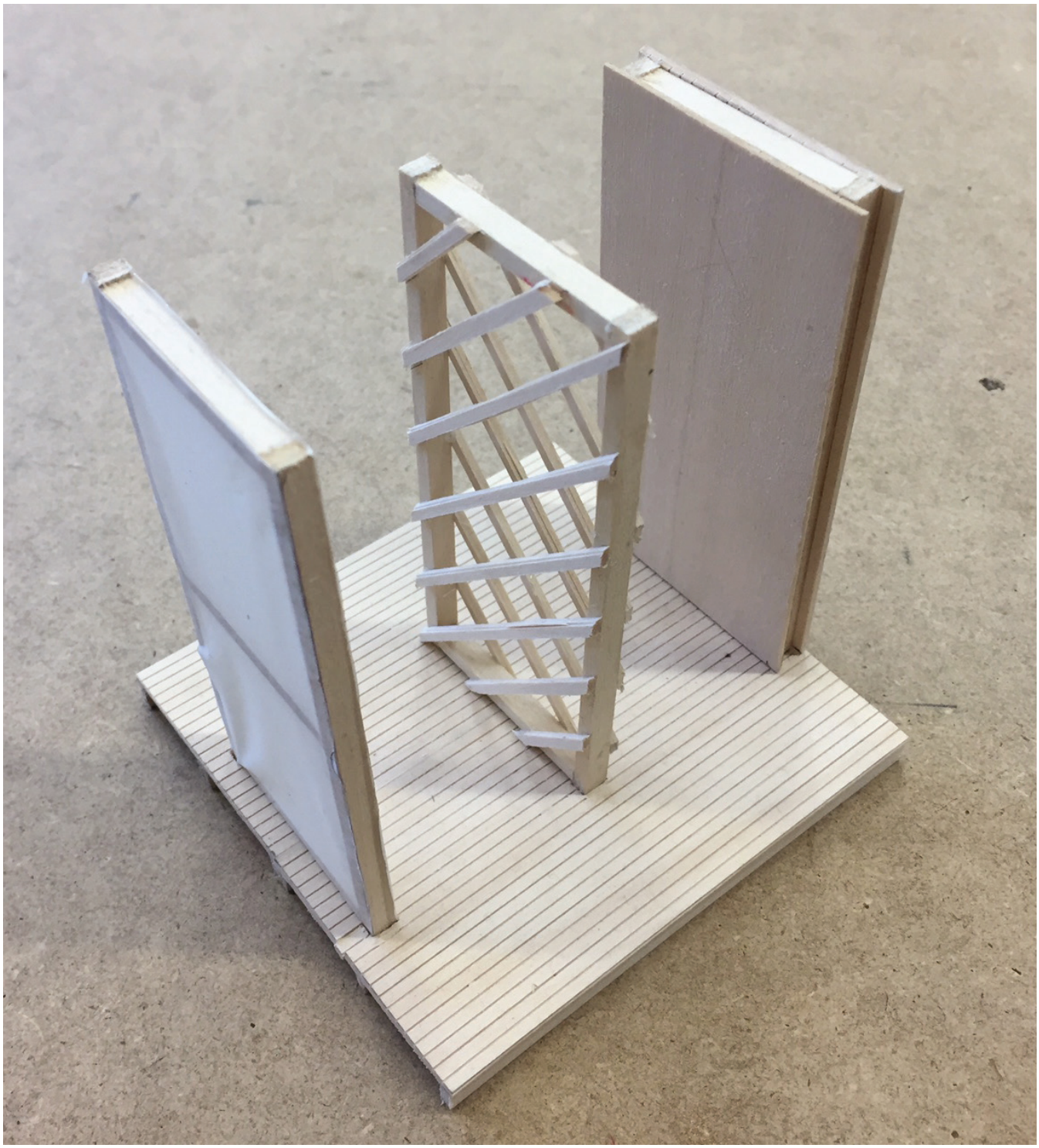
This customization allows the owner to dictate the privacy of the dwelling unit. The option to close off the interior with solid panels, or to open up the interior to the neighborhood with the translucent panels will drive the design of the interior partitions. This will lead to total customization of design by the owner. If the owner would rather construct the building based on a set of drawings rather than customization, there will be ten iterations of the exterior and interior plans to choose from. The driving force of this design would be a delivery of materials that would be the same based on whatever design the owner chooses. Regardless of choosing the customization route, or choosing from one of the ten pre designed drawing sets, the materials would be the same across the board making the fabrication and delivery easier and more accurate.

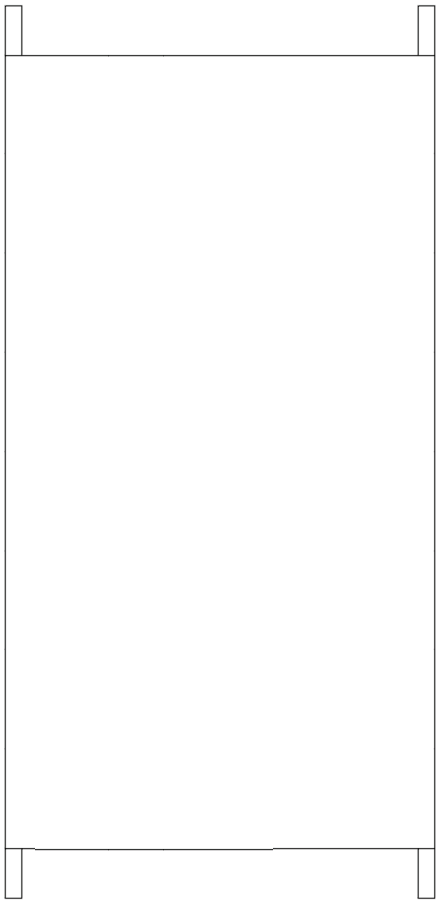


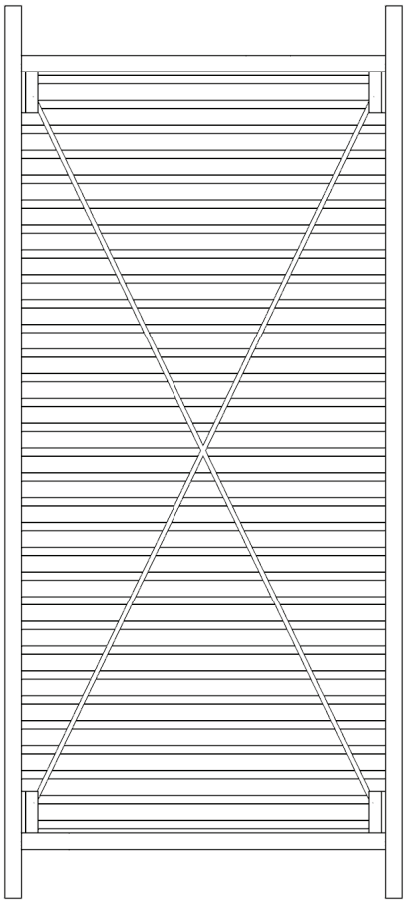


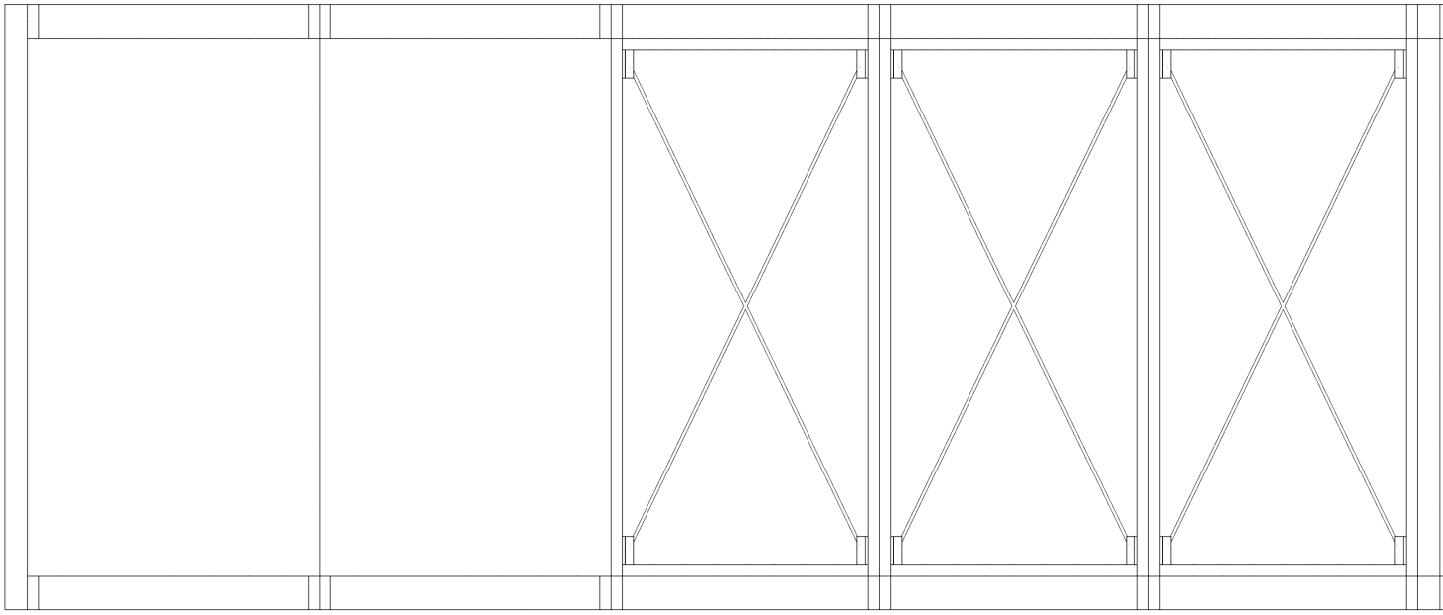


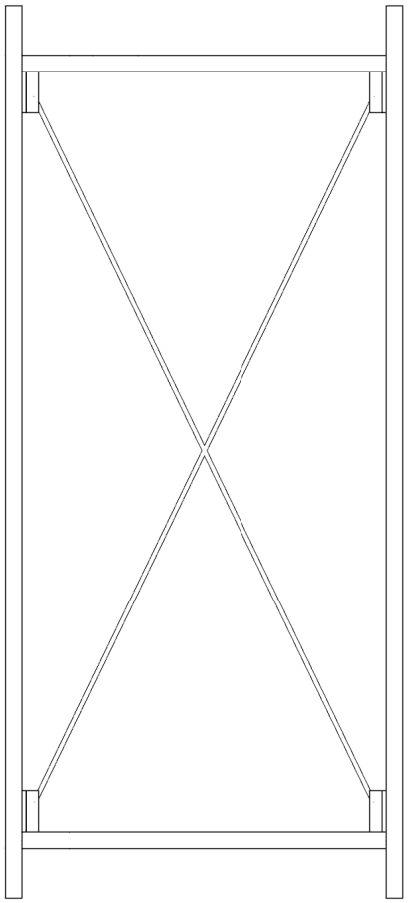


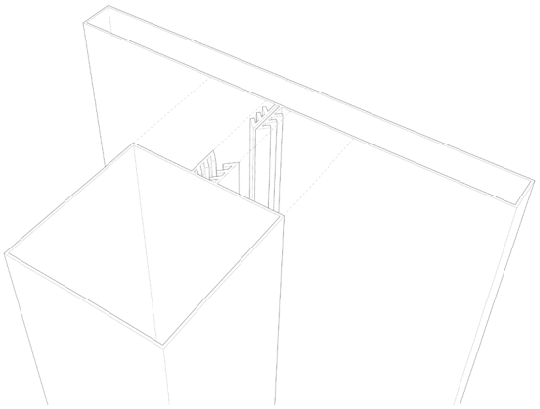


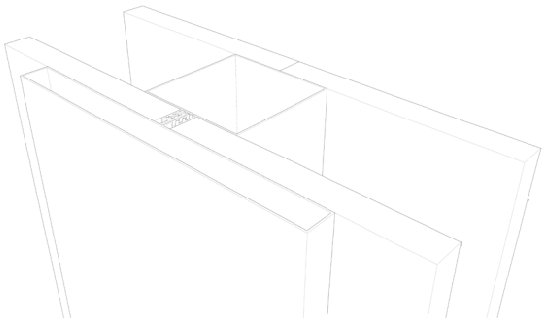


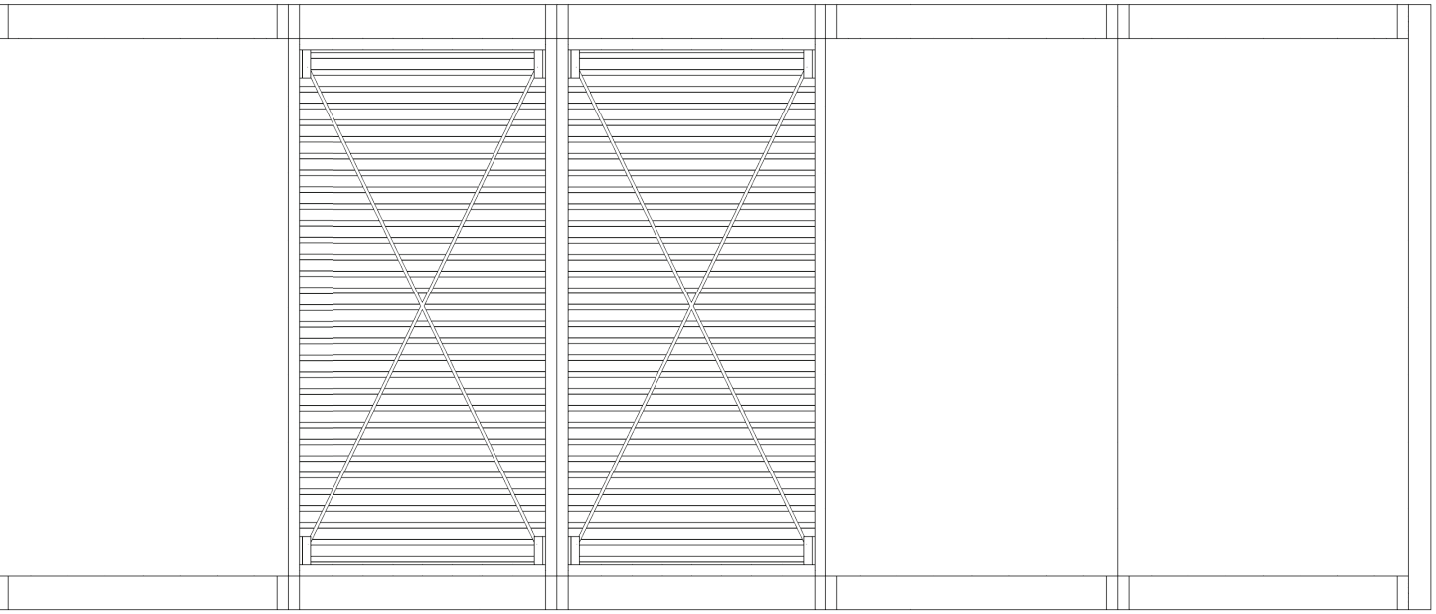












04 Research

4.1

With the projected increase in population in America and around the world, there is going to be an increase in construction demand. The population of the United State is going to increase by 50 million people within the next ten years. One question that arises is how are we prepared to handle this increase. The obvious concerns would be food demand in urban areas, gas and oil demand, and housing. America, and the rest of the world are not as prepared for the future as we would hope. Production levels need to increase, and sustainability needs to become front and center in every design. One thing that can help the increase in population, is prefabricated and modular design. There are four benefits to pre fabricated construction that separate it from regular construction.

ECO-FRIENDLY:
With traditional construction, there are usually wasted materials. Wood scraps, extra nails, and other waste. These usually just get thrown out and end up in a land fill. With Pre fabricated construction, that extra waste is usually recycled in house. The construction usually has tighter joints, and is more energy efficient.

FLEXIBLE:
With Pre fabricated construction, it can easily me transported, taken apart, and put together. This is more beneficial in the long run. It allows people the opportunity to move and take their home with them. It also allows for easy demolition with less pollution.

COST EFFICIENT:
Pre fabricated construction is more cost efficient. The prices can seem larger up front, but you save money when it comes to construction. The reduction in construction time, and a less labor intensive build will save money on the back end of the process.

CONSTRUCTION TIME FRAME:
This type of construction usually takes less than half the time of regular construction. This is beneficial to both the client and the builder. It allows the client to move in earlier and save money, as well as allow the builder to be able to take on more projects at once.

Time and money are two large factors taken into consideration when designing and building home. No one wants to spend more or wait longer than they have too when it comes to construction. Modular and prefabricated construction can save time and lower the cost of a project.

4.2

To understand modular and prefabricated construction, I feel that it is necessary to understand the history on how prefabrication started. The first signs of prefabrication can be traced back to 400,000 B.C. to the Nomads and settled dwellers. These people were predominantly on the move

searching for new locations to live. They would live in temporary structures made of tree trunks, branches, and leaves. They collected materials that could be easily transported and assembled so they would avoid having to find new materials with every move. With the change in the way humans live (crop production / livestock) prefab turned into more concrete construction.

Image 19: Components and Systems

A form of prefabrication that I never really considered was the use of brick and stone, a true example of "concrete construction." The Egyptians mass produced mud bricks to build entire cities, and the Greeks perfected the use of stone. Today, I wouldn't consider traditional brick and stone construction to be a part of prefabrication, but In the early years, I can see how mass production of building materials that all meet a modular dimension can be considered part of that group.

Modular dimensions are key for modular and prefabricated design. Advancing from the Egyptian and Greeks to the Japanese, A traditional Japanese home is one of the various types of modular timber framed construction. It is unique in the sense that it uses a basic dimensional order. They use a module called "shaku" which is about the same lengths as a foot. The shaku determines the size of the rooms and walls, but there is another dimension called the "ken" that determines the spacing between columns. The ken is roughly the size of 6-6.5 shaku depending on the specific area you live in. The wall elements in this style home can be open, translucent, or solid, and are usually on tracks so they can slide. Rooms can be multi use to take on different aspect during different parts of the days. There are prefabricated elements in this style of construction. The timber elements are prefabricated and use flexible joints to help deal with earthquakes. The timber elements only use timber. There are no other materials used when making the connections. This style home is one of he first major examples of a modularly organized building using prefabricated elements.

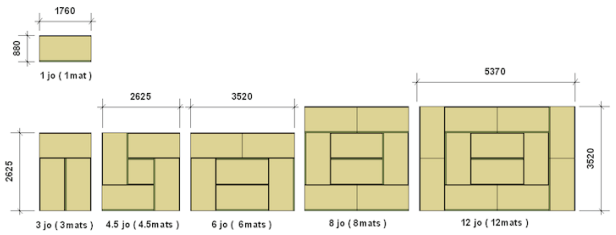


Image 20: Components and Systems

4.3

Using prefabricated elements in permanent design was not always the case. Temporary prefabricated construction became popular with the military. Military housing has progressed from small tents, to more stable light weight structures, to timber framed buildings, to corrugated iron, and then back to a canvas material. The use of tents were very important because they are very light weight and can easily be transported, constructed, and deconstructed. As the demand for military increased, more stable light weight structures were created, one example is demountable timber framed buildings that were used for hospitals, stables and housing. Wood structures were replaced by lighter more stable corrugated iron that was galvanized to reflect the sun. Military housing has evolved over the year and represents the bare essentials of prefabricated and modular construction.

The idea of temporary vs permanent is very important when it comes to this thesis. I believe to help the rebuild process, and to continue to help the destroyed city, the construction needs to be a permanent design solution. The entire building would be prefabricated and relocated to the site. The foundation will come in precast concrete pieces to be assembled on site. The wall panels will be prefabricated and attached to header and footer. The floor will be

the same system as the walls with added flooring to make the system flush, and the roof will be a different system to be further explored.

4.4

Part of what interests me in modular prefabricated construction is the ability to help people in a quick and effective way. After natural disasters, it is important to be able to help people and provide shelters. Prefabricated relief structures are very important in this regard. 32 million people are displaced from their homes each year due to natural disasters. After hurricane Katrina, many architects and designers were inspired to focus on modular relief shelters.

One concern that I have with this permanent modular design is the site work. Using precast concrete elements for the foundation is one way that I am exploring for my design. Precast concrete is built off site and transported to the site. It has the lowest site impact and can be implemented into the site in as little as one day. Since it is cast off site the weather does not play a factor in the concrete, and you can get a stronger more reliable product. The idea would be to create a crawl space foundation so that the building would sit about 2-3 feet above ground. This would help prevent water damage if a second storm passed through.

Image 21: Easi-Set Buildings

Creating a permanent design solution will give current residents a place to live while their home is being rebuilt. It will give the resident an option on weather to rebuild their destroyed home, or to make the new design their permanent home. In the case the owner rebuilds and moves back to their old location, the new modular buildings would serve as areas for new residents to move to, to continue the growth of the city.

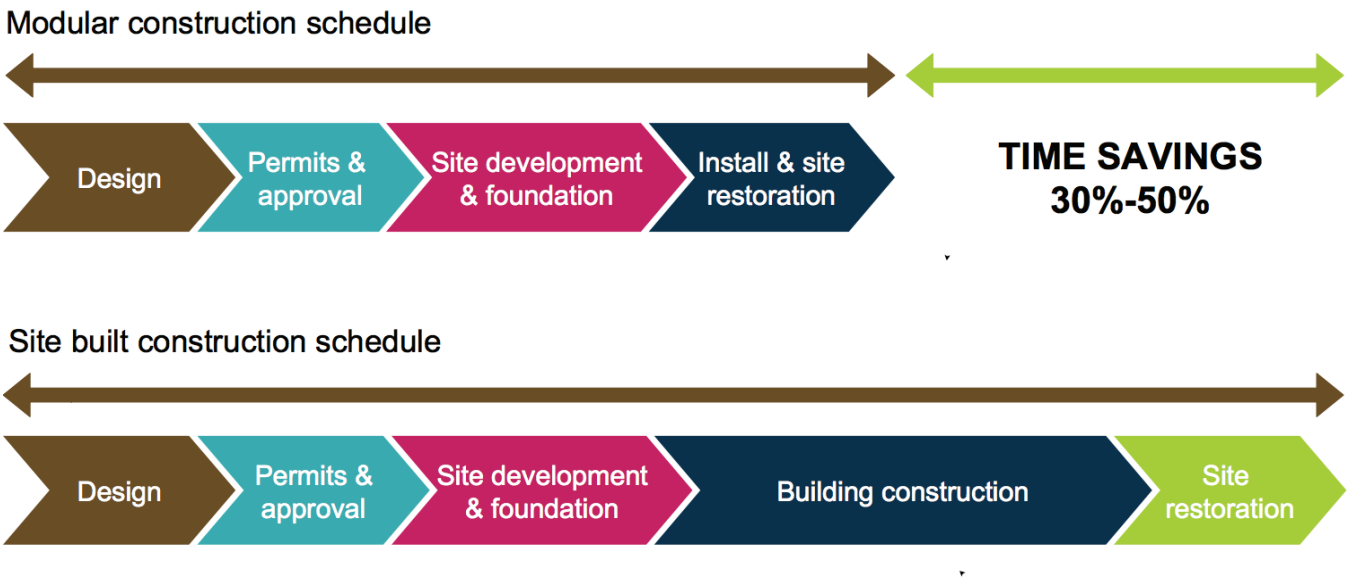


Image 22: Christian Donato

05 Site Analysis

5.1

With all the devastation that happened in Houston this past summer, I decided to focus on this city for my thesis. Houston is a unique city that has very loose zoning laws. It was established on August 28th 1836 and became a city on June 5th 1837. It totals about 669 square miles, and has grown and expanded creating an urban sprawl. The idea behind the master planning aspect of the thesis will focus on a neighborhood on the outskirts of Houston. Instead of focusing on how to prevent an urban sprawl, this integration will look into ways on how to design beautifully and mindfully in an area that seems to never stop expanding.

5.2

Houston had a population of 44,633 people in 1900, and that number has since grown to 2,319,603 people in 2017. In the past year, Houston had the largest population increase out of every American city, and it is the 4th most populated city. The population of Houston has increased by at least 125,000 people every year for the last ten years, and it is projected to continue this pattern. Houston's demographics have a wide range of ethnic backgrounds and cultures. It is 50.5% White, 43.8% Hispanic, 23.7% Black or African American, 6.1% Asian, and 19.2% other races. It is the youngest population in the country. With the diverse backgrounds of the people of Houston, it has created a very cultured city. Food is a very large part of Houston Culture. The residents eat out more in Houston than the residents in any other city. Houston has over 11,000 restaurants that include various foods from across the worlds. Along with the food, Houston has a popular arts and music scene. It has the 4th largest museum, district, as well as the ballet, opera, symphony, and theater.

Image 23: Magazine + Blog Di Architettura

5.3

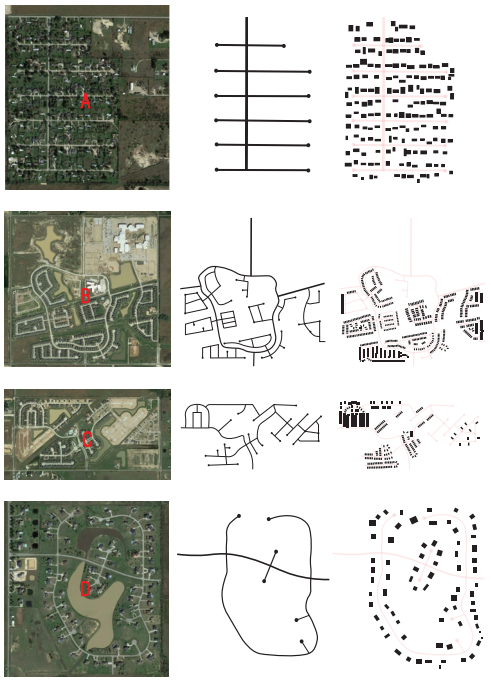
On August 26th, 2017 Hurricane Harvey made landfall in Houston leaving 82 people dead. The total rain fall was 51.88 inches, which was more rainfall in the five days than in the entire previous year. The weight of the water caused Houston to drop 2 centimeters in height. There was a total of 122,331 rescues and evacuations, 34,575 people had to use the local shelters, 450,000 people have asked FEMA for assistance, 215,000 students are out of school

and around 30,000 families will need temporary shelters during the rebuild.

There was a large impact on the agriculture from the local farms. There is an estimated $150 million dollars worth of agriculture damages caused by the hurricane. Houston is one of the largest exporters of cotton, cattle, wheat, corn, and soybeans. The cotton farmers were hit the hardest. The strong winds blew away the cotton before the storm even made landfall. Most of the crops were destroyed, and a majority of the crops that were not destroyed had to be thrown away due to bacteria in the rain water. Along with the crops, many residences and commercial buildings were destroyed. Residential housing suffered the most. There was a total of 72,000 houses damaged, and 2,215 of those were destroyed. The hurricane caused many people to leave the area. *5.4*

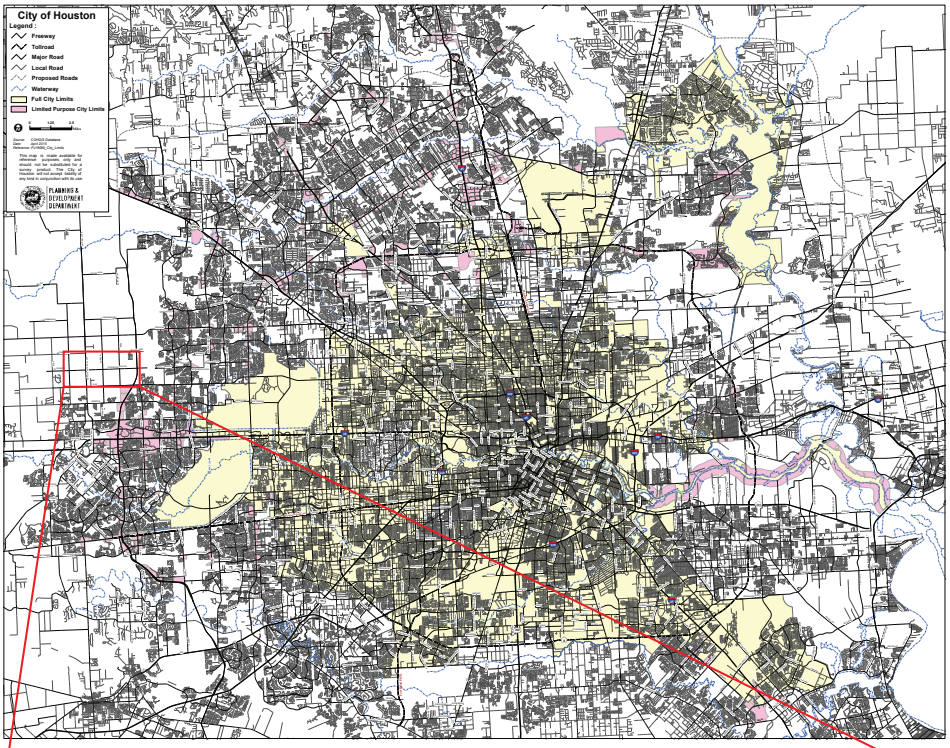
The site that I have chosen will be located west of the downtown area of Houston. Throughout the years, Houston has expanded in a radial fashion. It started by expanding southeast until it reached the waterfront, then it started to expand northwest. Houston has made plans for western expansion by creating roads and places for future neighborhoods. By keeping with their pre-planned expansion ideas, I have studied four existing residential complexes, and the infrastructure that surrounds it.

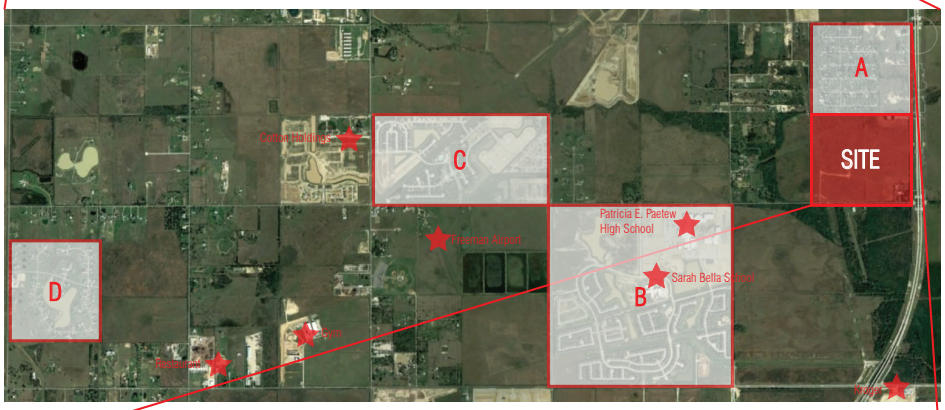
Area A and the Site are located within 2 miles of a Kroger grocery shop and other shopping areas. It is also conveniently located next to interstate 90, which travels north/south and heads directly to University of Houston. Area B is mainly a residential community and holds two local schools; Patricia E. Paetew High School, and Sarah Bella Elementary School. It is located between an airport and grocery store. Area C is the headquarters for Cotton Holdings. The leading infrastructure support and property restoration company in Houston. They serve domestically and internationally. It is also Located just North of the Freeman Airport. Area D is a residential community that is still in the development phase. It is located near restaurants, workout facilities, and sports complexes. Based on the surrounding area and new construction, the land will be developed to hold more commercial buildings.



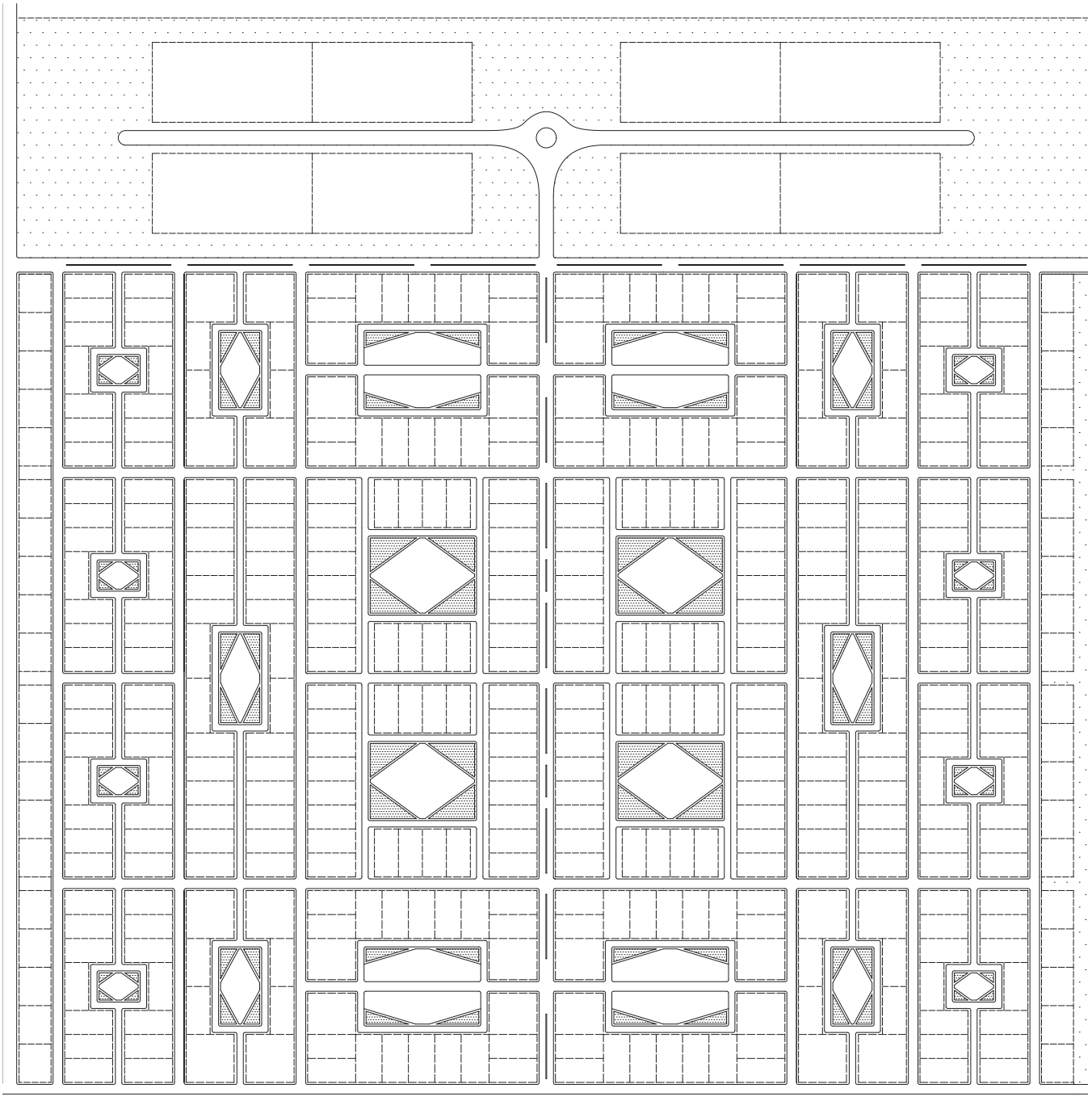
5.5

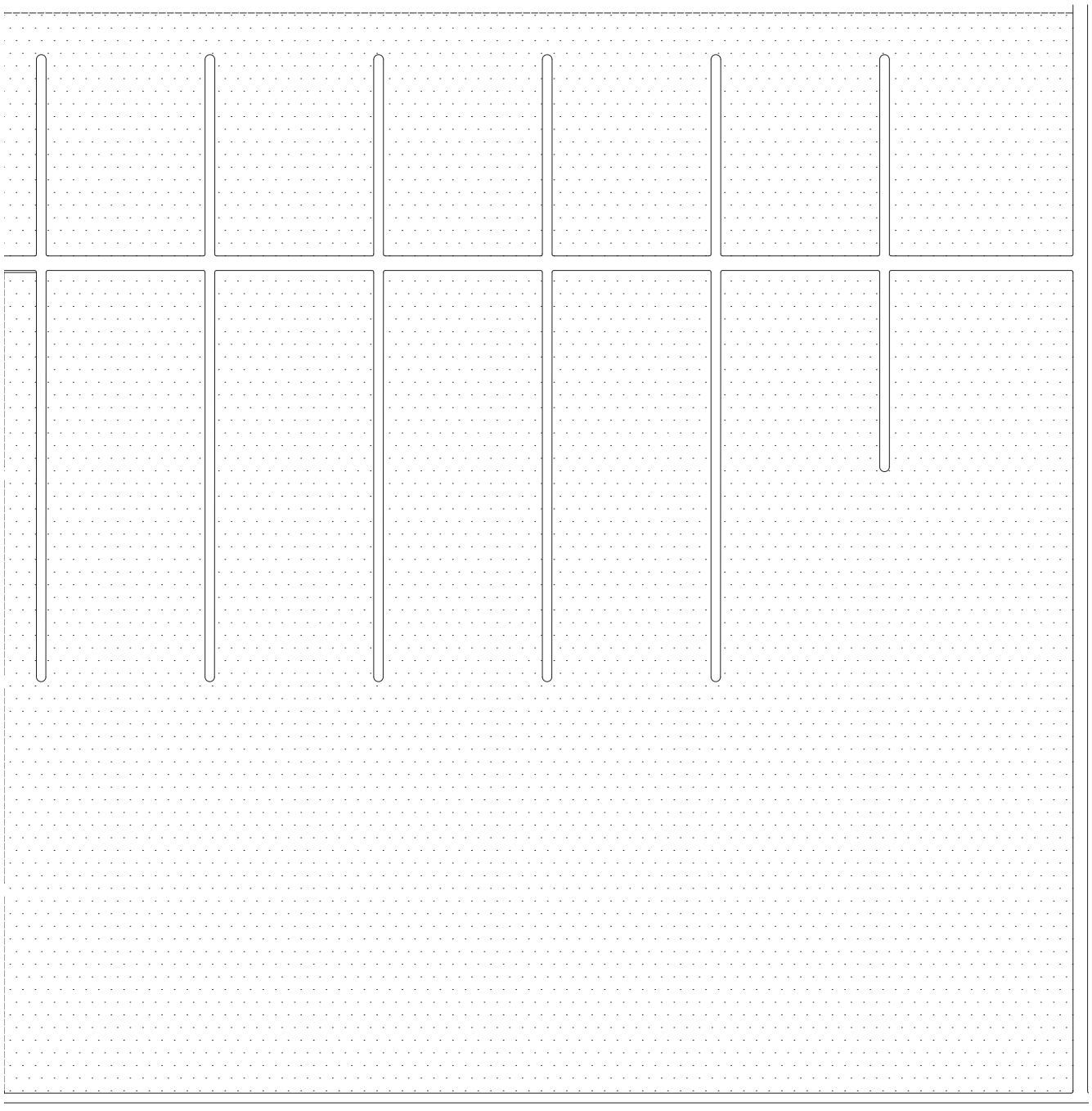
On the following page is the proposed master plan for a neighborhood in Houston. The location has easy access to two grocery stores, an elementary school, an high school, an airport, restaurants, and shopping locations. The proposed master plan is organized in a grid pattern to speed up the construction time, and allow for mass production of multiple neighborhoods and blocks. There are four different variations of blocks that vary in different sizes and lot numbers. A typical lot is 120’ x 60’. Each block has a shared public garden in the center, along with a private alley to allow access for equipment and trash collection. This allows the residents to produce their own food in a controlled environment, or to have shared space to create a sense of community. There are primary main roads that run perpendicular to each other, The primary roads consist of 4 lanes with a center median. The western side of the site will be the center for commercial buildings for the neighborhood. These buildings will consist of a grocery store to reduce travel time too and from the market, a library and education center, local shopping areas, and restaurants.

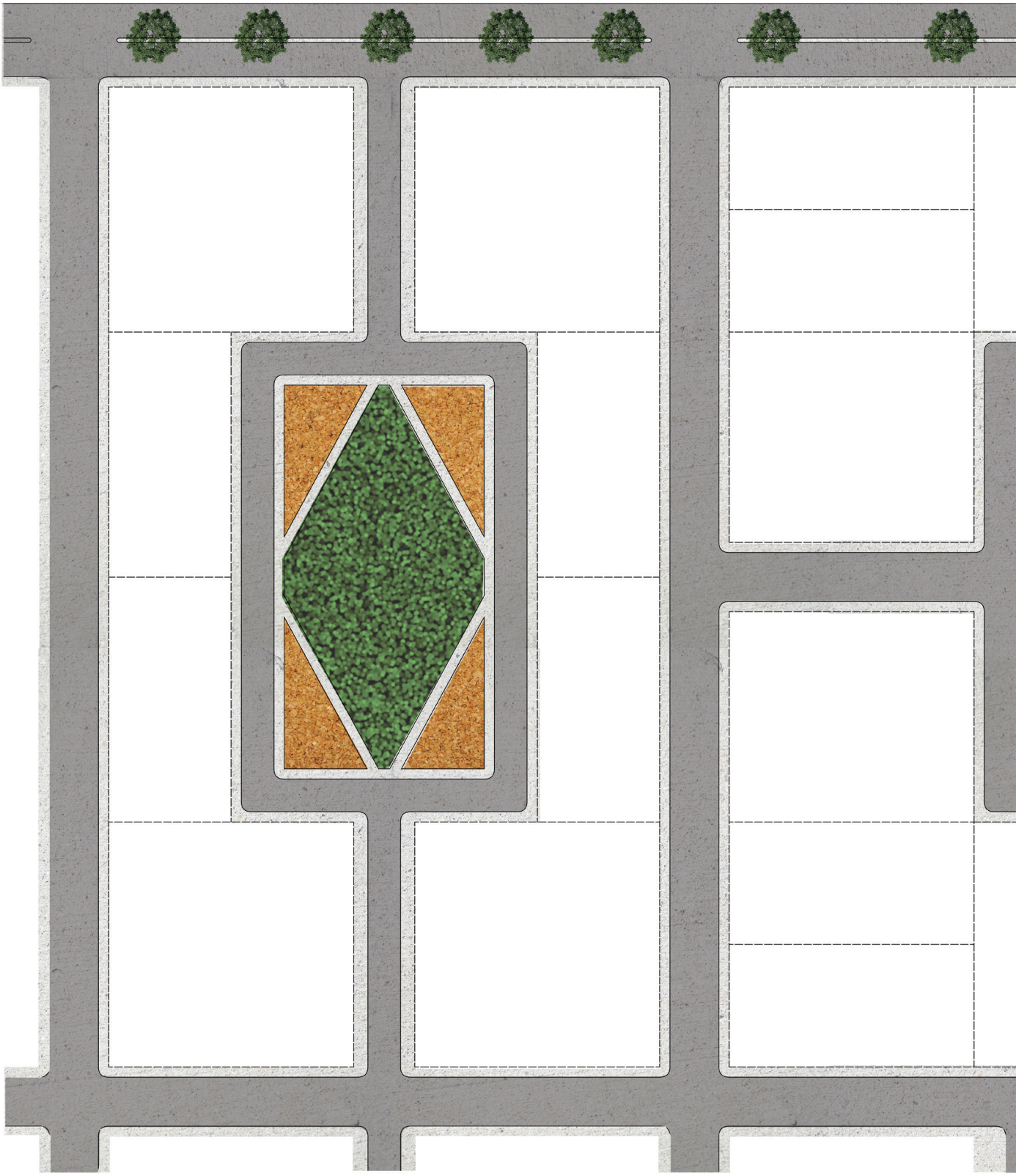

City of Houston
Legend :
Freeway
Tollroad
Major Road
Local Road
Proposed Roads
Waterway
Full City Limits
Limited Purpose City Limits
PLANNING & DEVELOPMENT DEPARTMENT

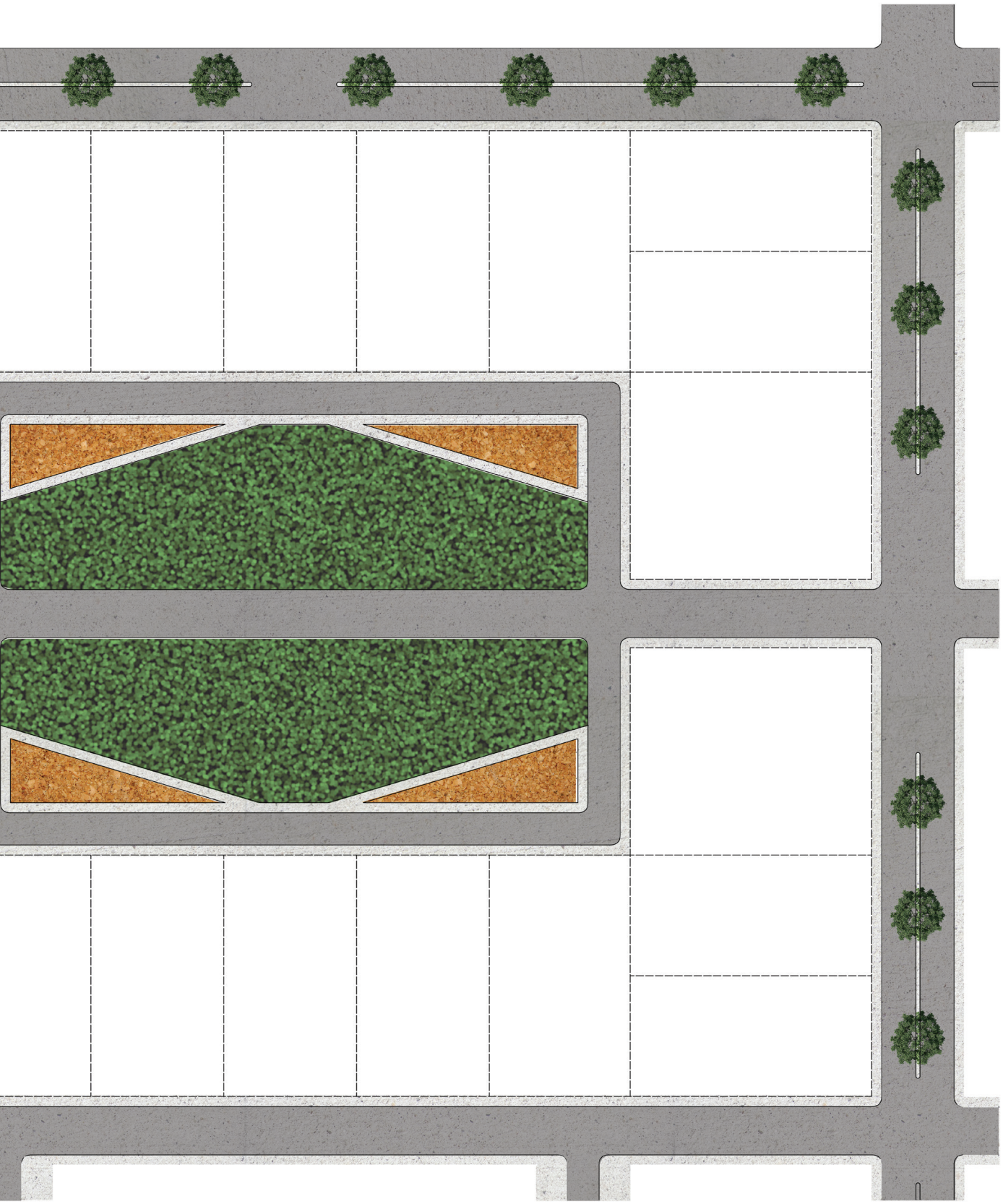

A
SITE
C
Patricia E. Paetow
High School
Sarah Bella School
B
D


SITE
A





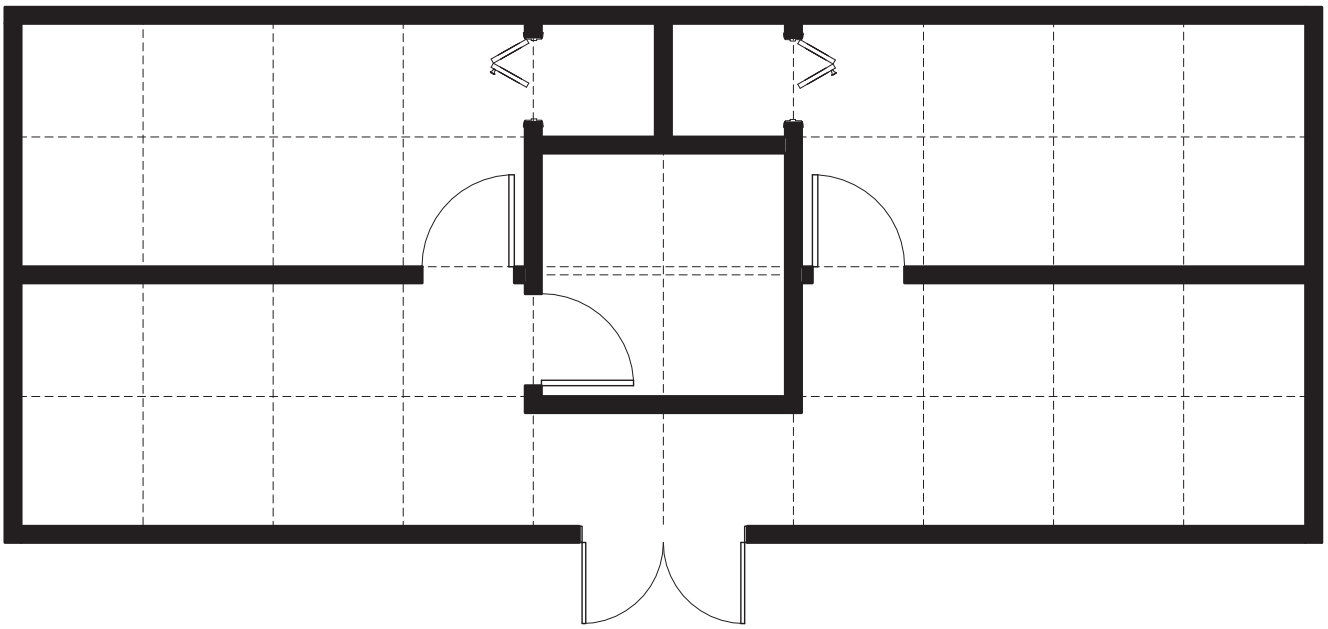


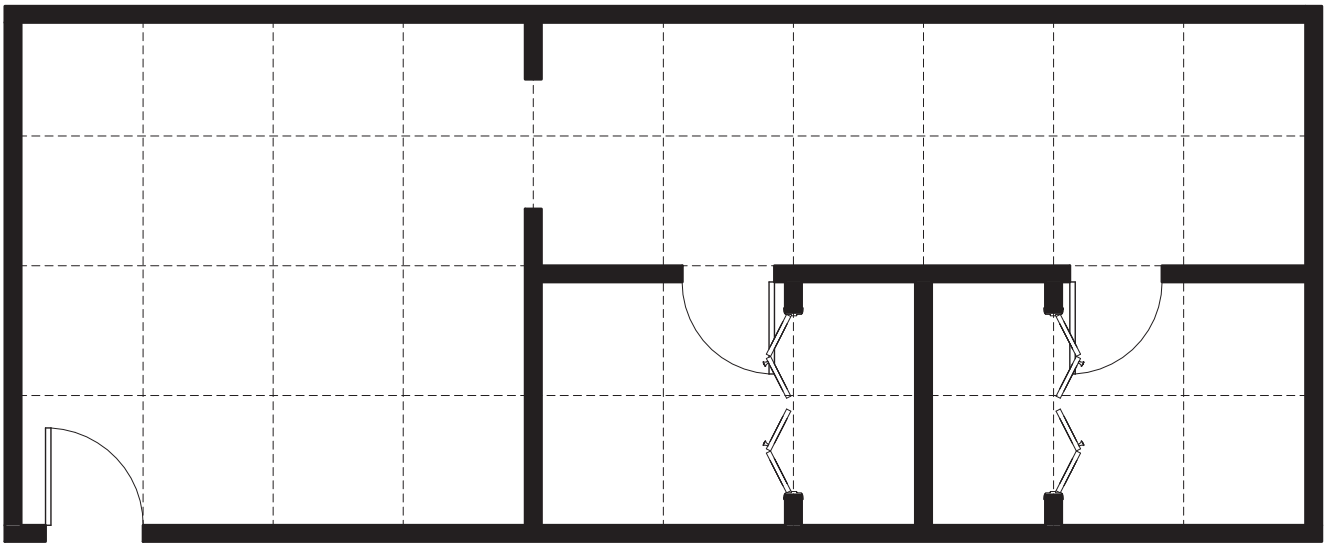


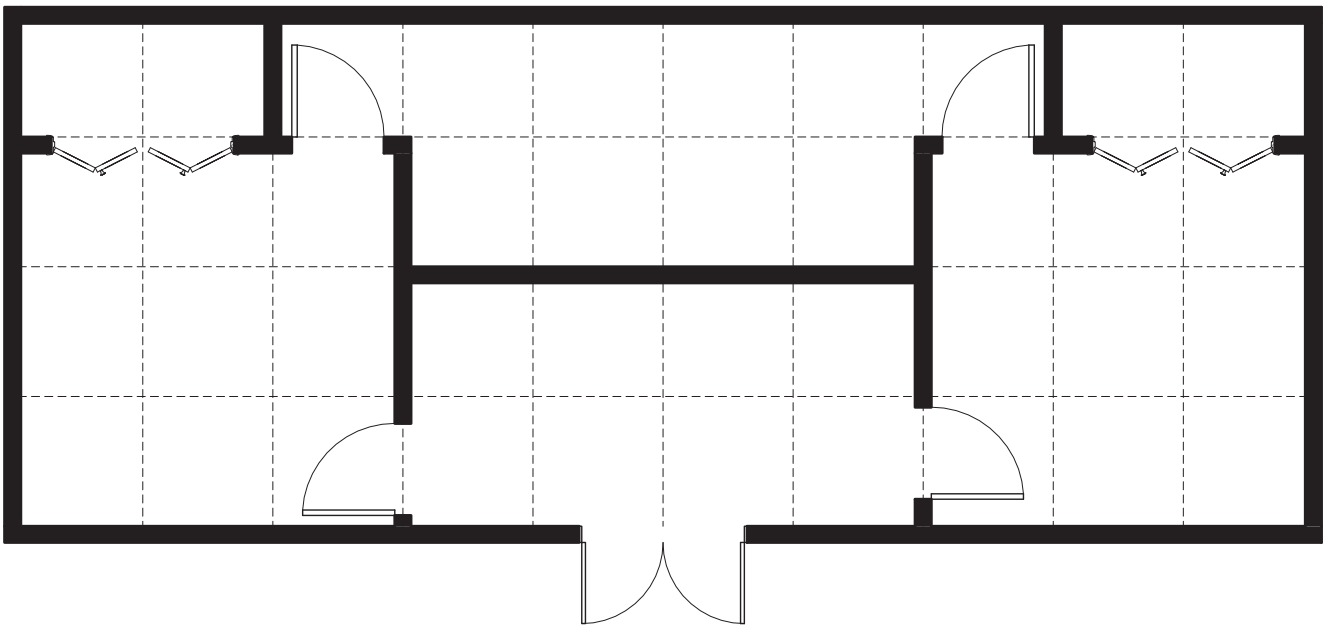
06 Schematic Design

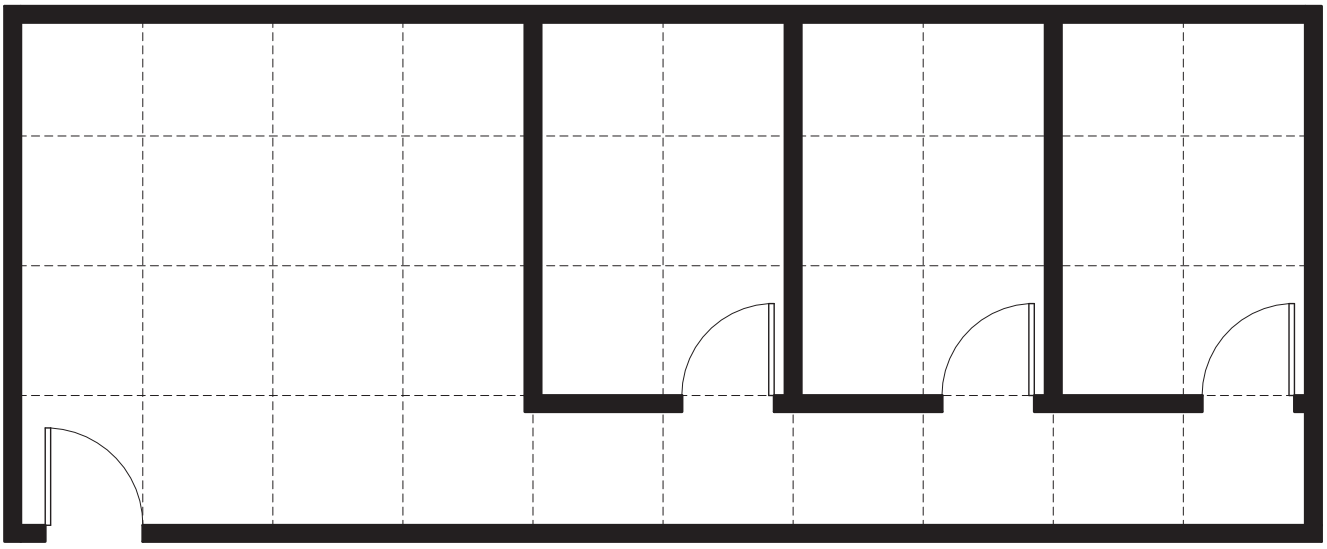
6.1

The first initial design I focused on was the layout of the plans. I knew that there needed to be a modular system so I decided to focus on common dimensions such as 4', 8', 12', and 16'. I made a series of diagrams using those common dimensions. The diagrams play off of each other in a random fashion. The purpose of the diagram was to see potential floor plan layouts based on those dimensions. I wanted to study how a modular system can create unique patterns, sizes, and layouts without just creating an organized grid. Once the grid patterns reached a point in which I believed I had enough to make some plan explorations, I picked four of them to make floor plans out of. The first four floor plans use a pattern with minor changes. The plans keep in mind the need for a bedroom, living room, kitchen, and bathroom. Looking at the four plans, I realized the need for space. This will be a design challenge I will focus on based on the small dimensions of the modular construction.









6.2

With the foundation, I wanted to design something that was both lightweight, as well as affordable. I was keeping in mind the idea that only two people would be constructing this unit, so I wanted to make sure that each footing was easily movable.

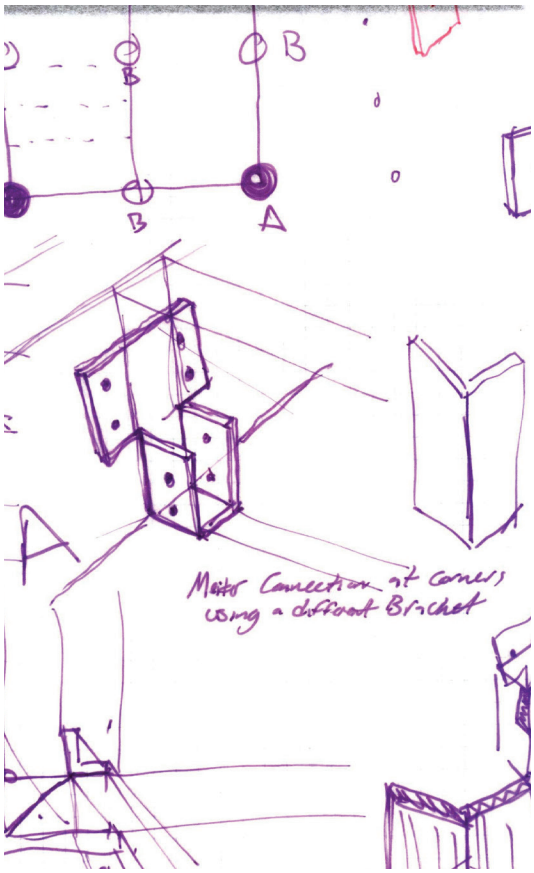
I started to look at free standing footings that could be buried in the ground. The idea that the footings would elevate the building off the ground but not be connected to each other was a strong driving force. I came up with the idea that the footing would be a concrete pier that flairs at the end to help with uplift. At the top of the concrete, there would be a metal plate that would be the anchor to a 6x6 stud. Each stud would come assembled with different angle connections to hold the bottom plate. The footings would ultimately be tied together with the bottom plate.

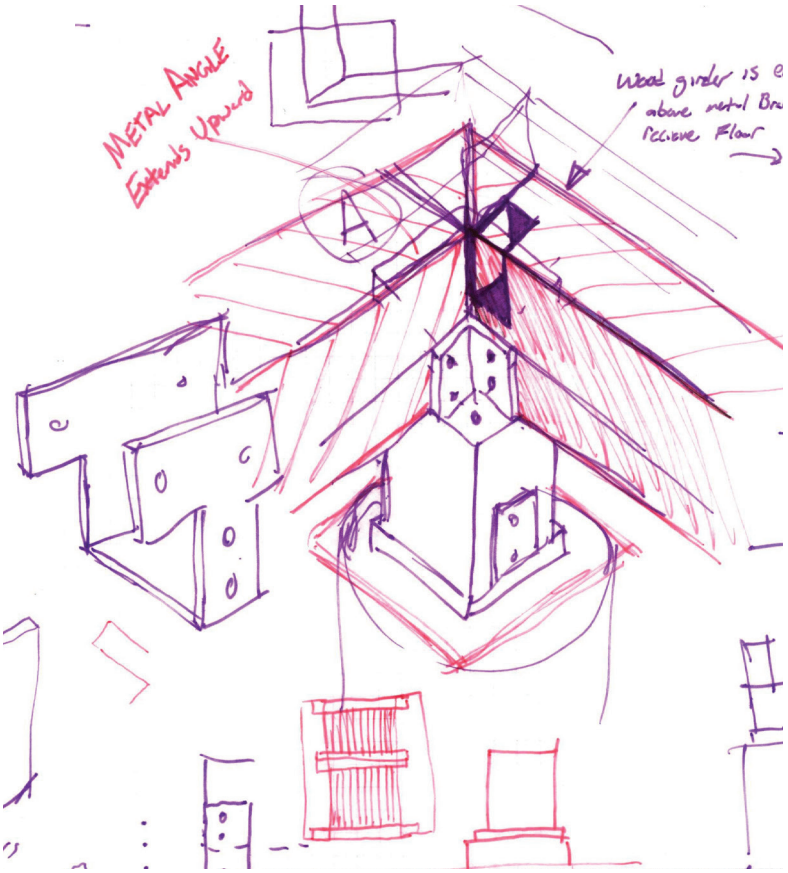
As seen in the two images below, The bottom plate would meet at the corner and be secured with steel angles connected to the foundation.

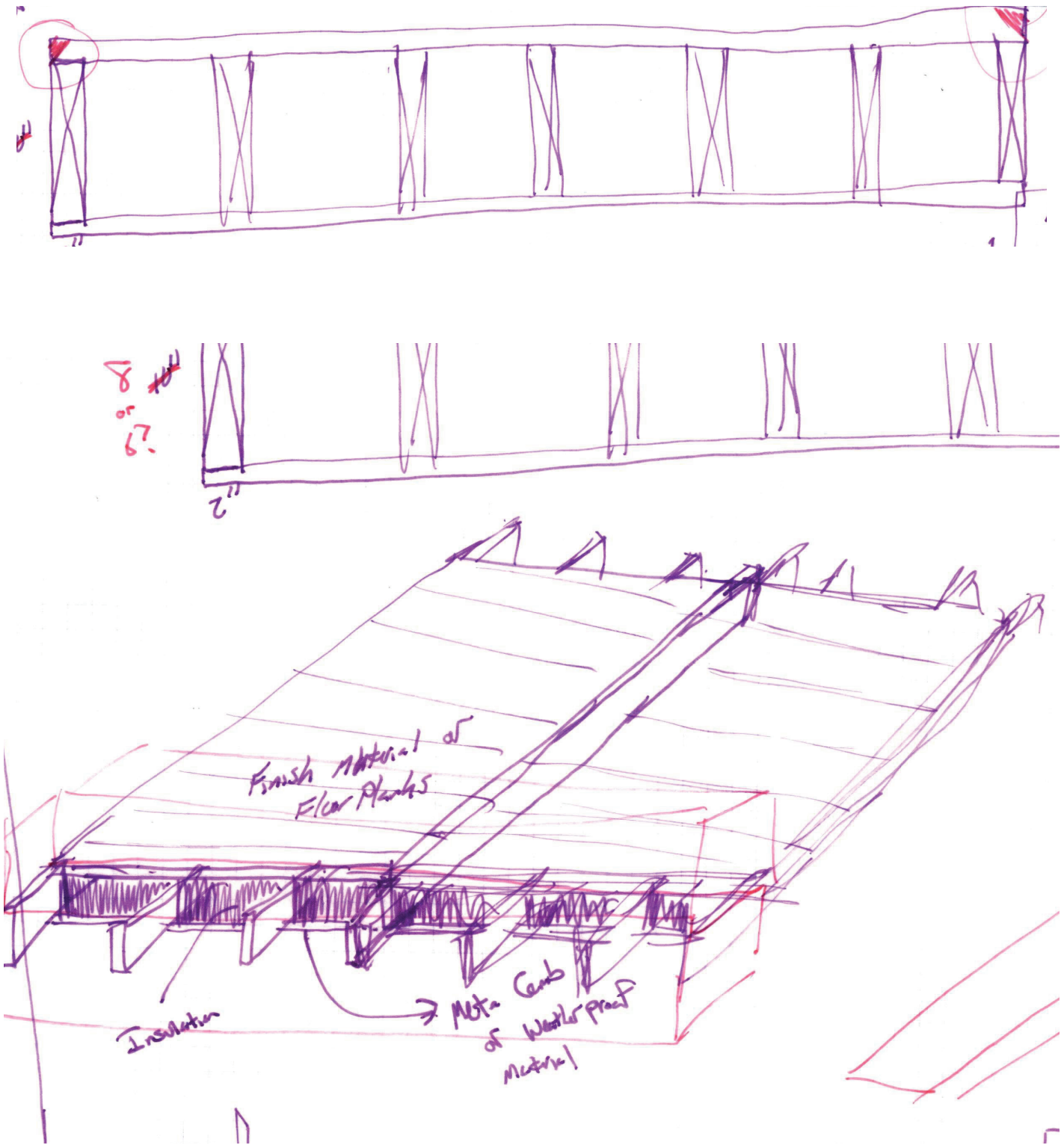
6.3

Once the footings were figured out, I wanted to focus on the floor connection. Keeping in mind the wall connection design, I wanted to use a similar way to connect the floor. The idea behind the initial design of the floor panels is to have 4'x8' panels that fit into cutouts on the bottom plates. The extended studs of the panels would fit into a punch out on the center girder, and then drop into place on the outside girders.

There would be a fixed floor panel that would come with plumbing fixtures built into it. This would slightly take away from the customization aspect by forcing people to designate a spot for their bathroom. It would allow for the plumbing to be organized and set up correctly. This can also give asses to wet walls for the kitchen area.



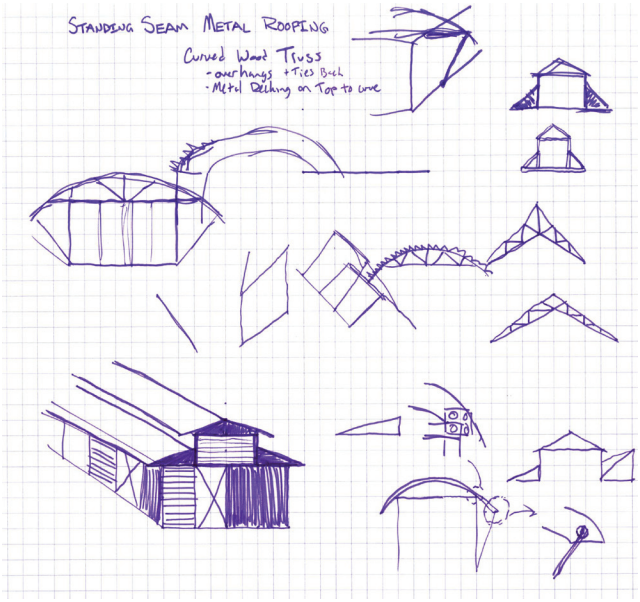


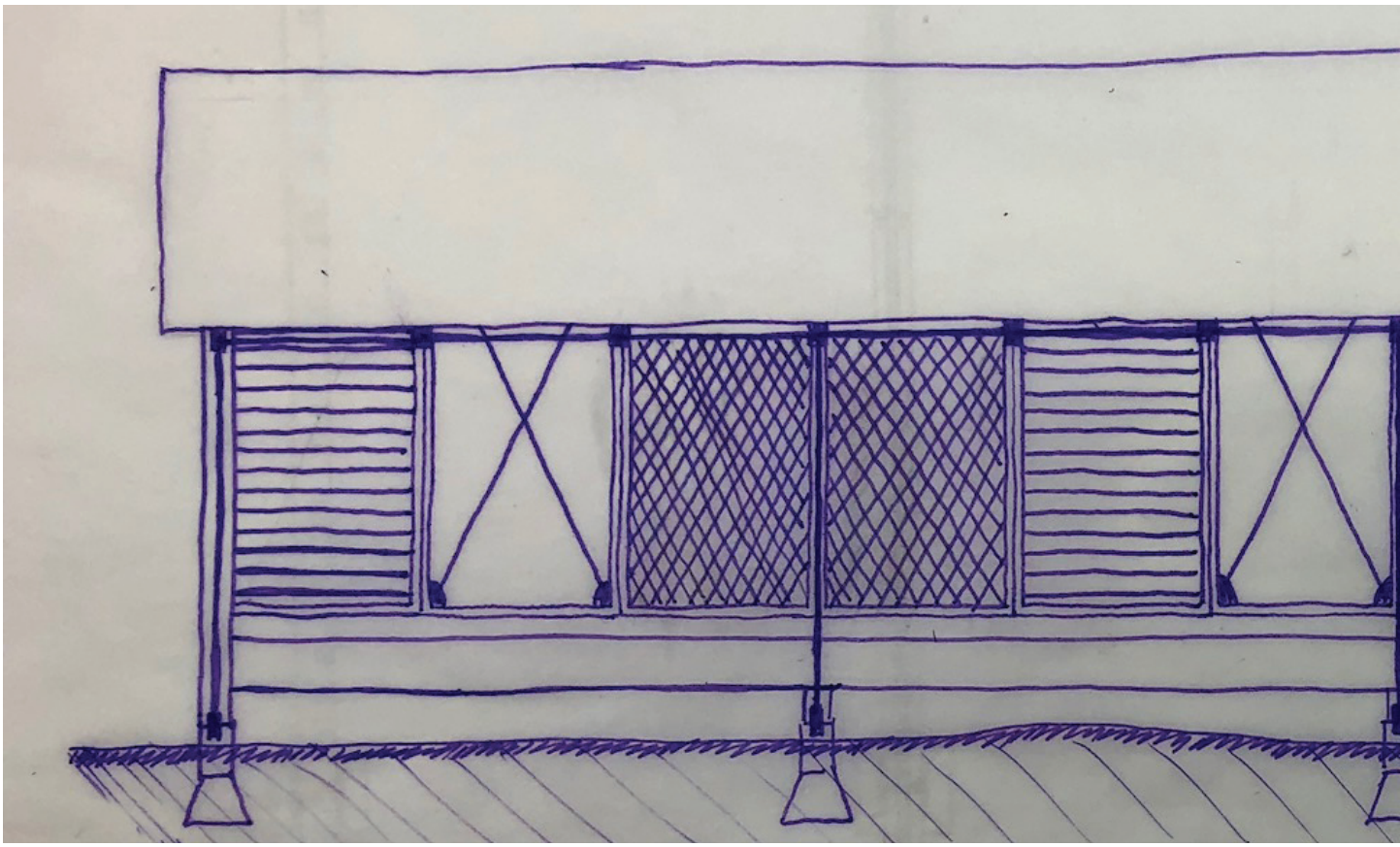

8
or
6?
2"
Finish Material of
Floor Planks
Insulation
Metal Comb
of Weather Proof
Material

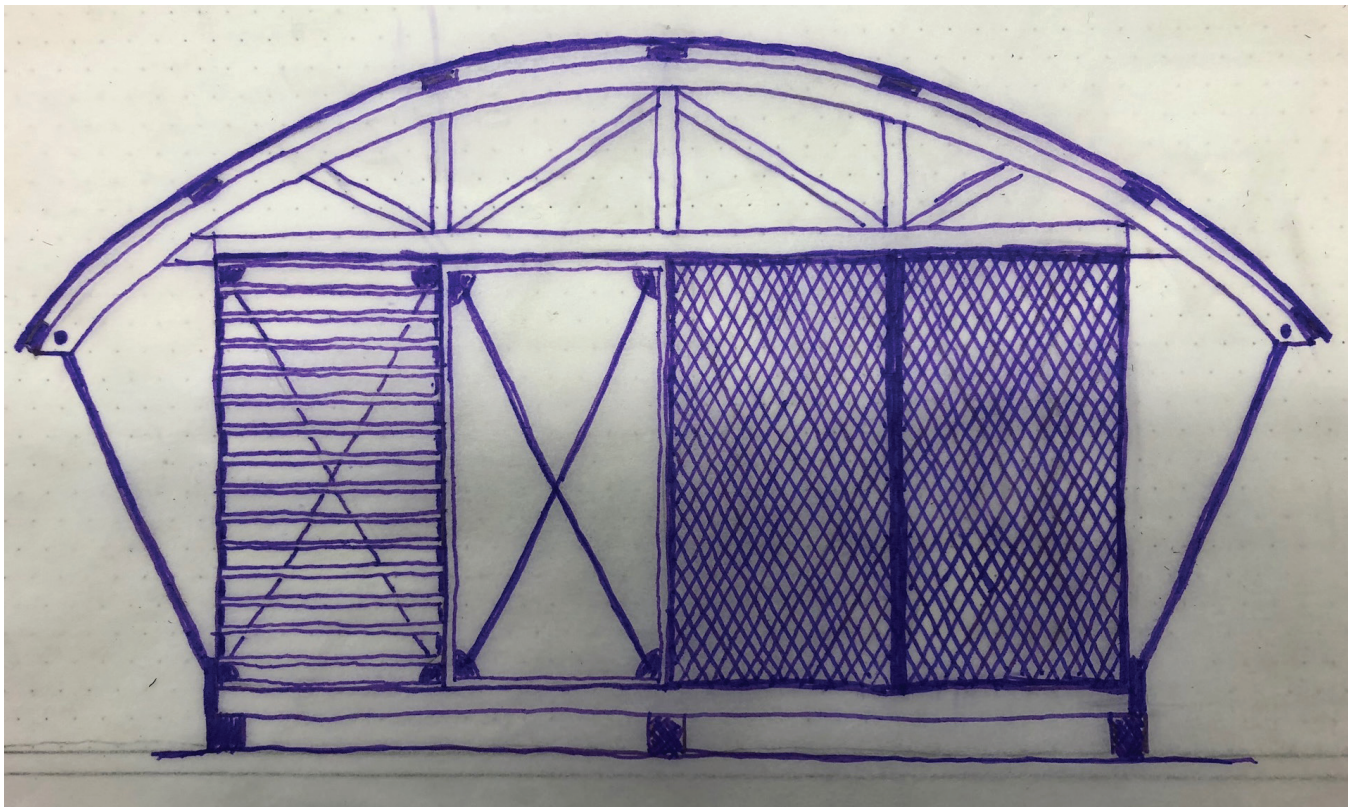
6.4

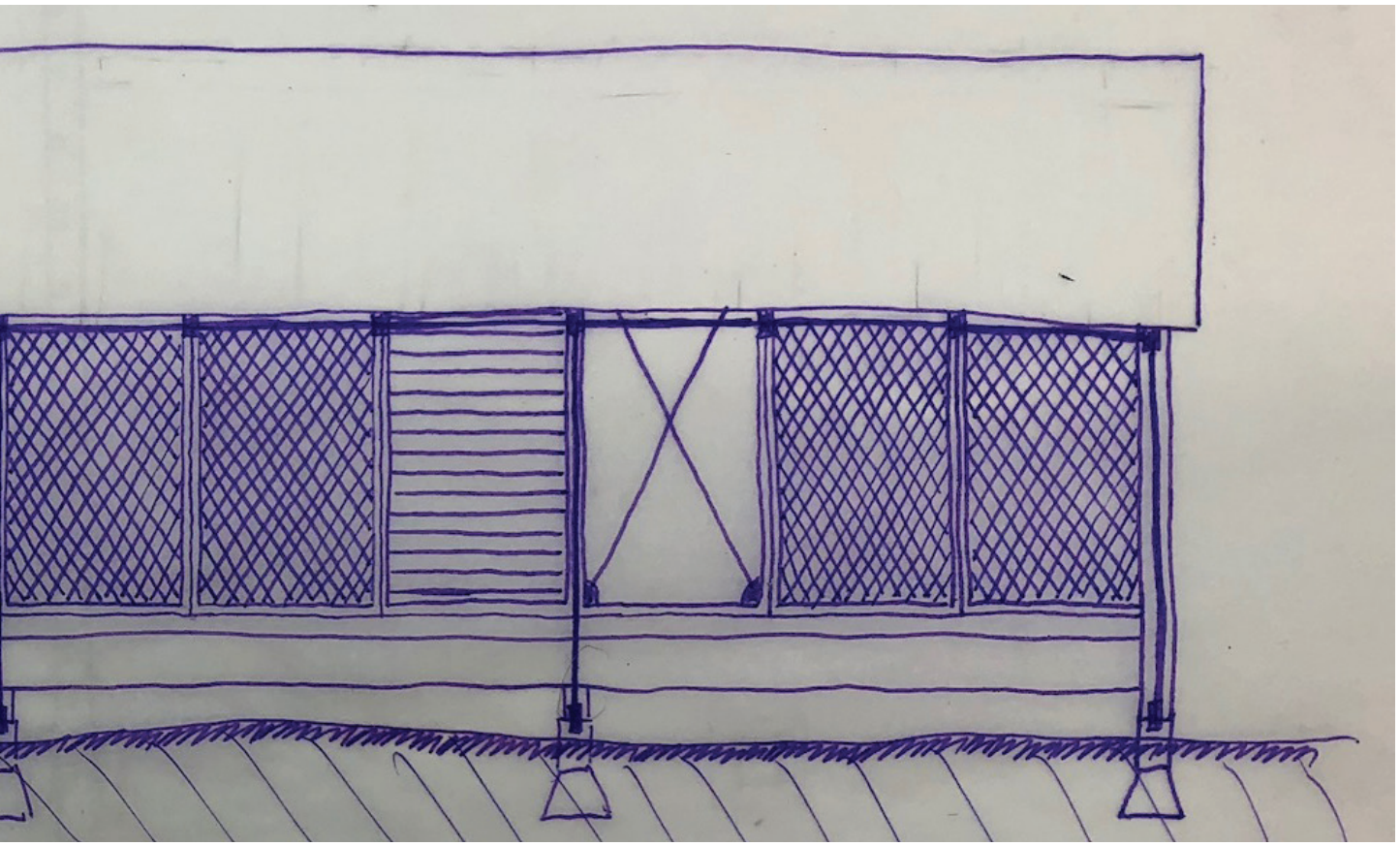
The roof was the next portion that I started to design. I wanted to keep the cost of the design low, without loosing quality of design. The idea of using canvas to enclose the building is not only a cost efficient material, but it can also form to most shapes.

The curved design is intended to help water and snow run off the roof as well as provide an overhang for the bright southern sun. There would be five major trusses spanning the building, with smaller joists in-between. The canvas would sit on top of the trusses taking the shape. The trusses would be tied down into the foundation with a series of steel piping. The piping would attach to a bracket connected to the footing, and then connect to another bracket on the trusses.







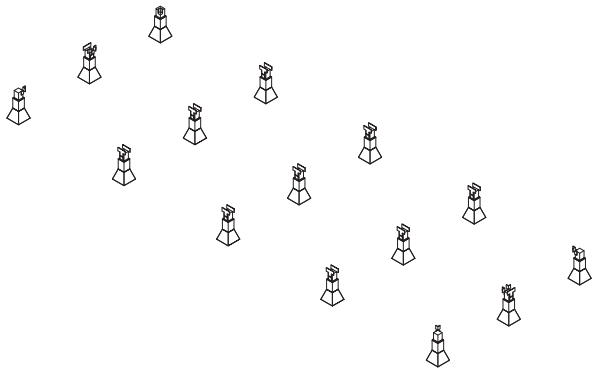


07 Design

7.1

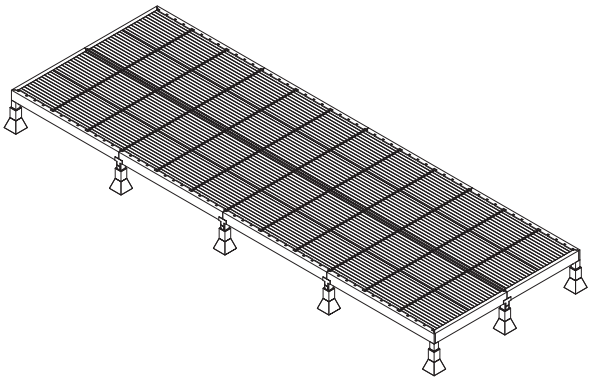
DAY ONE

Day One: The site work takes place by a third party. The foundations are put into place and ready for construction.



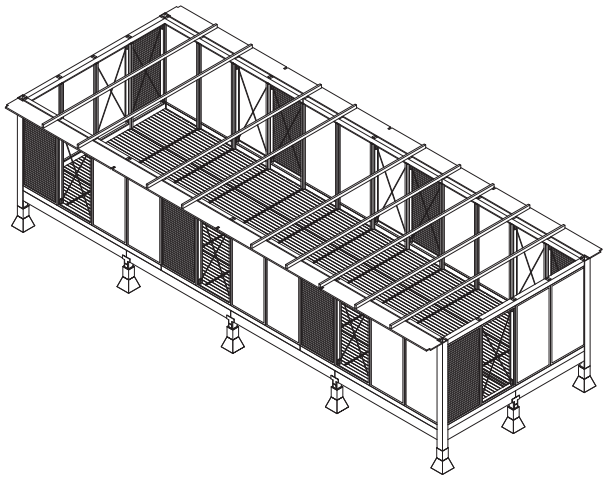
DAY TWO

Day Two: The girders are placed over the foundation. The floor panels are then inserted into the girders, and tied down by the bottom plate.



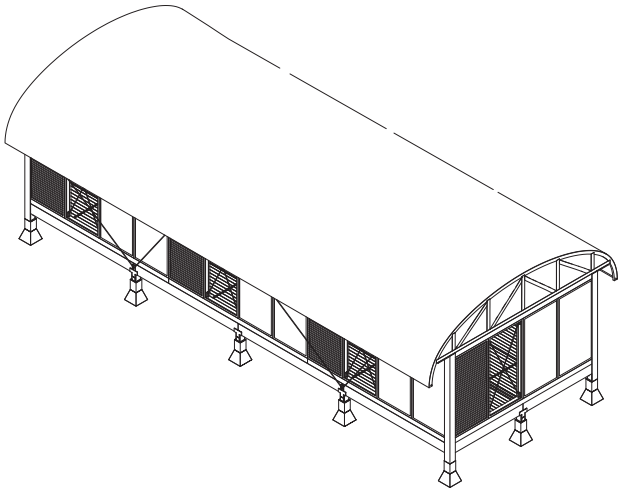
DAY THREE

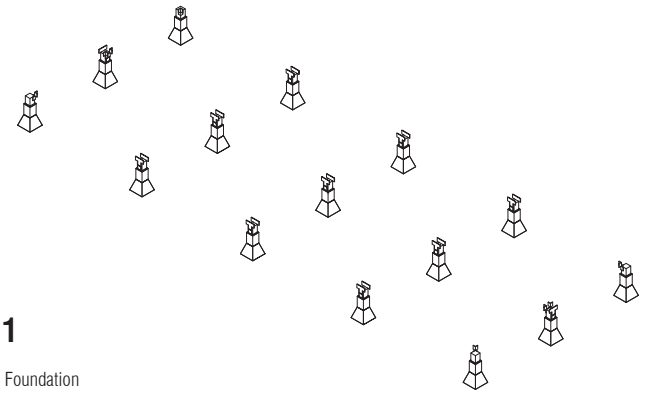
Day Three: The wall panels are inserted into the bottom plate, and tied together by a prefabricated header. Joists are then installed to stabilize the structure.



DAY FOUR

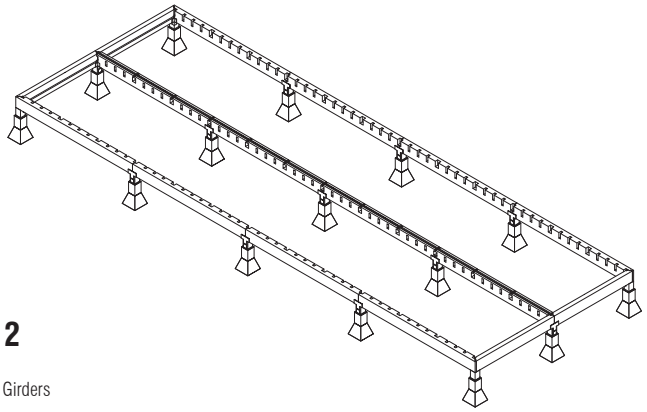
Day Four: The truss are installed, followed by a canvas roof. Steel rods are used to tie the trusses to the foundation.





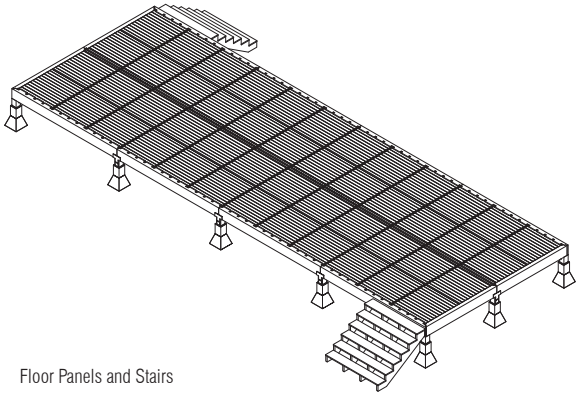
1

Foundation



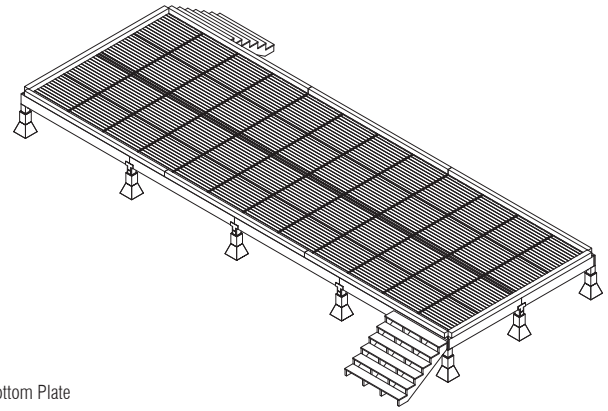
2

Girders



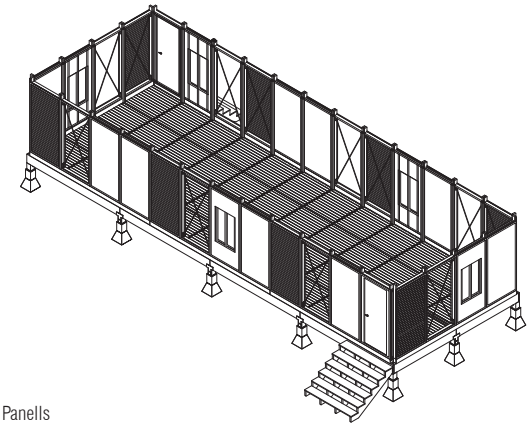
3

Floor Panels and Stairs



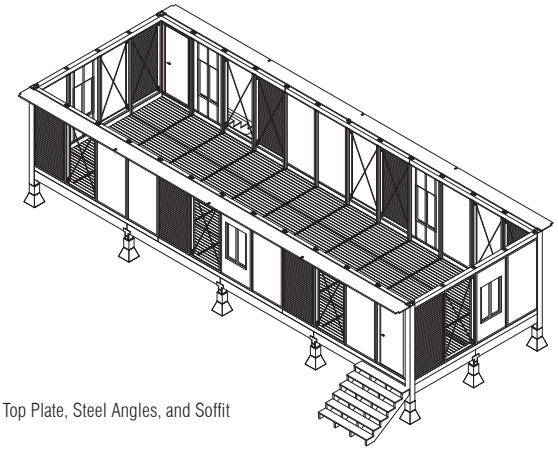
4

Bottom Plate



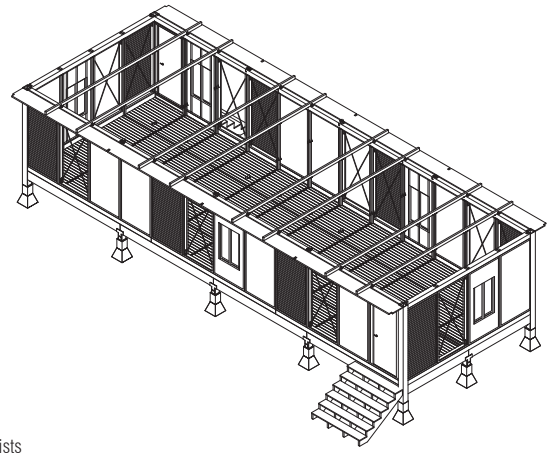
5

Wall Panells



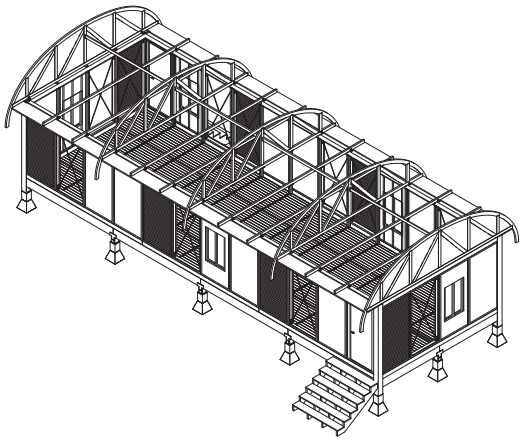
6

Top Plate, Steel Angles, and Soffit



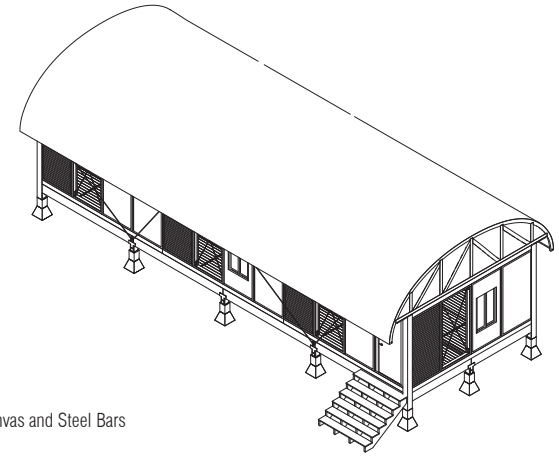
7

Joists



8

Truss

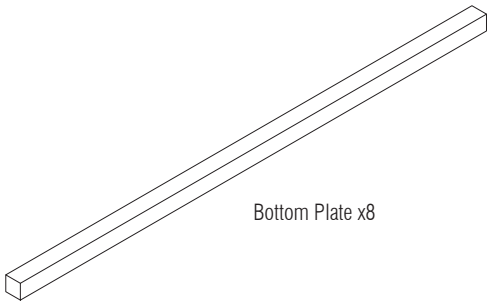


9

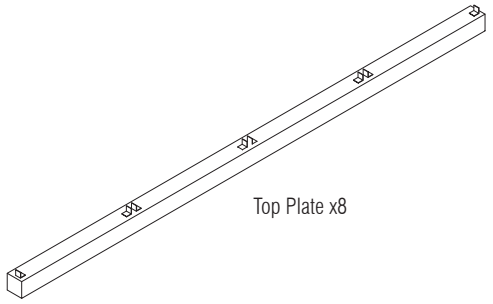
Canvas and Steel Bars

Kit of Parts and Cost Estimate

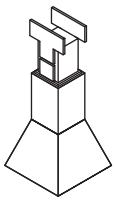
Disaster Relief Structure Cost Estimation and Quantity Take Off			
Prefabricated Elements			
Item	**Quantity**	**Unit Cost**	**Total Cost**
Footings	15	$ 85.00	$ 1,275.00
Girders	16	$ 125.00	$ 2,000.00
Floor Pannels	24	$ 110.00	$ 2,640.00
Bottom Plates	8	$ 56.00	$ 448.00
Solid Wall Panel	16	$ 68.00	$ 1,088.00
Glass Wall Panel	8	$ 168.00	$ 1,344.00
Screened Wall Panel	8	$ 218.00	$ 1,744.00
Partition Wall Panels	22	$ 45.00	$ 990.00
Partition Columns	16	$ 9.65	$ 154.40
Top Plate	8	$ 56.00	$ 448.00
Joists	8	$ 6.95	$ 55.60
Roof Soffit	8	$ 36.50	$ 292.00
Truss	5	$ 198.00	$ 990.00
Canvas Roof	1	$ 1,250.00	$ 1,250.00
Stairs	2	$ 42.00	$ 84.00
Steel Angle	4	$ 114.00	$ 456.00
Steel Rods	16	$ 24.00	$ 384.00
Connections and Bolts	**X**	$ 600.00	$ 600.00
Total Cost			**$ 16,243.00**



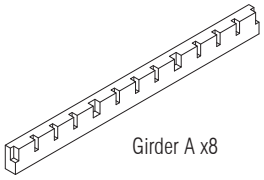
Bottom Plate x8



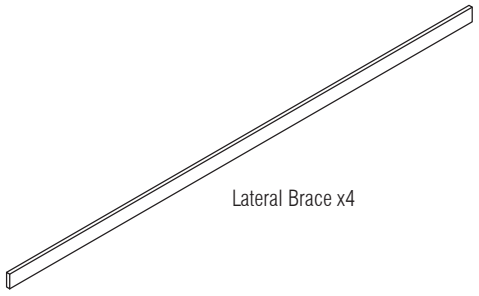
Top Plate x8



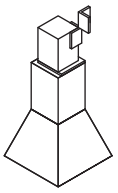
Footing A x9



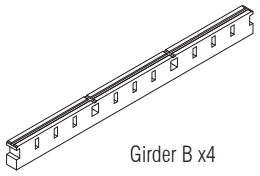
Girder A x8



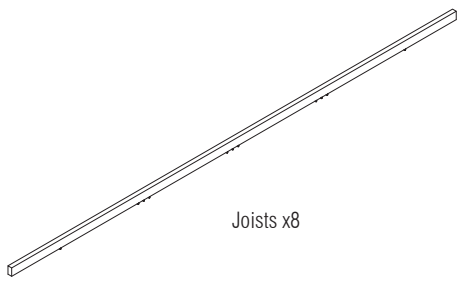
Lateral Brace x4



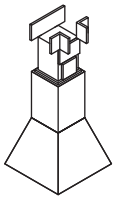
Footing B x4



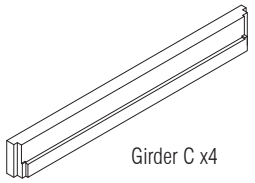
Girder B x4



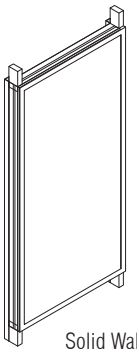
Joists x8



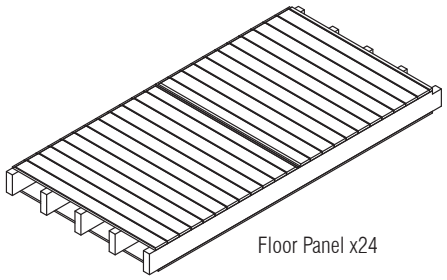
Footing C x2



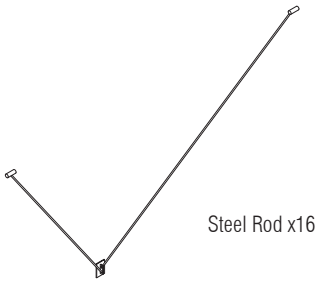
Girder C x4



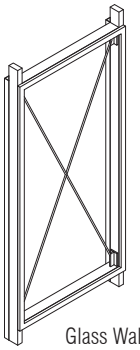
Solid Wall Panel x16



Floor Panel x24

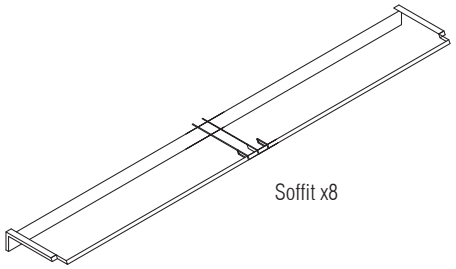


Steel Rod x16

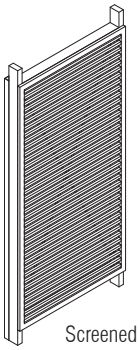


Glass Wall Panel x8

Partition Column x16

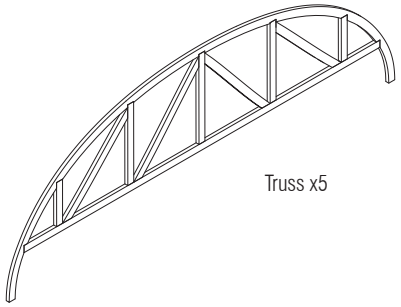


Soffit x8

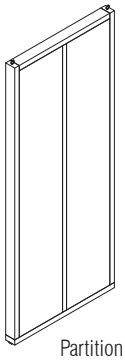


Screened Wall Panel x8

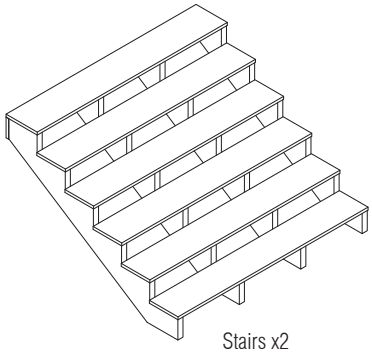
Steel Angle x4



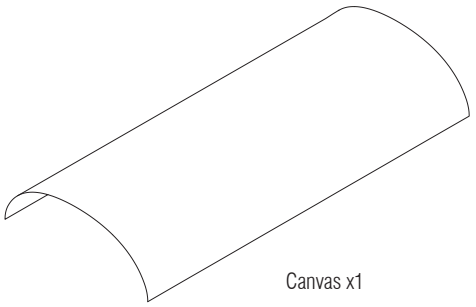
Truss x5



Partition Wall Panel x22

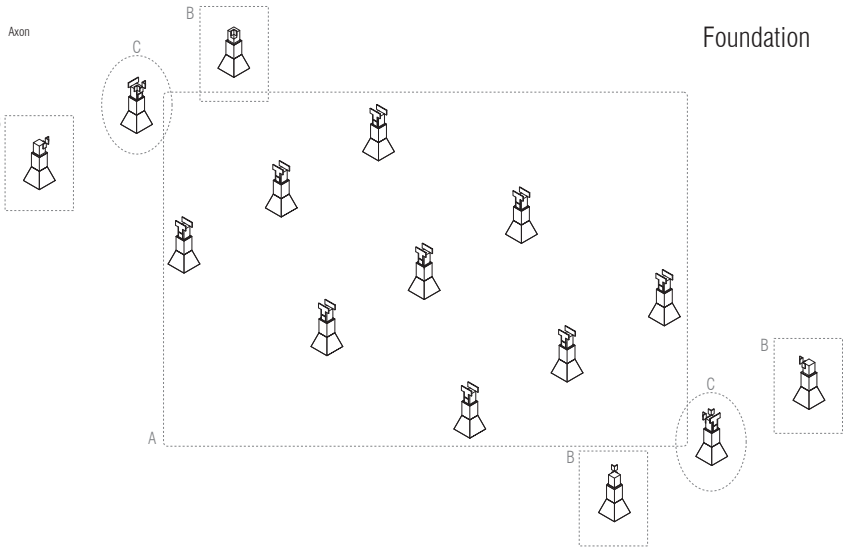


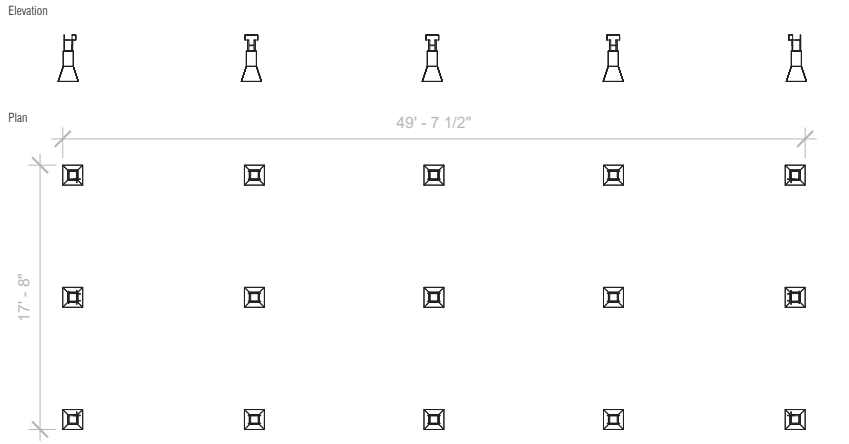
Stairs x2

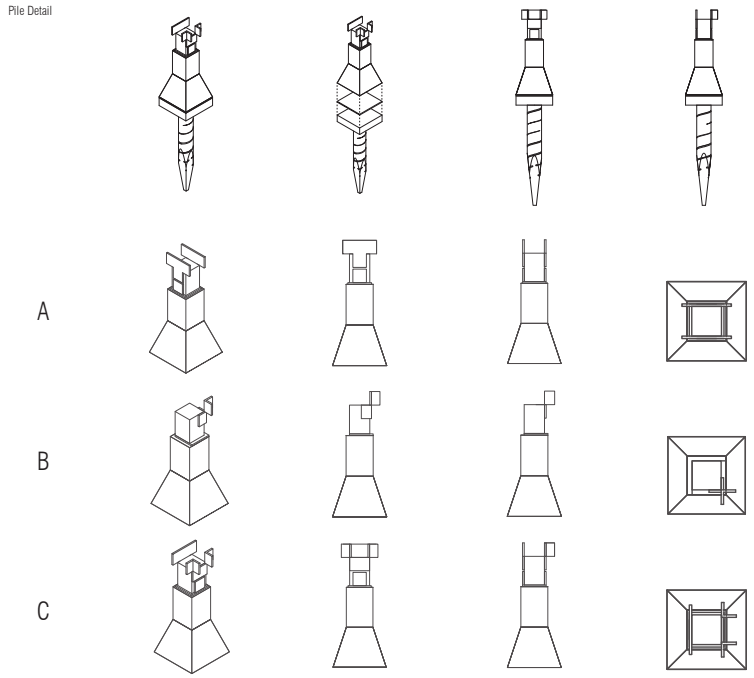


Canvas x1

Foundation

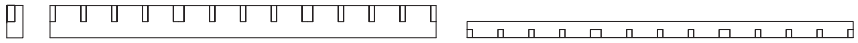






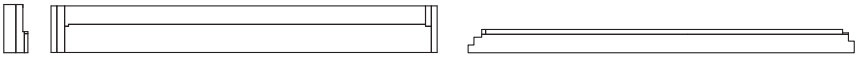
Floor and Girders

Girder A - Elevations and Plan View

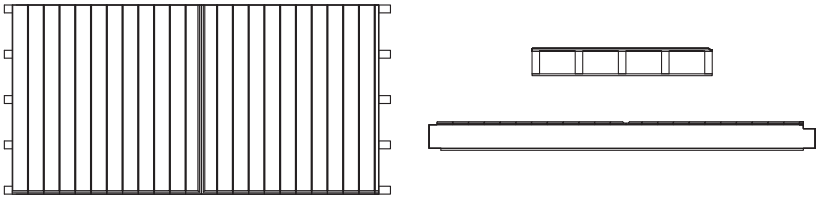


Girder B - Elevations and Plan View

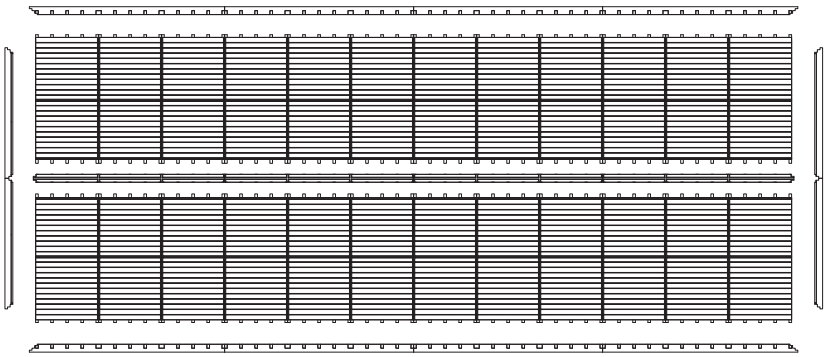
Girder C - Elevations and Plan View



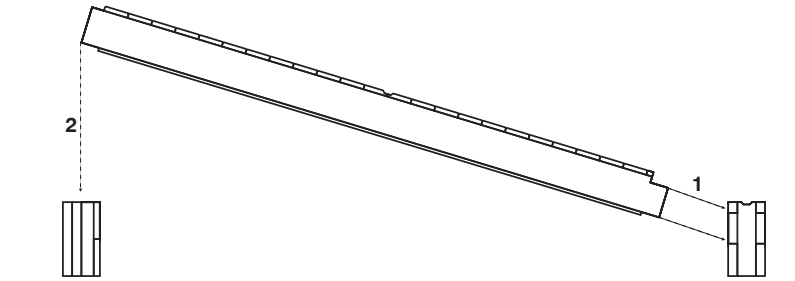
Floor Panel - Plan and Elevations

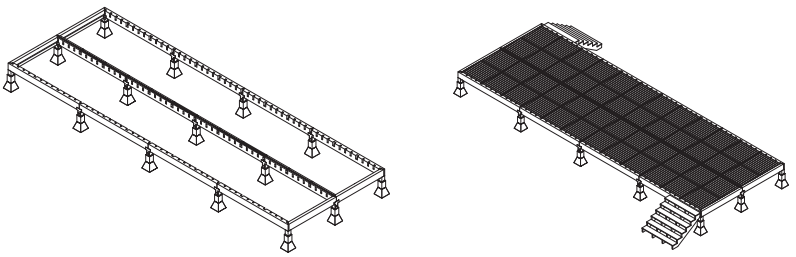


Floor and Girder Plan



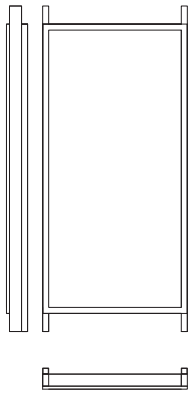
Floor Connection



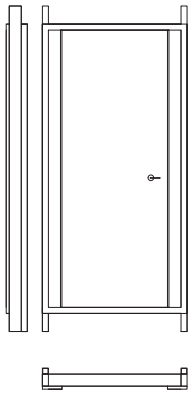


Wall Construction

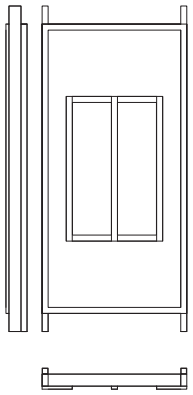
Solid Wall Panel



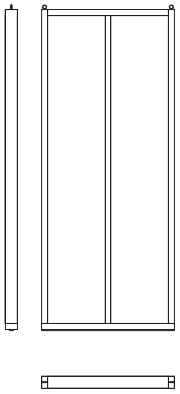
Solid Wall Panel With Door



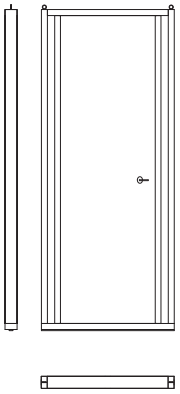
Solid Wall Panel With Window



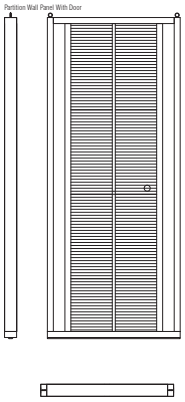
Partition Wall Panel



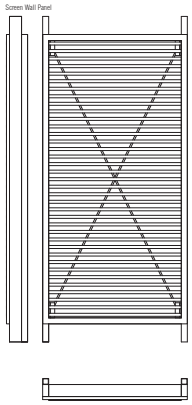
Partition Wall Panel With Door



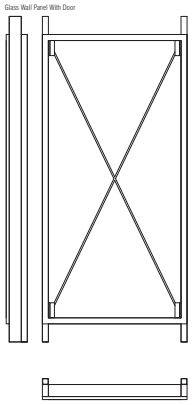
Partition Wall Panel With Door



Screen Wall Panel

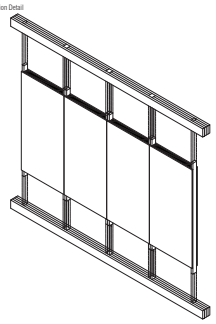


Glass Wall Panel With Door

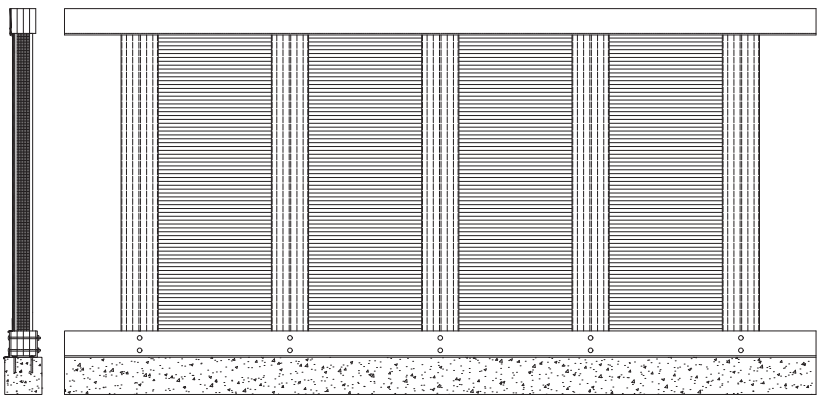


Exterior Cap Detail

Wall Connection Detail



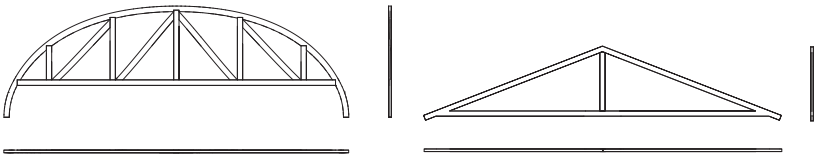
Wall Detail



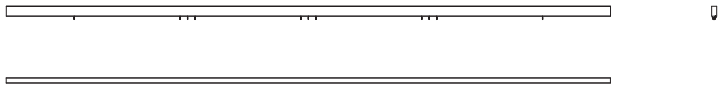
7.7

Roof System

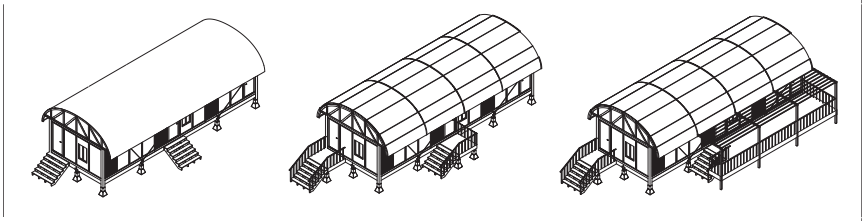
Truss System



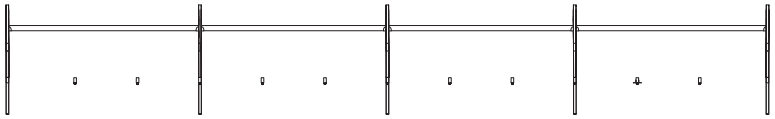
Joists and Hook



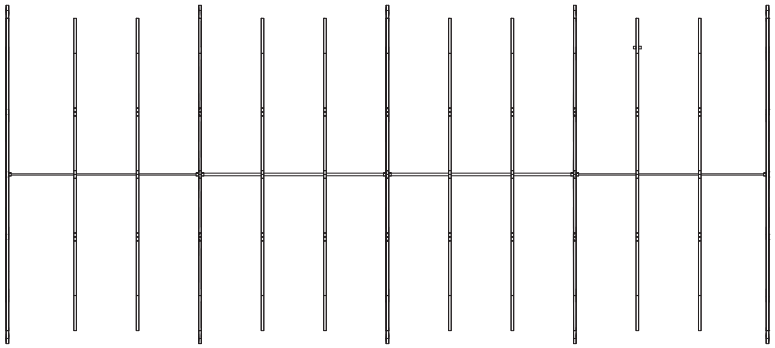
Building Roof Progression



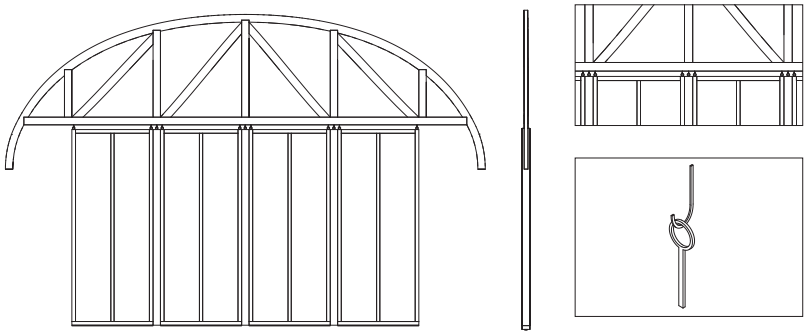
Roof Elevation



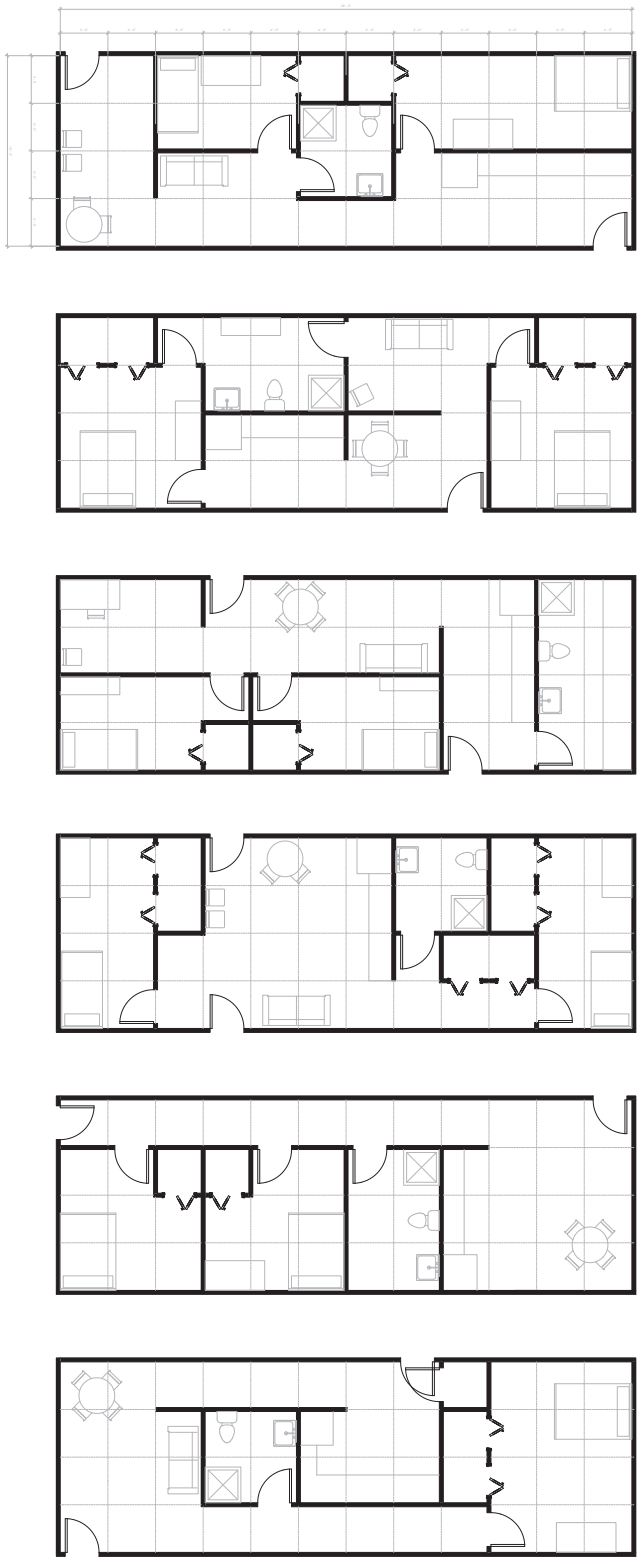
Roof Plan



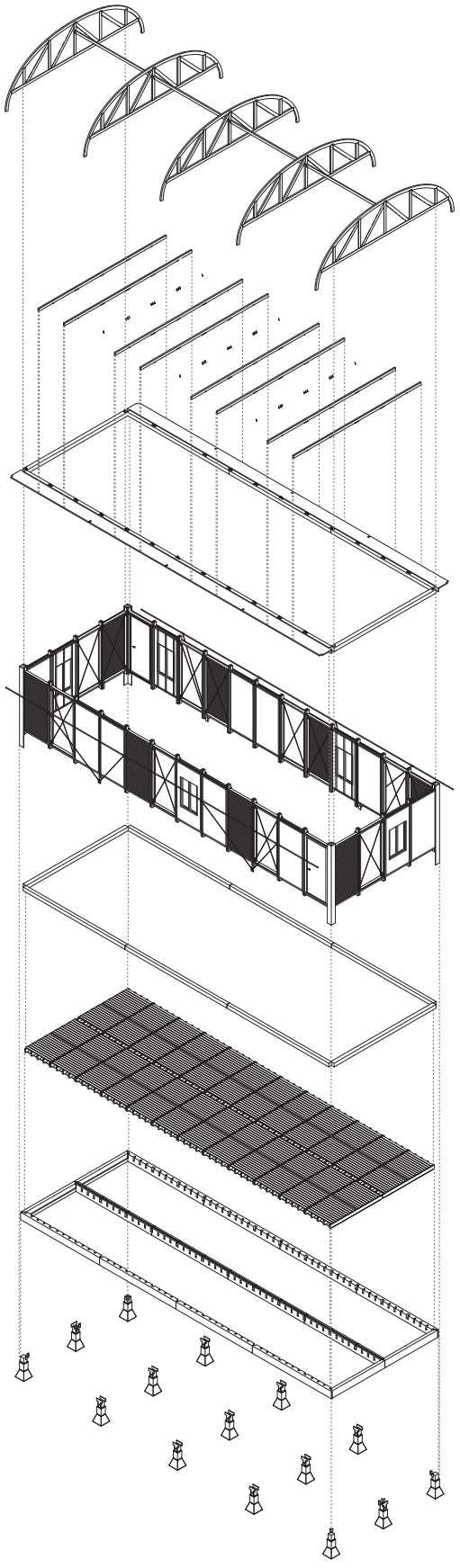
Roof and Partition Details

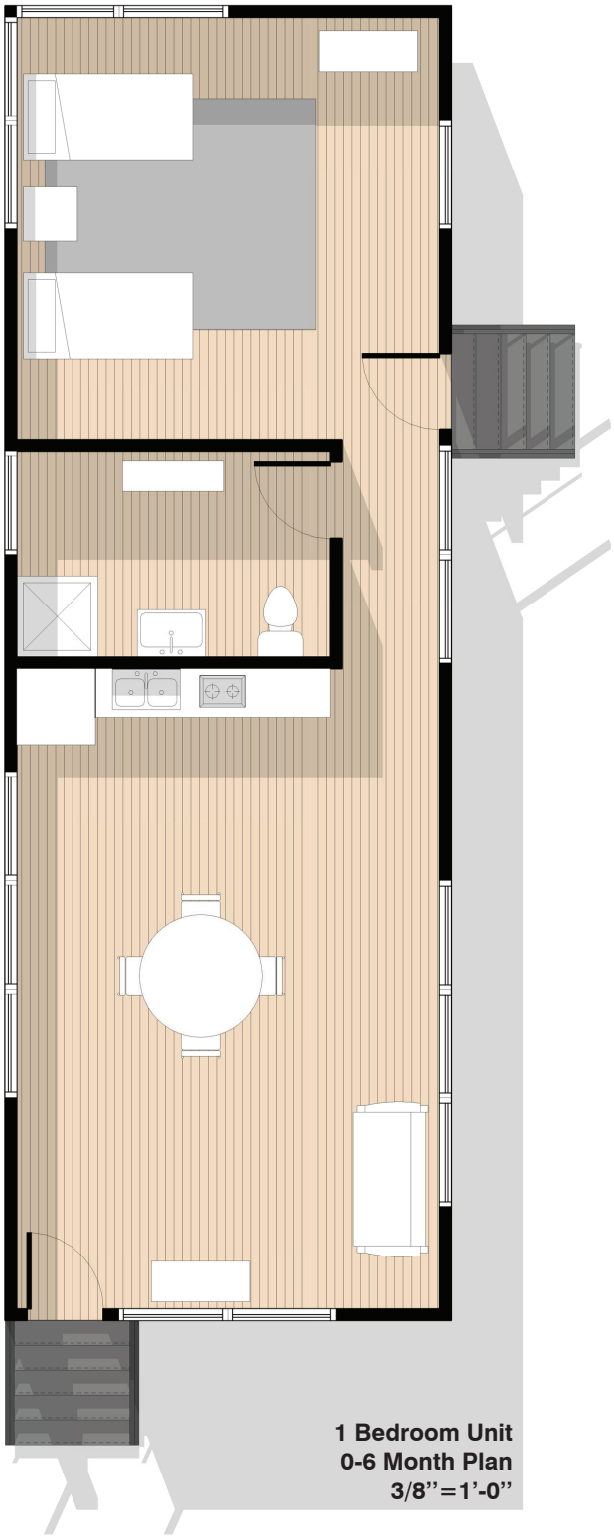


Floor Plans: 1/2" = 1'-0

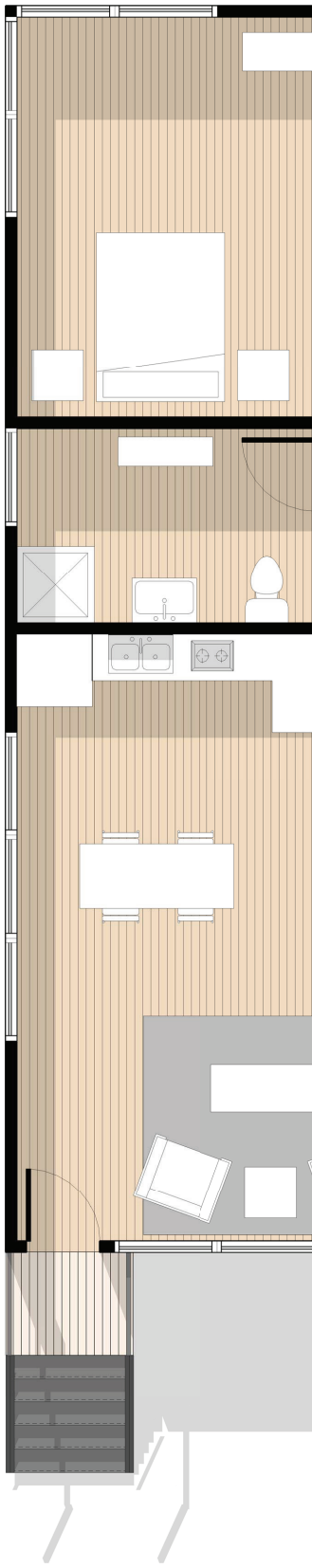


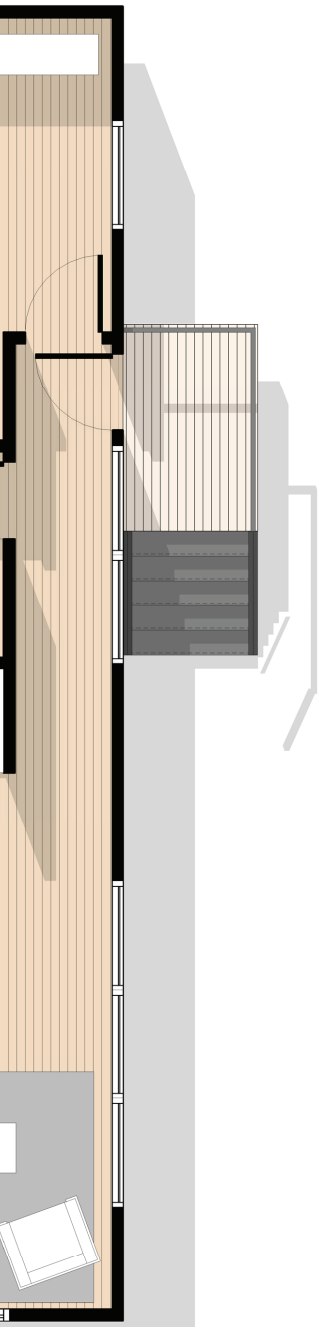
7.9



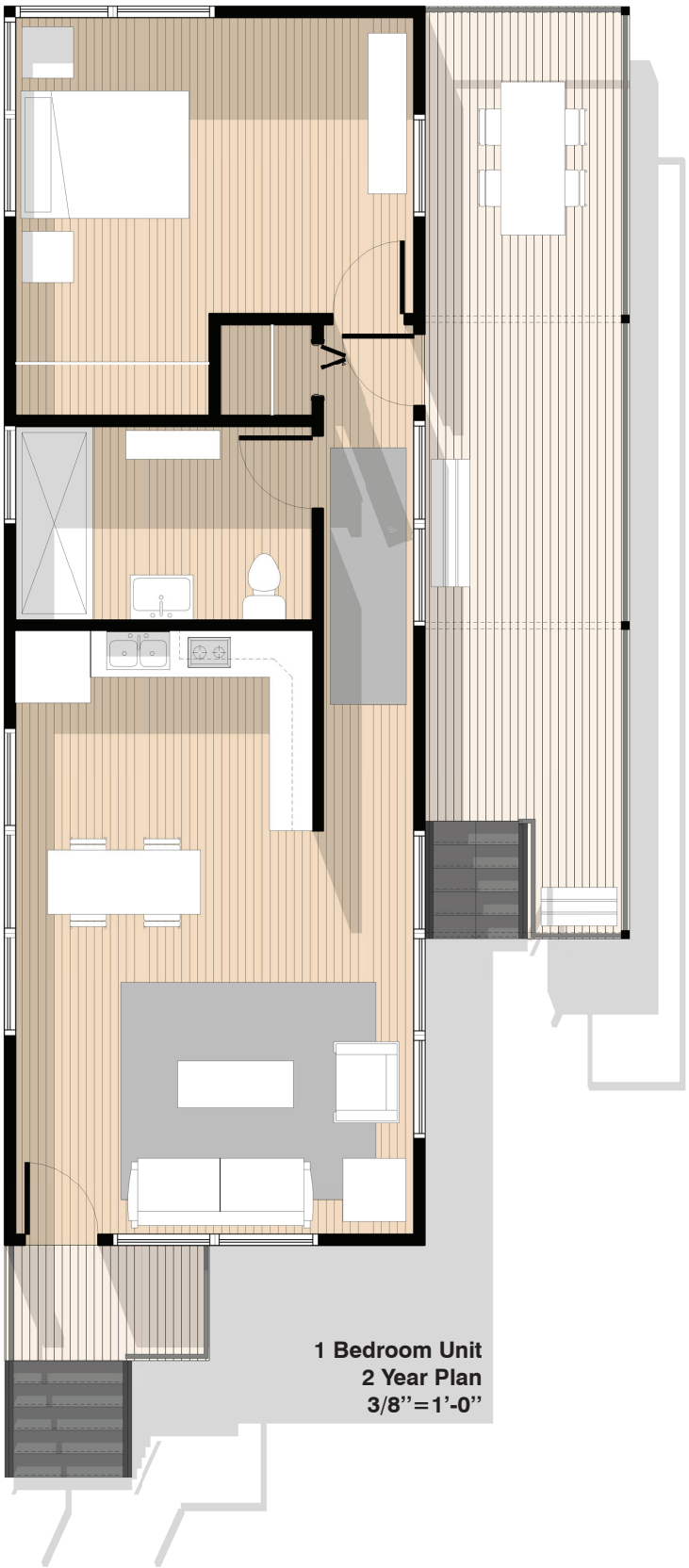


1 Bedroom Unit
0-6 Month Plan
3/8”=1’-0”

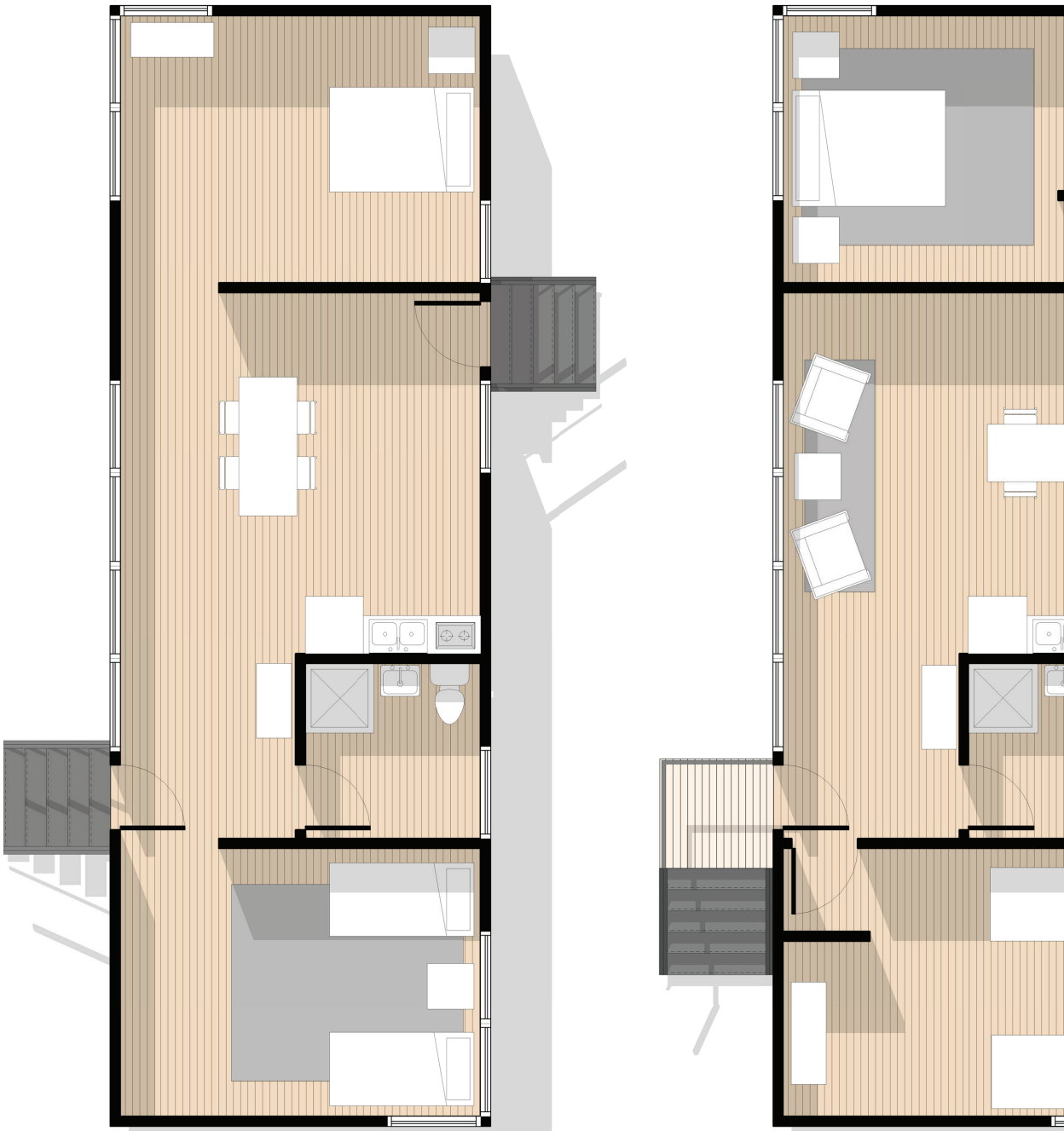




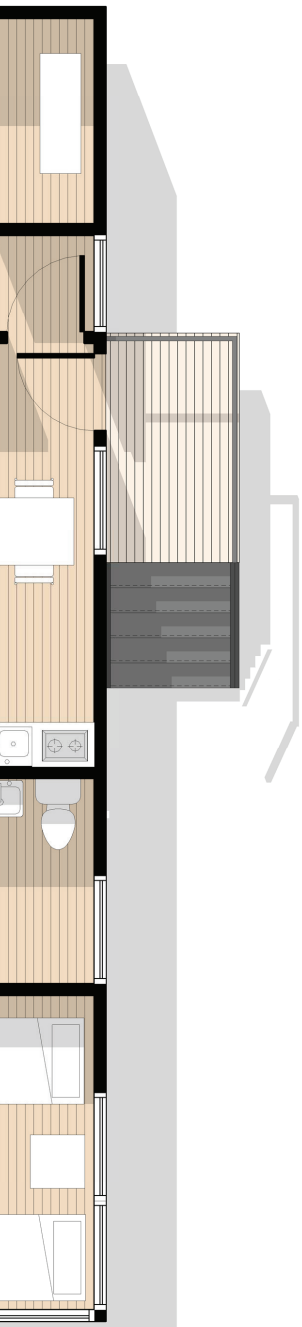
1 Bedroom Unit
1 Year Plan
3/8’’=1’-0’’



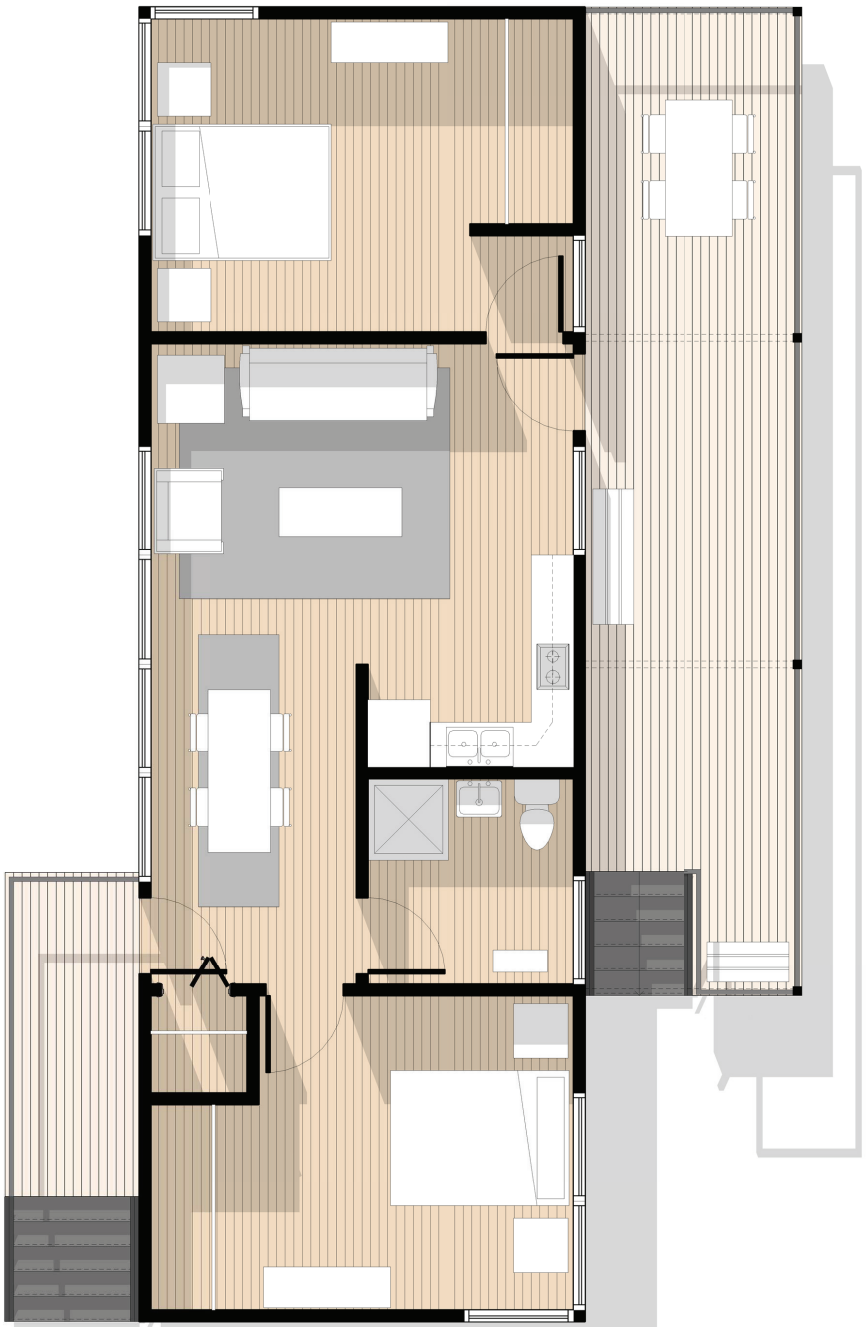
1 Bedroom Unit
2 Year Plan
3/8’’=1’-0’’



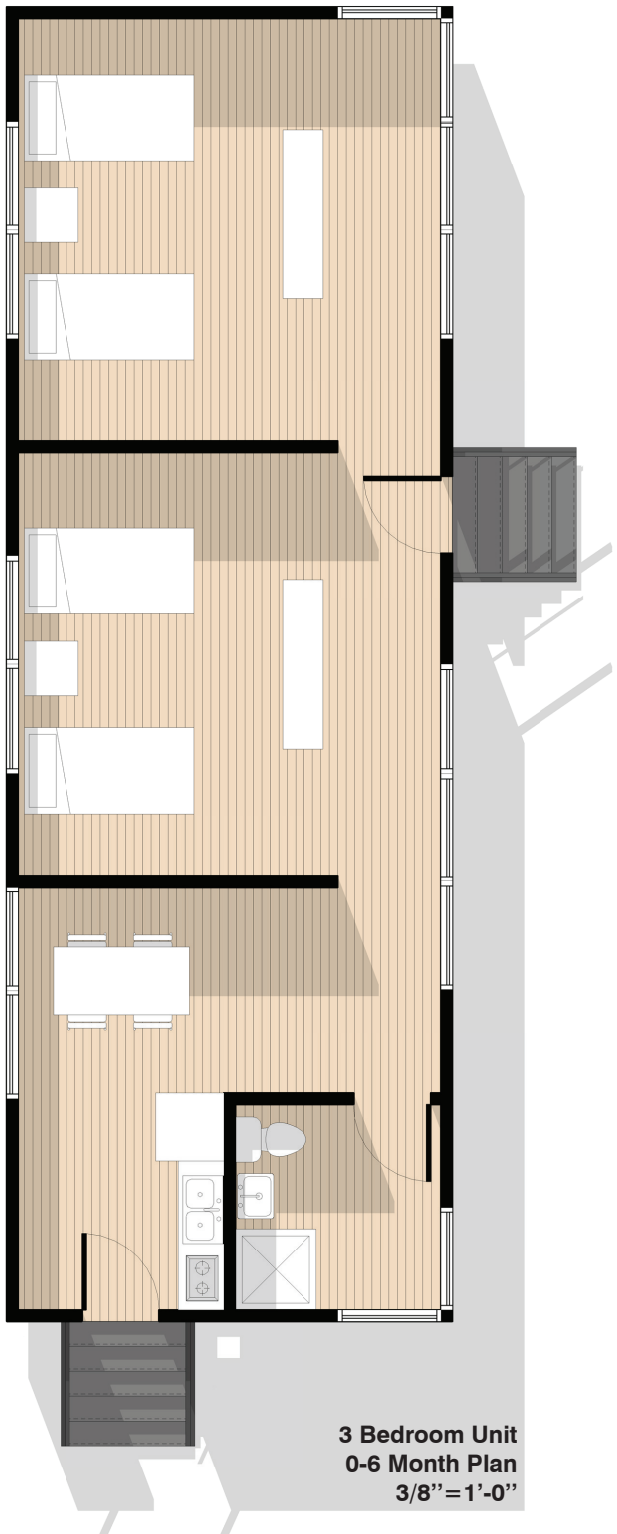
2 Bedroom Unit
0-6 Month Plan
3/8”=1’-0”



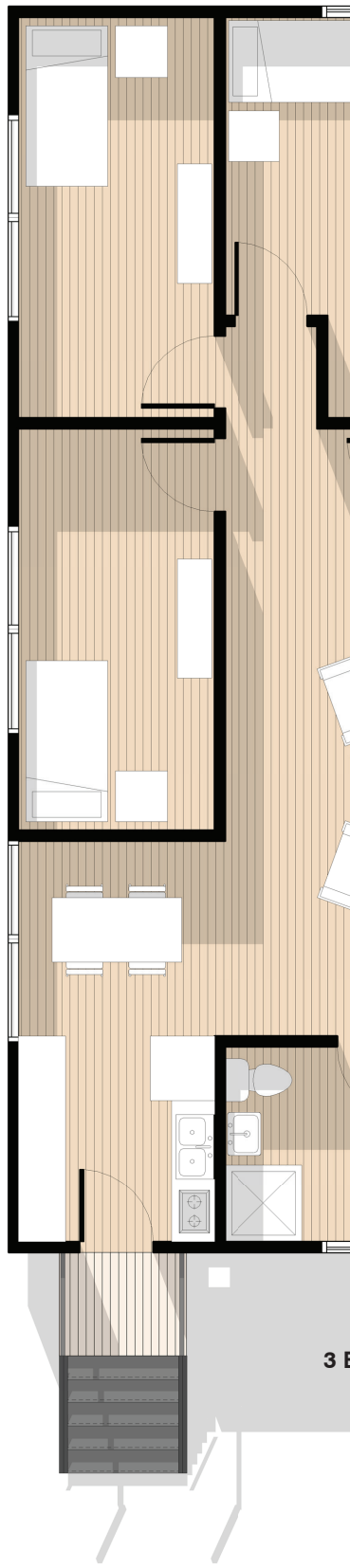
2 Bedroom Unit
1 Year Plan
3/8”=1’-0”



2 Bedroom Unit
2 Year Plan
3/8”=1’-0”



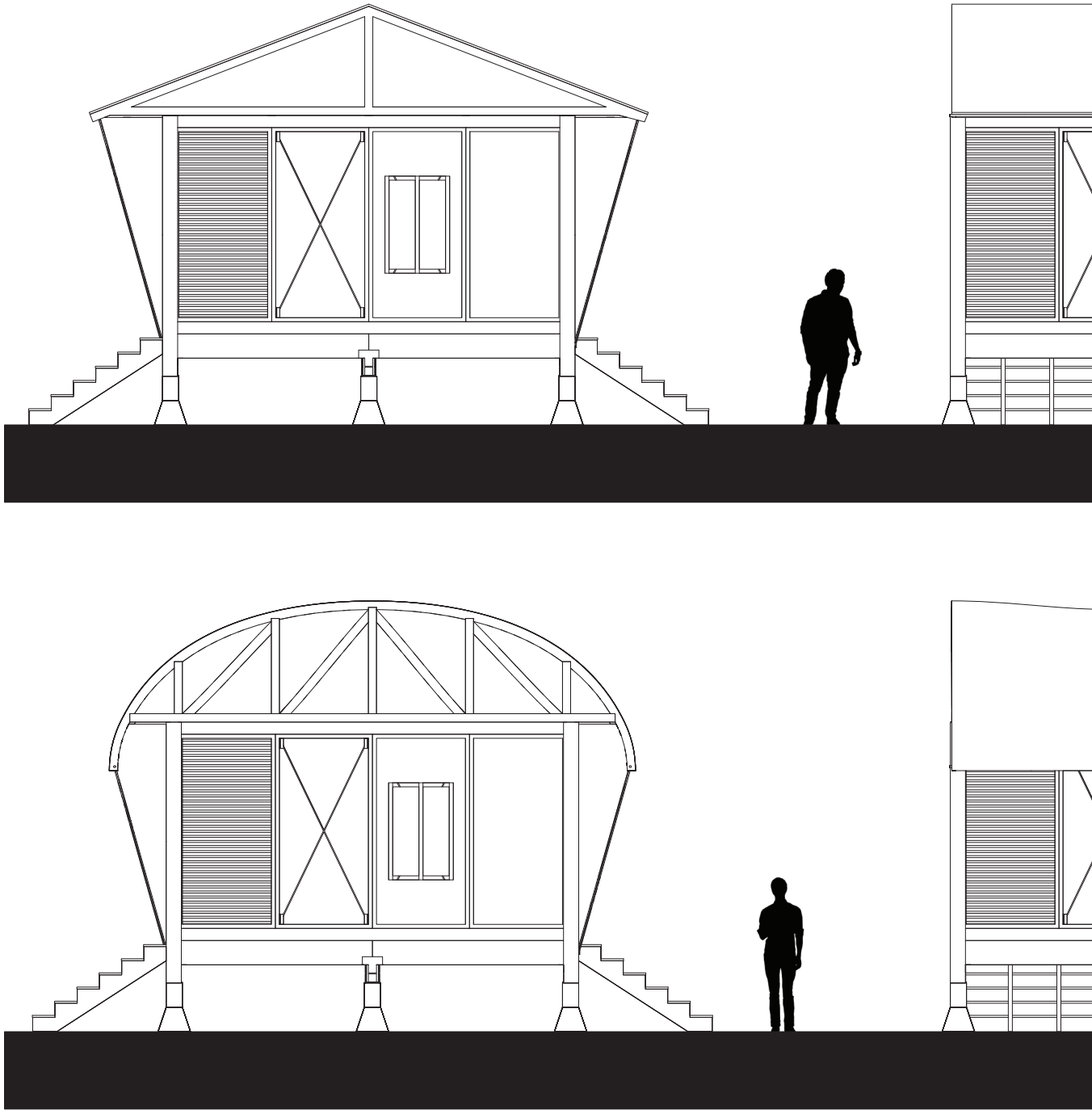
3 Bedroom Unit
0-6 Month Plan
3/8”=1’-0”

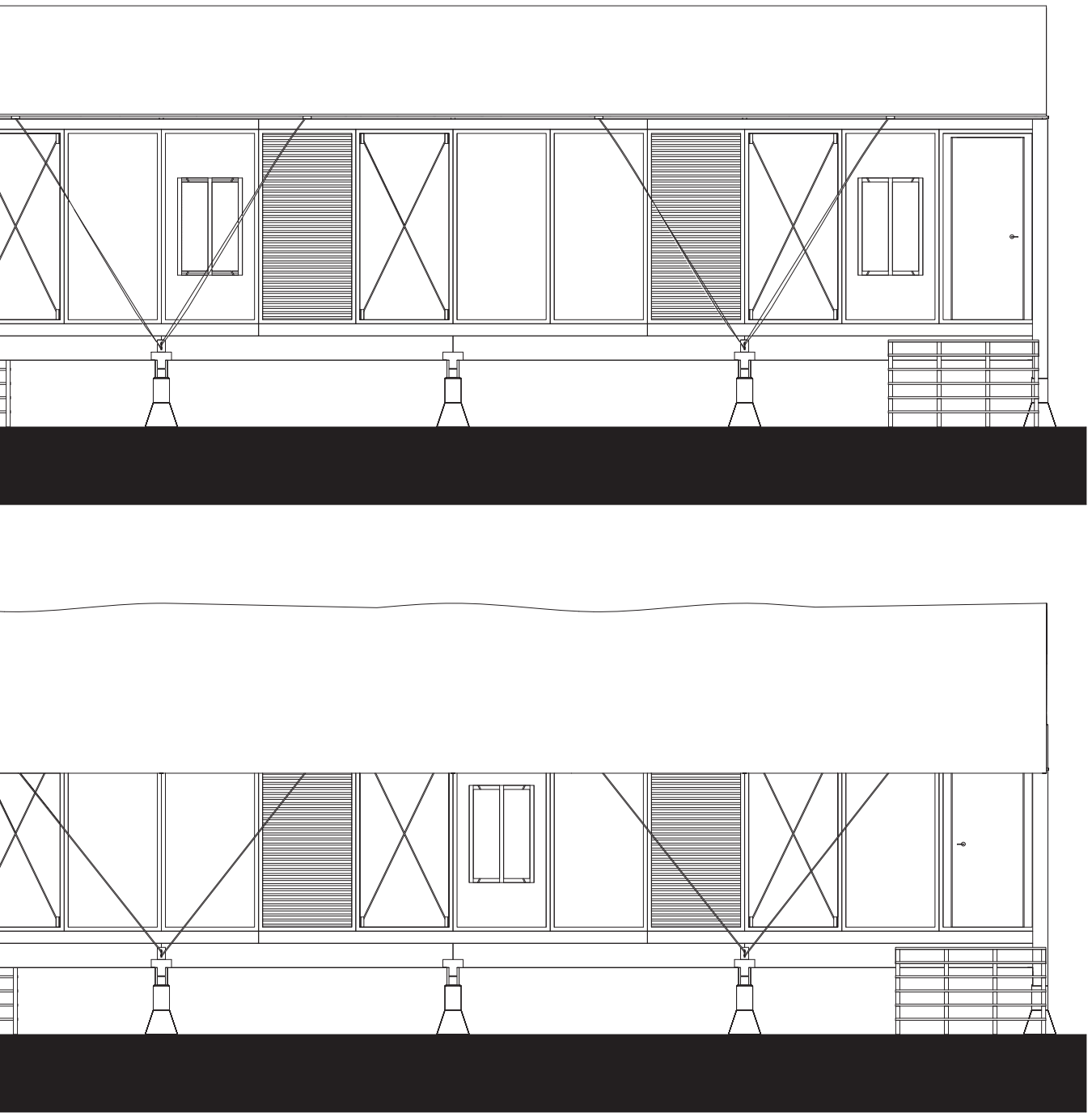


Bedroom Unit
1 Year Plan
3/8”=1’-0”

3 Bedroom Unit
2 Year Plan
3/8”=1’-0”

7.10





7.11

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