

**A GROWING BREATHING HOME:
A RESPONSIVE DESIGN TO SINGLE-FAMILY HOMES IN HAWAII**

A D.ARCH PROJECT SUBMITTED TO THE GRADUATE DIVISION OF THE UNIVERSITY
OF HAWAII AT MĀNOA IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE
DEGREE OF

DOCTOR OF ARCHITECTURE

MAY 2019

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Keywords: Single-family, Residential, Hawaii, Basalt Concrete

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This book is dedicated to my father, Chance Mactagone & the hard-working men and women of Ho'aloa Design Group who have forever instilled in me an unparalleled work ethic and always taught me that form follows function.

Blood ■ Sweat ■ & Beers ■



Acknowledgements

Right now, its 9:35pm on April 3, 2019 and I have to submit this thesis to be bound and published tomorrow afternoon. I saved writing this acknowledgements page as the very last thing I do because to me, it's the hardest part to write. Its hard because I have so many people in my life that I want to thank and "acknowledge" for helping me on my journey...

Mom, you know more than anyone else about all the craziness and work that goes into school, because you are the first person that I want to talk to in both times of trouble and times of triumph. From the first drop off at Webling Elementary to the final day at UH and all the moments in between, you have truly been the backbone of my support system. This book is a direct result of every hot dog home lunch for field trips, every afterschool walk home phone call, every early morning Kamehameha school bus drop off, every UH parking ticket, and every hug, kiss, and koala in between. I love you to the moon and back times infinity.

Bird, thank you for being a formidable opponent in the favorite child race, but after tomorrow I think theres a clear winner. Im kdding haha. Thank you so much for being my longest and most loyal friend, and for not telling mom and dad about all the times I hurt you as a child. You are and have been a constant inspiration to me not just for school, but for life. There are not a lot of people that can do what you do daily and be by yourself up there Vegas. (I know you're not alone, thank you Bryson for being there and being the best black jack partner). Which reminds me thank you for picking UNLV so we have a great place to visit, I love you birdy.

To the rest of my family, my aunties, uncles, cousins, and grandparents thank you so much for supporting me and giving me a childhood that was so fun and full of memories and I cant wait to create more. A special shout out to Robby for being my partner in crime for literally every possible thing from movies, Tekken, Tropics Nights, and just for our intellectual conversations, Love you brother.

To all my boys, you guys are the paly hard to my work hard. Thank you guys for always giving me a weekend to look forward to and a cold beer to wash the weeks work away. Its crazy to think how long we have been friends and I cant wait for a lifetime of crazy memories to be made, Love you guys.

Last but not least, a special thank you to my best friend and lava, I love you so much Irina, thank you so much for making the past few years the best I've ever had. I hope this book serves a small step toward a long and fruitful life together.

Abstract

Hawaii ranks number one for the highest real estate costs in the United States. This fact alone forces my generation into a dilemma when thinking about our first steps into home ownership. Investigations will be conducted as to what is causing this constant rise starting with the history of home making in Hawaii, from the hale pili and utilitarianism but to its current status as of 2018, looking specifically at materiality and construction methods. Hawaii's limited local resources result in the islands dependence on importing building materials ranging from lumber to steel and everything in between.

To combat the massive carbon footprint brought on by the import of building materials I will investigate what local options can be utilized as a primary material for single family home construction, looking at its structural and thermal qualities but most importantly its availability. This research will result in the conclusion that the best local building material, that will also boost the local economy, is locally sourced basalt concrete.

Based on a school of thought created by precedential research, a basic design that is responsive to Hawaii's unique climate and encourages growth over time will be developed. The basic design will be proposed to the local basalt concrete manufacturers and together we will devise a real-life structural approach to its construction that will utilize the qualities of the material while being cost efficient.

In order to ground the project into reality, I will research and propose improvements to an existing Department of Hawaiian Home Lands development plan that reinforce the design goals of the new single-family home design.

This dissertation will result in the design of new single-family home that will be constructed using local materials developed by local companies. A breathing home will support and encourage growth for my generation and the generations to follow.

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Chapter 1 Introduction: The Cost of Paradise

Chapter 1: Introduction: The Cost of Paradise

All research should start with an introduction, identifying what issues the research is setting out to understand and solve. This chapter will research and provide the evidence that there is a problem with the housing situation in Hawaii, specifically in the realm of single-family homes. Before researching the specific built environment, we begin with the inhabitants, the people of Hawaii and the challenges they face. The cost of living in paradise.

Figure 1: Hawaii 1950
Source: Time Magazine

1.1 The Rise of the Population in Hawaii

The oldest official record taken of citizens living in Hawaii dates back to 1900. It was recorded that 154,001 official citizens were living in the Hawaiian Islands. Within just ten years that number had risen by 24.6% to 191,874. After Hawaii became the 50th state in 1959, the U.S. census of 1960 was the first to include Hawaii in its statistics. At this first census the population had grown to 632,772 people. Since its first census record, the number of people in Hawaii has continued to increase but, the

percentage that they increase decade by decade has decreased. According to the most recent U.S. Census, it is estimated that the 2019 population of Hawaii is currently at 1.43 million. Of the eight major Hawaiian Islands, Oahu has the largest percentage of the population, with a total of 992,605 people. On Oahu, Honolulu is the largest city and county in the Hawaiian Islands and is home to an estimated 350,399 of Oahu's population. The next largest population resides on Hawaii Island, or the Big Island, with a population of 186,738 people, followed by Maui with 144,444 people. After those three islands, the remaining five islands have less than 90,000 people, with Kauai at 66,92, Molokai with 7,345, and Lanai with 3,135. Niihau has the smallest population of people with 170, while Kahoolawe has remained unpopulated.¹ According to the 2019 census, Hawaii is the 40th largest state in the union. Hawaii is considered small in terms of its total population when compared to other states in the U.S. but, Hawaii has a rather high number in the category of population density. In total, the eight major islands make up 10,931 square miles in surface area making its population density about 222.9 people per square mile. ²

¹ US Census Bureau, "Search Results," Results, December 13, 2014, , accessed August 26, 2018, <https://www.census.gov/content/census/en/search-results.html?searchtype=web&stateGeo=none&q=hawaii county hi&disambFipsCode=15001>.

² "Hawaii Population 2019," Hawaii Population 2019 (Demographics, Maps, Graphs), , accessed August 28, 2018, <http://worldpopulationreview.com/states/hawaii-population/>.

POPULATION

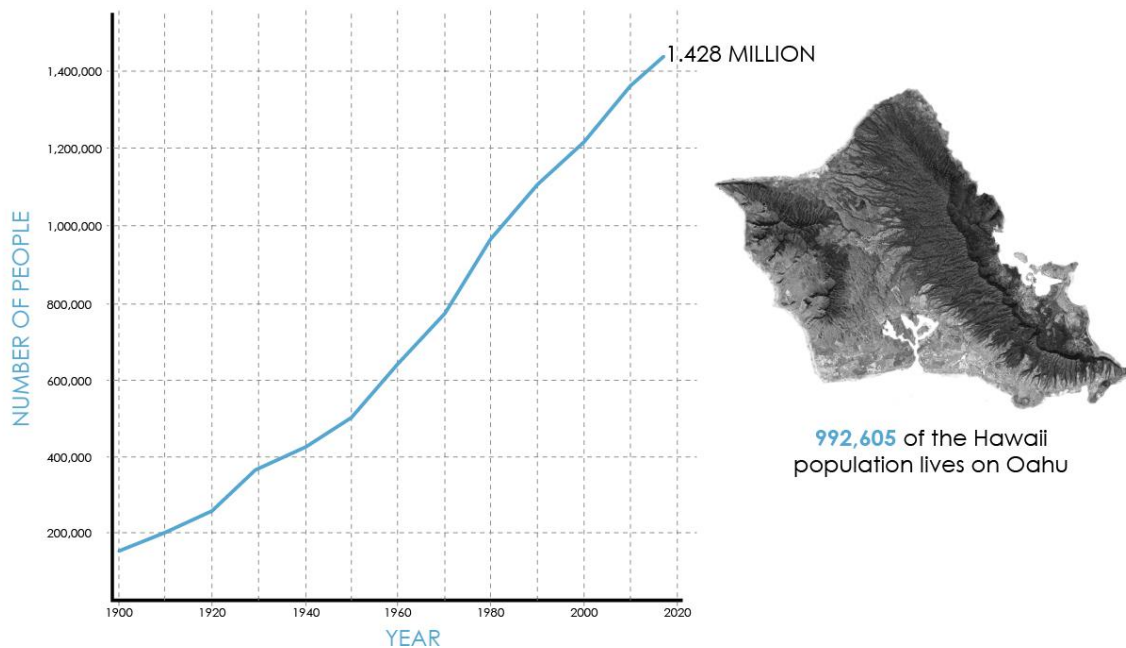


Figure 2: Population Chart
Source: Author

1.2 Cost of Living in Hawaii

When compared to the other states in the U.S., Hawaii ranks number one for the highest cost of living. One of the best ways to compare the cost of living in a given place, is to understand its price parity of goods. The parity price concept is used for both securities and commodities and refers to the price comparison of a specific goods cost in one place to the national average. For example, the national average cost of a dozen large eggs is \$2.62. In Hawaii a dozen large eggs costs \$5.21 on average.³ Food and many other goods are very expensive in Hawaii because practically everything must be imported. The energy production in Hawaii is also strikingly expensive. For

³ "Cost of Living in Honolulu, Hawaii, United States. Apr 2019 Prices in Honolulu, Hawaii.," Expatistan, Cost of Living Comparisons, accessed August 25, 2018, <https://www.expstatistan.com/cost-of-living/honolulu>.

example, the energy in Hawaii can cost triple what you would pay if you lived in parts of California.

Hawaii has a regional price parity score of 118.8, this means that the residents have to pay almost 19% more on average for basic goods and services. This is one component adding to the climbing median income per household needed for a comfortable life in Hawaii. To afford a comfortable living in Hawaii a household should have an income of \$73,486, whereas the actual median income is \$61,857. This fact alone already puts a strain on anyone trying to make or buy a home of their own in Hawaii.⁴

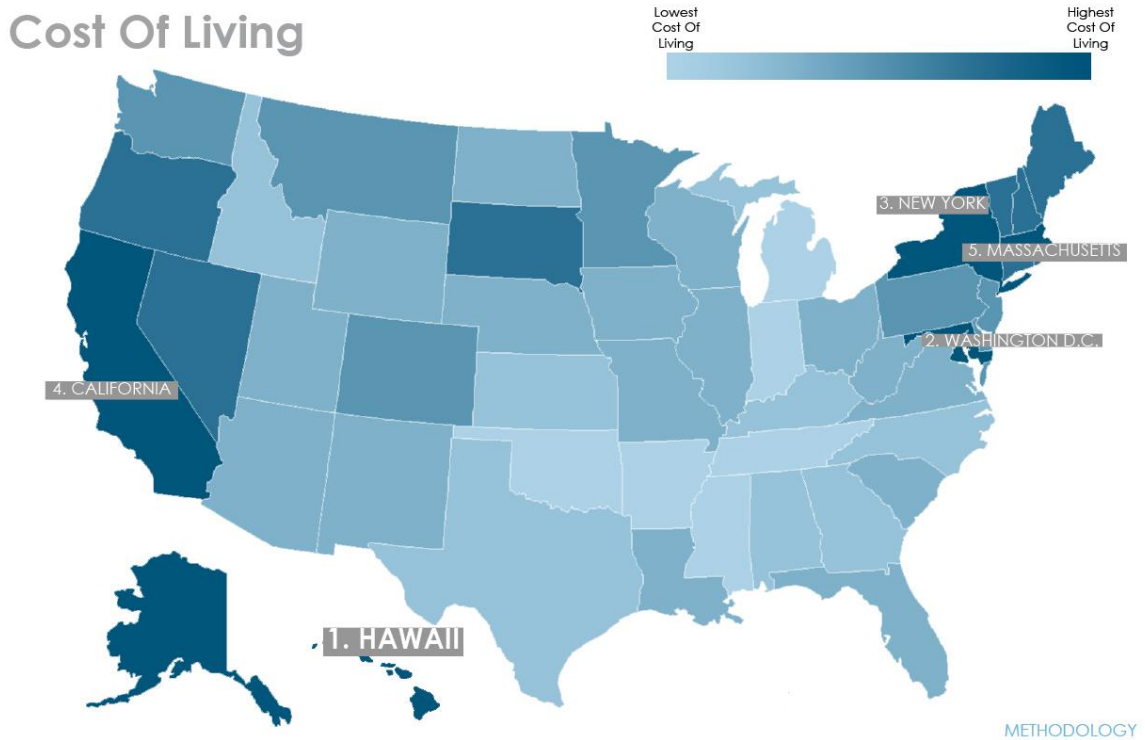


Figure 3: Cost of Living Heat Map
Source: Author

⁴ Bieber, Christy. "15 States With the Highest Cost of Living." The Motley Fool. July 05, 2018. Accessed September 03, 2018. <https://www.fool.com/slideshow/15-states-highest-cost-living/?slide=16>.

1.3 The Rise of Real Estate Costs

Along with holding the title of highest cost of living in the U.S., Hawaii also holds the title for the highest real estate costs in the U.S.. The median price for a single-family home in Hawaii as of the end of 2018 has hit a record high at \$810,000. This was an increase of \$24,000 from the previous year according to the Honolulu Board of Realtors. Hawaii being the highest ranked state for real estate costs is not a new development. In a 2016 study done by Sumner Lacroix, an economic professor at the University of Hawaii, Lacroix said "Even if we go back to 1950, we're still finding that there's a premium of almost 100% in the Hawaii home prices, it's always been expensive to buy here." Lacroix and other members of the UH economic research organization, used historic census data to show that home prices in Hawaii dating back to over 60 years ago were already higher than the other 48 states on the mainland. At that time, the national median price for a single-family home was \$58,600. In Hawaii single-family homes costed twice as much. After World War II housing exploded in Honolulu due to a large influx of people from the neighbor islands. The sugar plantations that supplied work on the neighboring islands were now starting to use more machines, and less manual laborers, resulting in the people coming to Honolulu to look for work. Commercial flights, full of tourists became more constant through the 1950's. Lacroix had this to say: ⁵

⁵ "UHERO the Economic Research Organization at the University of Hawai'i," UHERO, January 28, 2016, , accessed April 03, 2019, <https://www.uhero.hawaii.edu/news/view/300>.

“All of a sudden, people from the mainland find it much cheaper to get to Hawai‘i. They come to Hawai‘i, they like Hawai‘i — and we have a booming tourist industry,” he said. “So people’s wage rates are going up, as they do they’re more than willing to bid up the price of housing. We also see a big increase in the demand for housing; the supply just didn’t keep up for a variety of reasons.”⁶

Figure 4: United Landing in Hawaii 1960
Source: History

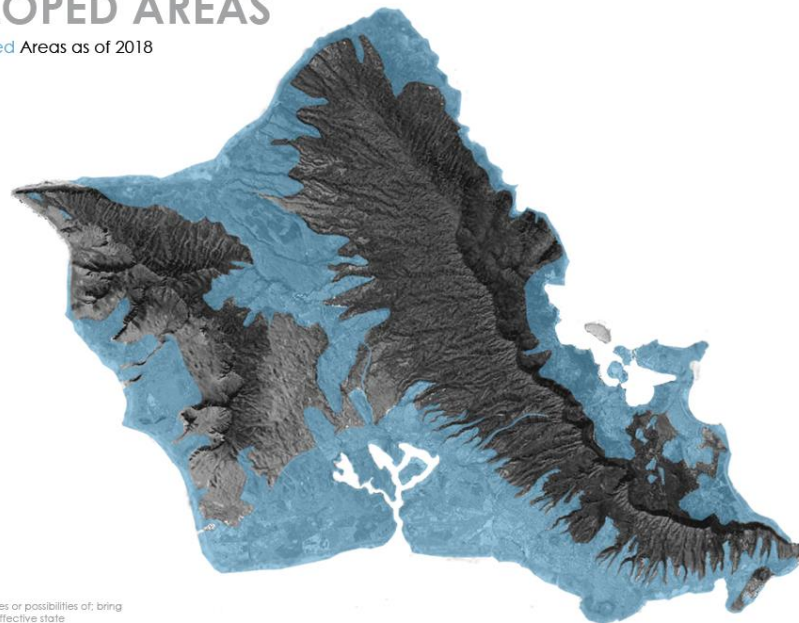
With the state of Hawaii being a collection of islands, there is already an issue that puts an increase on the real estate price, the issue of space. When other states on the continental U.S. need to expand to accommodate their growing population, they often have the luxury of more space to develop upon. “Here, when you drive out to Hawai‘i Kai, there’s ocean. Drive out to Nanakuli, you can’t go that much further, on the mainland there’s just more rings of suburbs, there’s more places where there

⁶ ibid

could be some expansion” said Lacroix.⁷ This question of space is one that has plagued Hawaii in the past and will continue to be an issue for the future. Through the late 80’s and 90’s, Oahu expanded its residential development throughout areas such as Mililani, Aiea, and further west to the Ewa Plains. With small land area and the specific climate we are provided with in Hawaii, our local building materials are also very limited if we do not use them properly, causing us to rely on imported materials to construct. This import of building materials causes an increase in price for processing, shipping, and handling thus increasing construction costs. We as designers and shapers of the built environment must understand and think about how much growth Hawaii can endure and just how we want to use the space that is left.

DEVELOPED AREAS

 = Developed Areas as of 2018



de vel oped
to bring out the capabilities or possibilities of; bring
to a more advanced or effective state
to cause to grow or expand
to elaborate or expand in detail
to bring into being or activity; generate; evolve

Figure 5: Developed Areas 2018
Source: Author

⁷ Molly Solomon, "Why It's Always Been Expensive To Buy a Home in Hawaii," Hawaii Public Radio, October 03, 2016, , accessed April 03, 2019, <https://www.hawaiipublicradio.org/post/why-it-s-always-been-expensive-buy-home-hawaii>.

Chapter 2 | History of Home Making in Hawaii

Chapter 2: History of Home Making in Hawaii

Ignoring the history of building in a specific place is often a crime that is committed when designing and building, especially in a place with such a rich and embellished history like Hawaii. This chapter looks to pay respect to some of the types of home making that has taken place throughout the history of Hawaii. We will be looking at how the people inhabited the space, its building materials, and its construction. Each of the selected building types and time periods will have a "Take away" section that will conclude the lessons learned and the ideals that will help guide the design of the new home design.

2.1 Utilitarianism & The Hale Pili

The built shelters in traditional Hawaiian society were role specific, meaning there were specific roles for each type of structure to accommodate. For example, the Kauhale was a shelter built specifically for sleeping. Other notable shelters, or hale, include the Hale Kuke (cooking house), Hale Mua (mens gathering house), and the Hale Pe'a (menstruation house). The location of each of these hale were determined by the geography and topography of the land. For example, housing that was based higher on the mountains, or Mauka of the island, may focus on supporting the cultivation of land crops such as the Hawaiian staple of kalo. The structures closer to the ocean, or Makai of the island, often focused on supporting any ocean-based activity, such as the Hale Wa'a (canoe house) which served as a shelter for building, maintaining, and housing canoes. Traditional shelters were constructed using native woods of Hawaii. The local woods were lashed and strung together using cordage often made from other local plants, such as olona and lauhala. The native pili grass was the most common material used for thatching roofs, giving each hale protection from the outer elements and gave off a pleasing fragrance to the shelter, coining the term "Hale Pili". Each shelter was constructed by the Kānaka Maoli, the native people of Hawaii,

who brought decades of knowledge and understanding of the land on which they lived. They understood the paths of the sun, how the winds blew through the land, and how often the rains would replenish their crops.⁸

Figure 6: Hale Pili 1823
Source: Peter T. Young

Takeaway

There are three major items to take away from researching the Hale Pili and the shelters of traditional Hawaiian society, and all three can be described in one word, Utilitarianism. Merriam-Webster defines utilitarianism as “a doctrine that the useful is the good and that the determining consideration of right conduct should be the usefulness of its consequences”. This means that every action should be appropriate,

⁸ "Wao Lani," Hawaii Alive | Realms: Wao Lani, 2011, , accessed December 16, 2018, <http://www.hawaiialive.org/realms.php?sub=Wao Kanaka&treasure=343&offset=0>.

every material used, be purposeful. This is what Hawaiian society translated into their building of their hale. The first take away comes from the use of all local materials based on its availability and the extremely efficient use of that material. The next take away comes from they used the land in the most efficient way possible, looking at the function of the space as a location guide to where the shelter would be built. Lastly, and maybe most importantly, they understood the natural elements surrounding them. The native Hawaiians not only understood elements like the sun, wind, and rain, but they respected it and built in ways to harness these elements in their design. This will serve as part of our design goals for our Breathing Home.

2.2 Westernization & Mission Homes

On March 30, 1820 the first missionaries arrived in the Hawaiian Islands. The group of Americans, including figures that would become synonymous with the changing of Hawaii, Hiram Bingham and Asa Thurston, sailed in aboard a ship called the Thaddeus. Sent by the American Board of Commissioners for Foreign Missions in New England, the missionaries arrived with the goal of turning the indigenous Hawaiian society into a Christian based way of life.⁹ With this mission came new home construction, foreign to traditional Hawaiian society. The early mission homes constructed in the 1820's, were built from materials that were shipped from Boston. The materials had already been measured and cut, making them ready to assemble into an imported wood frame house. The assembly was fast but because the homes were preplanned in New England, they were constructed for the climate of New

⁹Sean Munger, "Civilizers or Conquerors? The First Missionaries to Hawaii.," SeanMunger.com, December 04, 2013, , accessed December 18, 2018, <https://seanmunger.com/2013/12/03/civilizers-or-conquerors-the-first-missionaries-to-hawaii/>.

England consisting of small windows to help retain heat inside and even included short eaves to prevent breakage from the loads of New England snow. Over time the foreign Americans realized their New England style homes are not the most efficient use of the unique situation presented by the Hawaii climate. It was also difficult for those back in New England to build for an environment that they have never experienced, so the mission homes began to take on new design and materiality. By the 1840's mission homes now included larger windows for ventilation accompanied with large shutters built with direction and purpose of sun direction. New spaces were built with the homes including larger parlors and gathering areas like covered porches and balconies. These covered outdoor areas increased the adaptation and interaction between indoor and outdoor lifestyles that couldn't be done in the New England climate. Dining halls and cooking houses, which were separate, now began to become common additions inside of the main house. The materiality of the homes also began to become more local with the incorporation of basalt and coral stones that were formed into building blocks.¹⁰

¹⁰ "The Hawaiian Mission Houses Historic Site and Archives: Where Two Worlds Meet," Historic Buildings, , accessed December 18, 2018, <https://www.missionhouses.org/collections/historic-buildings>.

Figure 7: Hawaii Mission Home
Source: The New Citizens Press

Takeaway

The evolution of the mission home architecture throughout the early 19th century in Hawaii illustrates the adaptation of missionaries from New England to the climate, culture, and building materials that the islands provided, much like the native Hawaiians. The prefabrication of the original homes through the 1820's made assembly efficient, but the shortcoming came with the home design and materiality. The bringing together of multiple gathering spaces and the increase of outdoor covered areas is a staple that has carried throughout local home building and Hawaii culture.

2.3 Immigration & Plantation Style Homes

Major plantations began to take over in Hawaii as soon as sugar cane was introduced in 1841. From the middle to the late 1800's sugar cane and pineapple plantations grew the economy of the islands and not to mention the population. Within this time over 337,000 people immigrated to the islands to satisfy the labor needed to work in these plantations. Much like the influx of new home types with the arrival of the missionaries, a new major shelter type began to arise to house all these new laborers, leading to large plantation homesteads. Laborers lived in smaller home on the homestead while the plantation owners and skilled workers lived in larger homes. These homes were built on post and pier and consisted of single wall construction. They were often constructed of imported timber like Douglas Fir and termite resistant redwood. The plantation style homes, as they would come to be known, were built to house the maximum amount of people while still maintaining an open and appealing aesthetic. This was a result of the connotation that the nicer, and bigger the plantation home, meant that your plantation was large and doing well economically. Often, you will find unique built-ins in the kitchen, dining rooms and bedrooms. The single-story design featured low profile wood frames with exposed rafters and plank siding. The wide roofs allowed for large outdoor gathering spaces that often encompassed the entire home allowing for ample interaction with the surrounding nature.¹¹

¹¹ "Plantation-Style Architecture - Kaua'i," Kukui'ula, March 21, 2014, , accessed December 20, 2018, <https://kukuiula.com/plantation-style-architecture-kukuiula/>.

Figure 8: Hawaii Plantation Style Home
Source: Remodelista

Takeaway

After running its original course of being a home for plantation owners, plantation style homes became a desired residential style for the people of Hawaii through the early 1900's. Toward the end of the 20th century the plantation style was becoming less desirable as popular trends from the west coast of the continental U.S. became the new norm and our reliance on imported building materials grew. In recent years the desire for plantation style homes has returned to the Hawaii real estate market. The wide hipped roof design can be seen as the inspiration for even large-scale commercial projects like Ala Moana Shopping Center. The style has also become the new basis for much of the residential developments in West Oahu especially in and around our site of Kapolei. The plantation style home embodies the emergence of

residential architecture in Hawaii that combined style with purpose, but since then it has become nothing more than a gimmick in real estate.

2.4 Large Scale Development

Large scale development in Hawaii can be reduced to a single issue that needed to be addressed, housing was needed, and needed badly for the large influx of people that began to flood the islands. The first major developments began to take shape in early 1920 with neighborhoods being constructed in Pacific Heights, St. Louis Heights, Wilhelmina Rise, Nuuanu, and Manoa. These neighborhoods began to reinforce the hierarchy of wealth differences among the people in Hawaii. The wealthier bought homes located higher up the heights of Honolulu, the richest purchasing homes at the tops of Tantalus for its panoramic views and isolation. Through the latter half of the 1920's a breakthrough in how we would traverse the Honolulu area was completed. Street cars along with other forms of public transportation became available, meaning that people could live further away from where they worked. At this time, it was a necessity to live near your work place, as cars were luxury items and were not very common amongst the working people, but once the selling price began to drop, automobiles pushed expansion over the entire island. Through the 1940's and 50's the tourism industry began to take off in the islands, specifically in Honolulu.¹² With the growth of Waikiki and the business districts of Downtown Honolulu, people began to branch out further and further from the center of Honolulu. Development of neighborhoods and districts all over the island began to take shape, most of them funded by private developers. This growth at the time showed how much promise

¹² Hawaii Living, "Guide to Honolulu Real Estate History," Hawaii Living Blog, February 06, 2018, , accessed December 27, 2018, <https://www.hawaiiliving.com/blog/history-honolulu-real-estate/>.

Hawaii would hold as the 50th State, but with Honolulu being the hub of much of the work on Oahu, this growth also meant people living further from their jobs, thus setting up the next major issue with the Hawaii lifestyle, traffic.

Figure 9: Large Scale Development
Source: Hawaii Aerial Media

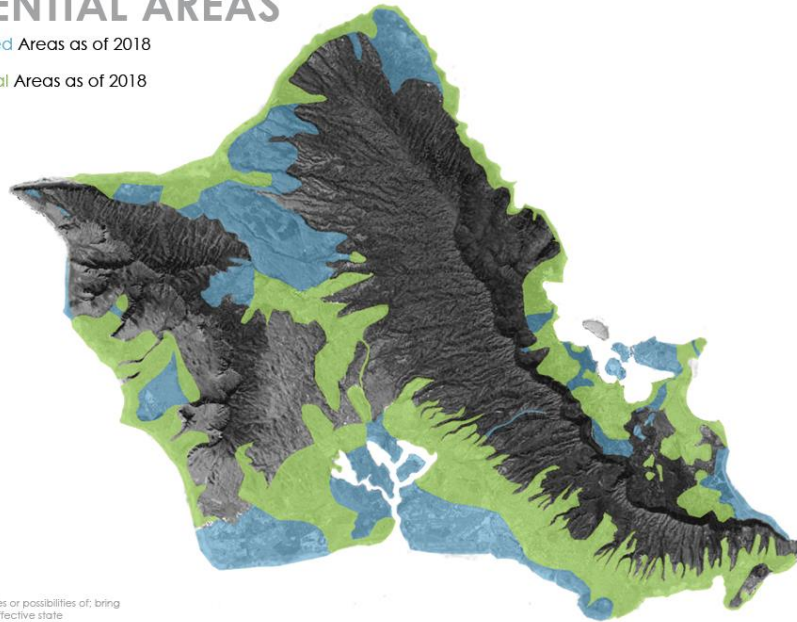
Takeaway

Looking at the large-scale development that has taken place throughout the middle of the of 20th Century, there is one major issue that was caused as a side effect of the overwhelming growth, which is large masses of people living further from their place of work. After the growth of infrastructure and the influx of thousands of people, traffic has become a large issue on the island of Oahu, and we have spent the latter half of the 20th century and the start of the 21st century trying to fix and cater to that traffic. The traffic situation is reinforced by the rising of real estate costs, especially in the Honolulu area. This research of how the development of Honolulu, and the greater

Honolulu area, is one of the driving reasons for my site selection of Kapolei. Kapolei is the up and coming city of Oahu, and before the large-scale development takes over, I want to develop a community of affordable homes for the people that will become the labor force of the new city.

RESIDENTIAL AREAS

-  = Developed Areas as of 2018
-  = Residential Areas as of 2018



de vel oped
to bring out the capabilities or possibilities of; bring to a more advanced or effective state
to cause to grow or expand
to elaborate or expand in detail
to bring into being or activity; generate; evolve

Figure 10: Developed Residential Areas
Source: Author

Chapter 3 | Alone in The Pacific: Hawaii's Unique Geography & Climate

Chapter 3: Alone in The Pacific

At 3,637 km from the nearest continental shoreline, the Hawaiian Islands are the most isolated group of islands in the world. Because of its isolation and surrounding ocean, designing in Hawaii presents a unique opportunity. When designing any form of architecture, you must first understand the environment you are building in, not only from the context of its immediate surrounding site but from its overall geographical location in the world. By understanding a place's geographical location, we begin to learn the difficulties and opportunities that each place presents. Difficulties and opportunities present themselves in a place's geography, ecology, and climatic elements. If we can understand the different fragments that make each place unique then we will be able to design and execute an effective strategy that is site specific and site appropriate. This chapter researches the geography, ecology, and climate of Hawaii serving as one of the steps towards designing and building in a more effective manner.

Figure 11: Hawaiian Islands (Satellite View)

Source: NOAA

3.1 Geography

The tropical, green islands of Hawaii are the visible peaks of a chain of sunken volcanic mountains stretching from Hawaii to the Aleutian Trench in the North Pacific. Excluding the 8 largest and major islands that appear on all maps are remaining stretch of the island chain consist of mostly atolls. These atolls are inactive stumps of volcanic rock surrounded by coral reefs.¹³

Figure 12: Hawaii Island May 3rd Eruption
Source: CBS News

¹³ "North America," World Atlas - Maps, Geography, Travel, April 07, 2017, , accessed January 25, 2019, <https://www.worldatlas.com/webimage/countrys/namerica/usstates/hiland.htm>.

As a shocking contrast to the typical tropical paradise like climate, the peaks of the iconic volcanoes Mauna Loa and Muana Kea on the Big Island are often snow-capped. Kilauea, the youngest volcano in the Volcanoes National Park, still occasionally erupts, excreting lava and creating new land. The last major eruption took place on May 8, 2018 and lasted until August. It covered more than 13 square miles of land and created over 875 hectares of new land of the coast.¹⁴ Other volcanoes include Haleakala of Maui, which is considered active but is not currently erupting.

Figure 13: Koolau Mountain Range
Source: Hawaii Magazine

Mt. Waialeale on Kauai is widely described as one of the rainiest areas on earth, with over 450 inches of rain per year. Varying sea cliffs line the outer edges of many

¹⁴ Laura Geggel, "The Science Behind Hawaii's Surprising 2018 Volcanic Eruption," LiveScience, June 04, 2018, , accessed January 27, 2019, <https://www.livescience.com/62563-hawaii-volcano-eruption-2018.html>.

islands, with the Na Pali coast of Kauai, the southeastern edges of Maui and the north coast of Molokai being the most dramatic. These steep cliffs are not common on the island of Oahu. Hundreds of narrow streams flow from the volcanic peaks to either the sea or the fertile valleys below. On the island of our site, Oahu's Diamond Head, is one of the island's most famous landmarks. Its very distinct profile and look is a contrast to the large sloping Koolau mountain range that splits the island, creating slight variants of different ecosystems within the mostly tropical and mild tempered Hawaii climate.

3.2 Ecology

An ecosystem can be best described as a naturally occurring biological community existing and functioning within a specific physical environment. We as human beings are a biological community, and over time we have existed through multiple ecosystems, each becoming more and more man made. Before man made interventions can be applied to any site, it is important to understand the natural occurring elements that make that place unique. For Hawaii's mild temperature, there are still a numerous number of ecological habitats, each featuring a wide range of coastlines, marine life and land ecosystems. Because we are designing for human habitation, we will focus on the two major land-based ecosystems that make up the Hawaiian Islands, the Coastal areas and the Terrestrial areas.

Figure 14: Hawaii Rainforest
Source: Lonely Planet

Coastal Areas

Hawaii's coastal areas are comprised of sandy beaches and rocky shorelines. The shorelines usually vary between those two options and are characterized by steep or gently sloping cliffs. The areas with steep cliffs have little access to the ocean whereas those with gently sloping precipices contain attractive looking tide pools. The accessible sandy coastal areas are crowded with tourists and locals alike, all of which are participating in different activities ranging from tanning to surfing. This is all different ways that we as humans inhabit the coastal areas of the islands. In order for us to design effectively in the coastal areas, the way we inhabit them is very important to understand. My project is located in Kapolei, Oahu which is considered more of

terrestrial area but and understanding of the surrounding coastal areas in also imperative.¹⁵

Figure 15: Na Pali Coast, Kauai
Source: Blue Ocean Adventures

Terrestrial Areas

Hawaii's terrestrial areas are located further inland on every island, consisting of humid air that is driven by the trade winds. This moisture laden air has produced fertile vegetation, tropical rainforests and waterfalls which further creates homes for numerous species of animals and plants. The island of Oahu is split by the steep and large Koolau mountain range. This mountain range causes more consistent rainfall and trade winds to be characteristics more common with the east side of the island. Conversely, the west side of Oahu consists of dryer air, higher temperatures, and lower amount of rainfall. This lack of rainfall results in little vegetation, and the vegetation that is there has become resilient to said dry conditions. Our site of Kapolei, is located

¹⁵ "Hawaii Ocean Science & Technology," Ecology, 2018, , accessed February 9, 2019, <http://www.hawaiiocesience.org/ecology.html>.

right on the edge of what would be considered the west side of Oahu, this presents an interesting opportunity as it has mild rain but not as heavy as locations on the eastside

Figure 16: Waianae, Oahu
Source: Cat SmallEars – All Trails

It also experiences heavy sunlight from the west setting sun. All these factors present challenges and opportunities.¹⁶

3.3 Climate

The climate of an area can be best described as a composition of varying types of weather.¹⁷ A lot of the “beauty” associated with the islands are features of Hawaii’s climate, that include mild temperatures throughout the year, moderate humidity, and persistent northeastern trade winds. There is also very significant short-range precipitation, meaning that there can be different amounts of rainfall that vary greatly over short distances. This combination of elements allows most of Hawaii to have only

¹⁶Ibid

¹⁷US Department of Commerce and NOAA, "Honolulu, HI," Pacific Region Headquarters, , accessed February 12, 2019, http://www.prh.noaa.gov/hnl/pages/climate_summary.php.

two distinct seasons. A summer that takes place between May and October and a winter taking place between October and April.

A good percentage of homes currently in Hawaii do not have any climate responsive design interventions, most looking as if they could be placed anywhere in the world. If we can understand the unique opportunity that Hawaii's climate presents, then we can design and build as a response to the climate and not ignore it as most designs here do.

Figure 17: Manoa Rainbow
Source: Hawaii Magazine

Hawaii's specific location in the world is 19.8968° N, 155.5828° W putting it in the part of the world known as the tropics, where day length and temperature are relatively the same all year round.¹⁸ Hawaii's longest days last around 13.5 hours and the shortest days being around 11 hours. On the opposite end of the day length

¹⁸ "Hawaii, USA," Latitude and Longitude Finder, , accessed September 03, 2018, <https://www.latlong.net/place/hawaii-usa-10262.html>.

spectrum, the state of Maine has its longest days hitting 15.5 hours and its shortest being 8.5 hours. Having these more or less uniform daylengths lead to low seasonal fluctuations in the amount of incoming solar radiation and thus lessening the variation of temperature. On a clear winter's day, flat terrain in Hawaii gains at minimum, 67 percent more solar energy between sunrise and sunset than on a clear summer's day.

Figure 18: Hawaii Sunset
Source: Comunitat Valenciana

The surrounding Pacific Ocean provides the air with moisture and acts as a huge thermostat, since their own temperature varies only slightly compared to large land masses. The seasonal temperatures of the ocean surfaces near Hawaii are only 6 degrees, ranging from 73 to 74 degrees between the months of February and March, up to a high 80 degrees late September or early October. There is also a small variation of temperature between night and day of one or two degrees. Hawaii is more than 3,600 km from the nearest continental landmass, which is the southern tip of Alaska. Therefore, the air that makes its way to the island, regardless of its origin, will exhaust enough time across the ocean to mitigate their initial properties, even if they are quite harsh. During the winter months, there is also Arctic air that reaches Hawaii. This Arctic

air flow can rise as high as 100 degrees during its time spent traveling over the waters of the North Pacific Ocean. Whereas most of the Continental United States will experience its warmer months through June and July, Hawaii's warmest months are through August and September, and its coolest months are February and March as opposed to December and January.¹⁹ This seasonal delay is a direct result of the surrounding oceans temperature, and how it affects the land temperature.

Figure 19: Air Temperature
Source: University of Hawaii Geography Department

¹⁹ Sasha Trubetskoy, "How Far Is Hawaii from the Nearest Landmass?" Sashat.me, March 04, 2017, , accessed February 20, 2019, <https://sashat.me/2017/03/03/how-far-is-hawaii-from-the-nearest-landmass/>.

Above the ocean near the coasts of Hawaii, average rainfall is between 25 and 30 inches per year. Some areas of the islands receive as much as 15 times that amount. On the opposite end of that range, some areas receive less than a third of that. This is mainly caused by mountain rains, which are rains that form inside of the trade winds, due to its heavy moisture gathering as the wind moves from the top of the oceans up and over the steep terrain of the islands. Upon the higher areas of the mountains of Hawaii, the maximum rainfall ranges between 2,000 and 3,000 feet. The amount decreases rapidly as the altitude increases resulting in the highest slopes being relatively dry. Another source of major rainfall are the large cumulus clouds that build up over the mountains. Hawaii's strongest rains come from winter storms between October and April. Often the strongest thunderstorms do not occur in areas with the highest average precipitation. It's the relatively dry areas that receive sums that exceed half of their average annual precipitation within a day or even a few hours. The leeward and other drylands get most of their rainfall from the winter storms, making their rainfall a seasonal occurrence, leaving the summers dry. This is the best description of where our site of Kapolei is located. In contrast to Kapolei, the more humid regions, where rainfall is more consistent, coming from both winter storms and trade wind showers, the seasonal differences are much smaller. Although rainfall throughout the islands in one area or another is rather consistent, drought is not foreign in Hawaii. These drought periods in Hawaii rarely affects an entire island at one time. In the islands, drought can occur when there is an absence of winter storms or trade winds.

When there are no winter storms, the dry leeward areas are affected the most, especially if it is followed by a dry summer. The absence of trade winds are mainly what affects the windward and highland region because they receive less of their rain from winter storms. The winter storms are not the biggest storms that Hawaii must prepare for.

Figure 20: Rainfall
Source: University of Hawaii Geography Department

3.4 Hurricanes in Hawaii

Hurricanes generally form in areas with increased thunderstorms over warm, tropical oceans and are one of the most destructive storms on earth. The destructive rage of hurricanes is driven by a combination of strong winds, heavy rain, and carry high waves and storm surges. Hurricanes are relatively rare in the Hawaiian Islands. Since the beginning of recorded history, some form of strong windstorms have hit all the major islands of the Hawaiian chain.

Figure 21: Hurricane Iniki Storm Path

Source: Hawaii News Now

In August of 1950 the first officially recognized hurricane in Hawaiian waters was Hurricane Hiki. Since Hurricane Hiki in 1950, five hurricanes or tropical storms have caused severe damage throughout Hawaii. Hurricane Nina (1957, Hurricane Dot (1959), Hurricane Iwa (1982), and Hurricane Estelle (1986) all caused their fair share of damage throughout the island chain.²⁰

²⁰ Steven Businger, "HURRICANES In Hawaii," HURRICANES IN HAWAII, , accessed November 03, 2018, <https://www.soest.hawaii.edu/met/Faculty/businger/poster/hurricane/>.

Hurricane Iniki was the most powerful hurricane to hit the islands. Forming on September 5, 1992, Hurricane Iniki made its way to the island of Kauai at its peak intensity with winds of 145 miles per hour with gusts reaching 225 miles per hour, making it a category 4 hurricane. Iniki caused \$3.1 billion in damage and more importantly, cause six deaths. At the time, Iniki was among the costliest United States hurricanes in history. A critical problem with the events of Hurricane Iniki started with The Central Pacific Hurricane Center, who failed to issue tropical cyclone warnings and watches at the minimum 24 hours in advance. With the absence of any type of warning it is a miracle that only six people lost their lives. The damage was greatest on Kauai, with 1,400 homes destroyed and another 5,000 severely damaged.

Figure 22: Hurricane Iniki Aftermath

Source: Hawaii News Now

Just because we don't have these brutal forces of nature occur very often, does not mean that we should not design without them in mind. According to Howard Wiig, Energy Analyst with the Hawaii State Energy Office, designing with safe rooms and storm shelters in mind may soon to be part if energy and building code requirement. With that said I believe it will be important to keep this in mind when designing our new home.

Chapter 4 | Building Materials

Chapter 4: Building Materials

In order to find a new local building material for the single-family home, it is important to understand the current building materials being used on the islands. This chapter will look at the three most common building materials used for single-family home construction, taking into account their basic anatomy, structural qualities, thermal qualities, and most importantly their availability on the island. After researching each of these materials, a matrix will be formed rating these qualities to visually see the strengths and weaknesses of each one.

4.1 Steel

One of the most influential building materials throughout the last century is steel. Steel makes for an exciting material because of its ability to be adaptable and malleable without compromising its strength and structural stability. In building construction there are primarily two types of steel are used. There is hot rolled and cold formed steel. Cold formed steel is used in smaller builds, such as residential projects, serving as an alternative to your typical dimensional lumber wood framing. This cold formed steel is light, but still very firm and stiff and proves to be cost-effective for such a high-production steel. There are multiple benefits of using steel for construction, from the manufacturing perspective to the structural perspective. Steel is termite resistant, fully recyclable, and non-flammable. Although when steel is exposed to heat for a period, its structural integrity becomes more compromised. In comparison to wood when held to heat or fire, wood will hold its integrity longer than light gauge cold formed steel.²¹

²¹ Terence Bell, "The History of Steel," The Balance, , accessed October 2, 2018, <https://www.thebalance.com/steel-history-2340172>.

Figure 23: Cold Formed Steel Stud Wall System
Source: CFS Curtain Wall

The major issue that comes with steel is that it is not a local material. By local material I mean that it is not something that we can produce here in Hawaii without the reliance of imported goods. There are a multitude of metal fabrication shops here in Hawaii that supply local contractors, but these shops import and order millions of dollars of metal and fabrication equipment each year to meet these demands. This increases the embodied energy of the material a great deal being that before the material is used at any site in Hawaii, it has to be prepped and fabricated in the continental U.S., shipped overseas, then fabricated once more for its specific role on Hawaii and then installed on the site.²²

²² Foreign Trade Div., "Hawaii State Imports," Hawaii State Imports, May 23, 2018, , accessed October 03, 2018, <https://www.census.gov/foreign-trade/statistics/state/data/imports/hi.html>.

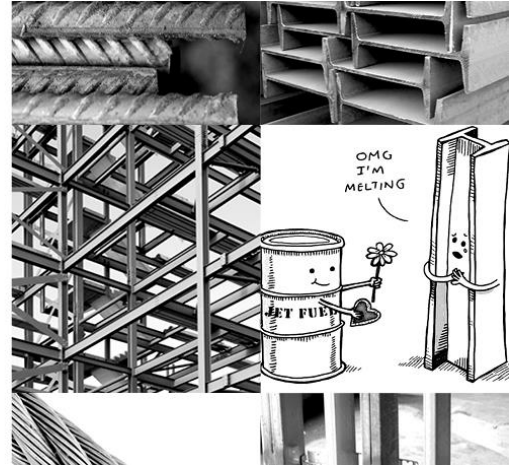
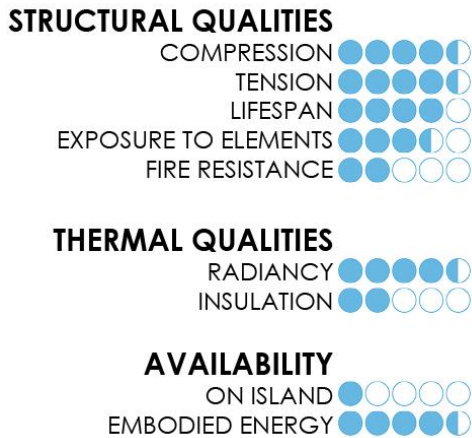


Figure 24: Steel Matrix
Source: Author

Takeaway

Steel is one of man’s strongest industrial creations, but with the Hawaiian Islands being so small and their isolated location, there are no large-scale steel manufacturers on any island. This causes us to rely on imported steel and metal materials. Steel has also been known to lose much of its structural integrity in fire situations. It is also very poor at insulating on its own but has a high radiancy. With availability being an important driver behind the design and materiality choice for the single-family home, it is very unlikely that steel will play an integral role in our specific design process, and more specifically with the structure of the single-family home.

4.2 Wood

Dating back to the native Hawaiians and the Hale Pili, wood has always been a major building material in the islands. Wood is a versatile natural material and the only renewable building material. Wood builds are usually constructed by using a combination of different components, and dimensions of lumber. Together, these fastening components and lumber come together to offer the best possible structural capacity, thermal, sound and moisture insulation, fire resistance and a long service life. When fabricating wood products very little external energy is required in comparison to other building materials. When manufacturing other building materials, you are always starting a limited amount of natural materials, combined to make a single building product. These natural components that go into other building materials go through extraction and processing, which both require lots of energy, often in very large quantities and from fossil fuels.²³

Figure 25: Dimensional Lumber Construction
Source: Hoaloha Design Group

²³ "Wood Is a Sustainable Construction Material," Swedish Wood, , accessed October 03, 2018, https://www.swedishwood.com/about_wood/choosing-wood/wood-and-the-environment/wood-is-a-sustainable-construction-material/.

While wood is a very good natural resource for building materials, we don't have any trees growing here in Hawaii that could be used as a sustainable resource for structural lumber, without reinforcements. Once again, we are forced to rely on foreign, imported materials for our single-family homes. According to a study by the Hawaii Agriculture Research Center, Hawaii imports over 500,000 tons of lumber for various building materials each year.²⁴ The most common imported woods used for building materials are white pine, white oak, Douglas fir, cypress, and cedar.²⁵

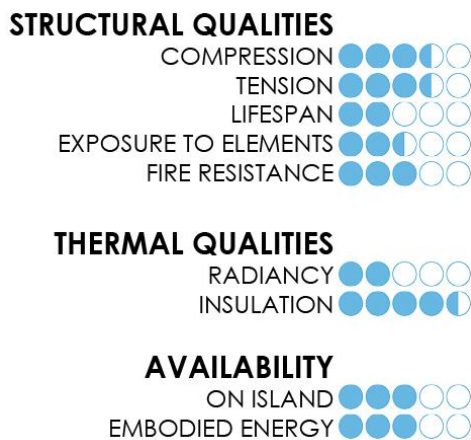


Figure 26: Wood Matrix
Source: Author

Takeaway

Although we live in a tropical environment surrounded by trees, not many can be used for structural construction, causing us to rely on engineered, imported lumber for our typical stick frame construction. The days of using native growing plants like the olona and lauhala as building materials are long gone but, there is an opportunity to use wood that has since been introduced to Hawaii to design nonstructural elements that can be modified to withstand nature in a more effective manner.

²⁴ Nicklos S. Dudley and James E. Quinn, Hardwood Lumber and Wood Product Market Analysis for Hawaii, PDF, Honolulu Hawaii, May 04, 2014.

²⁵ "Choosing a Timber Species," Timber Frame HQ, , accessed October 04, 2018, <https://timberframehq.com/timber-framing-101/timber-species/>.

4.3 Concrete

Since the beginning of time, humans have used stone and some related items to help shape the environment around them. In modern time, this is still true with stone being used in the form of concrete. Amongst the different man-made building materials, concrete is the most commonly used. Since its inception it has been used extensively, especially in large scale builds such as buildings, bridges, roads and dams. Concrete is a composite material, meaning that its final form is a combination of an assortment of ingredients. Concrete consists mainly of four major ingredients; aggregates, sand, cement, and water. The aggregates are usually made up of different sizes of gravel and other rock granules. When mixed together in the appropriate proportions, these ingredients harden and dry over time forming a solid.

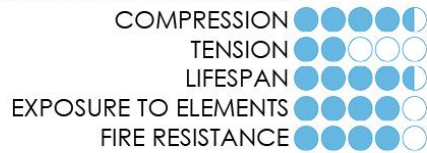


Figure 27: Double T Concrete
Source: Author

Concrete is a highly selected building material because it has a relatively long lifespan that includes very little maintenance. Before it hardens to its final form, concrete is very pliable, meaning it can be shaped and formed to just about anything

with the proper care and tools. Once it does harden the concrete is very strong in compression and it non-combustible. With its strengths in compression, concrete does have a relatively low tensile strength when compared to materials like wood and steel. The tensile strength of concrete can be increased with the inclusion of steel rods, wires, cables or mesh. It is also possible for concrete to experience cracking over times, some more severe than others. The physical characteristics, like the look and feel of concrete can be controlled. These characteristics are determined by the aggregate and cement used and by the water to cement ratio. This ratio also helps determine the strength of the concrete, meaning the less water usually results in stronger concrete. Concrete has a relatively high embodied energy as a result of the aggregate extraction, preparation, and transportation.²⁶

STRUCTURAL QUALITIES



THERMAL QUALITIES



AVAILABILITY



Figure 28: Concrete Matrix
Source: Author

²⁶ "Designing Buildings Wiki Share Your Construction Industry Knowledge
Www.designingbuildings.co.uk," Concrete - Designing Buildings, , accessed October 06, 2018,
<https://www.designingbuildings.co.uk/wiki/Concrete>.

Takeaway

Unlike the previous two material types, we in Hawaii do have companies that manufacture concrete. There are even some alternatives that use local basalt and coral as the aggregate in the concrete mixture, as opposed to imported sand from Canada and aggregate alternatives from Portland. This provides an opportunity for 3 of the 4 ingredients in a concrete mix to be found locally making concrete a very good candidate for design material. This locally sourced material will lower the embodied energy, the carbon footprint, and the overall cost of construction.

Chapter 5 | Grace Pacific Pre-Stress

Chapter 5: Grace Pacific Pre-Stress

John and Walter Grace founded Grace Brothers Ltd. in 1931 and since then they have grown to be Hawaii's largest asphalt paving contractor with operations on Oahu, Hawaii, Maui & Kauai. In 1984 The company expanded its product line to include the manufacturing of hot mix asphalt and the production of crushed basalt, limestone and sand aggregate. The plant is PCI certified to produce Precast and Prestressed structural products, Bridge components, and Architectural precast concrete. Their scope of work includes the design, manufacture, and delivery of multiple products, as well as planning assistance for the best possible use of their precast components. On October 4th 2018 I was able to go on a tour of their plant and facilities located in Kapolei Industrial.²⁷

5.1 Kapolei Plant Visit



Figure 29: Grace Pacific Plant Visit
Source: Author

²⁷ "GPRM Prestress," GPRM Prestress | Grace Pacific LLC, , accessed September 28, 2018, <https://www.gracepacific.com/subsidiaries/gprm-prestress>.

I was able to join a private tour that was being given to a local construction management company. We were given a presentation on the products and services that Grace Pacific provides as well as a guided tour of their plant and facilities.



Figure 30: Grace Pacific Plant Tour 1
Source: Author

The Kapolei plant serves as Grace Pacific's forming, casting, preparation, and storage hub for all of their state-wide projects.



Figure 31: Grace Pacific Plant Tour 2
Source: Author

We were able to see how their precast concrete components were made, showing us examples of steel molds and wooden molds used to form the concrete.



Figure 32: Precast Concrete in Steel Form
Source: Author



Figure 33: Precast Concrete in Wood Form
Source: Author

Grace Pacific generates precast concrete forms of all kinds to fit any given design circumstance. After the concrete dries, the product is removed from the mold and is stockpiled and recorded for each project. Amongst their more popular products is the 8" hollow core units that is used for walls and floors alike.



Figure 34: Precast 8" Hollow Core Units
Source: Author



Figure 35: Precast 8" Hollow Core Units 2
Source: Author

Along with the hollow core units, the stocked yard was filled precast double T concrete units that varied in size.



Figure 36: Large Precast Double T Unit
Source: Author

The Grace Pacific team had the precast concrete process down to a specific science, including how they transported these massive units around the yard. There were large cranes and pulley systems that would mobilize and prepare the units from transfer.



Figure 37: Large Crane and Pulley System
Source: Author

The Kapolei plant also acts as the storage facility for tons, actual tons, of aggregate. A large percentage of this aggregate come from local quarries here on Oahu, specifically the Makakilo quarry.



Figure 38: Aggregate Piles
Source: Author



Figure 39: Aggregate Piles 2
Source: Author

Among the aggregate piles there was 3/8" basalt gravel, fine basalt sand, and coral sand. All locally farmed ingredients used in some of their products. This limits the embodied energy of the extraction and transportation of the material that makes up concrete.



Figure 40: 3/8" Basalt Gravel Aggregate
Source: Author



Figure 41: Fine Basalt Sand Aggregate
Source: Author



Figure 42: Fine Coral Sand Aggregate
Source: Author



Figure 43: Fine Silica Sand Aggregate
Source: Author

Along with their strides in making an almost completely local concrete product, they have been trying to get their clients to use a basalt fiber rebar alternative to the typical steel rebar as reinforcement for the concrete. This basalt fiber rebar will function the same as the steel rebar would, without the chances of corrosion and will once again be another local product.



Figure 45: Basalt Fiber Rebar 1
Source: Author



Figure 44: Basalt Fiber Rebar 2
Source: Author

Takeaway

Having the opportunity to visit the Grace Pacific plant in Kapolei was an awesome experience and helped jump start my creative process, allowing me to channel my research I conducted into an initial design. After seeing how local this basalt concrete product can be, limiting both the carbon footprint and embodied energy of the product, I am shocked that more places around the island are not using it in their construction process. We were told by those giving the tour that the basalt concrete is just not desirable by clients because they fear change and do not want to stray from what they know. I am willing to stray with this product and use it to be the main building component in the single-family home design.

Chapter 6 | Creating a School of Thought

Chapter 6: Creating a School of Thought

After identifying what building materials to be used for the home design it is important to create a school of thought, and by that, I mean to conduct precedent studies. The purpose of this chapter is to use these precedent studies to understand how some of the great minds of architectural history have used the same or similar materials to build successful structures. We will also look briefly at the history of the architect and the history of the building itself, and thus develop a takeaway conclusion of elements that will help create a successful single-family home design for Hawaii.

6.1 I. M. Pei & Jefferson Hall

I. M. Pei, or Ieoh Ming Pei, was born on April 26, 1917. Pei made his way to the United States in 1935 where he enrolled at the University of Pennsylvania, eventually transferring and graduating from Massachusetts Institute of Technology in 1939. Due to the events of World War II, Pei was unable to return to China and began his architectural career in Boston. I. M. Pei's designs often act as an extension and elaboration of the

Figure 46: I.M. Pei
Source: Archinnet

rectangular form. He distinguishes himself amongst other great architects of the time through his bold arrangements of groups of geometric shapes and his use of high contrasting materials, spaces and surfaces. Pei has won numerous awards including the Pritzker Architecture Prize in 1983.²⁸

²⁸ The Editors of Encyclopaedia Britannica, "I.M. Pei," Encyclopædia Britannica, December 10, 2018, , accessed December 20, 2018, <https://www.britannica.com/biography/I-M-Pei>.

In early 1960 I.M. was selected to design the core of buildings for the University of Hawaii at Manoa's new expansion, The East-West Center. The East-West Center is an education and research organization that was developed to strengthen relations and understanding among the people of Asia, the Pacific, and the United States, which is exactly what Pei accomplished.²⁹ Jefferson Hall and the other buildings of The East-West Center combine aspects of traditional Japanese architecture with elements of modernism.³⁰ Pei and his team created an elegant design using the heaviest design material, concrete. In June of 2012, *Honolulu Magazine* and a panel of local architects wrote a piece, titled *Hawaii's Best Architecture*, and had this to say about Jefferson Hall and The East-West Center, "Not only are the buildings and Japanese garden beautiful, but so is the mission and what it has accomplished in its 50 years." Francis Oda of G70 International adds in the same article that "The huge overhangs of concrete on both structures took pre-cast, post-tension concrete to its limits at the time."³¹

Takeaway

With the East-West Center being here on campus at the University of Hawaii, I have had the opportunity to experience Jefferson Hall in person. It is a true marvel, even by today's standard of architecture. Its large concrete structure shows how resilient concrete can be in the Hawaii climate and sparks the thought of how it can be

²⁹ "West Center | [Www.eastwestcenter.org](http://www.eastwestcenter.org)," East, , accessed December 21, 2018, <https://www.eastwestcenter.org/>.

³⁰ "Concrete in Paradise: The East-West Center at the University of Hawaii," Concrete in Paradise: The East-West Center at the University of Hawaii, January 01, 1970, , accessed December 22, 2018, <http://modernistarchitecture.blogspot.com/2015/12/concrete-in-paradise-east-west-center.html>.

³¹ "Honolulu's Best Architecture," Honolulu Magazine, , accessed January 8, 2018, <http://www.honolulumagazine.com/Honolulu-Magazine/June-2012/Honolulus-Best-Architecture/>.

used at a smaller scale. It shows how successful pre-cast and pre-stress concrete members can be when used properly. I. M. Pei's use of rectangular elements to construct Jefferson Hall also show how simple geometry, when grouped correctly, function well not only as a clear and sound structure, but also look extremely beautiful.

Figure 47: Jefferson Hall, I.M. Pei
Source: Author

6.2 Vladimir Ossipoff & The Outrigger Canoe Club

Often referred to as the master of Hawaiian Architecture, Vladimir Ossipoff was born on November 25, 1907 in Vladivostok, Russia. Ossipoff was very well traveled by the time he landed in Hawaii. Spending most of his childhood in Tokyo, Japan with his military father, Vladimir emigrated to the United State in 1923.

Figure 48: Vladimir Ossipoff
Source: Build Blog

In 1931 Vladimir graduated from the University of California Berkley and found himself on his way to the Hawaiian Islands where he declared his "War on ugliness". The ugliness Ossipoff is referring to comes from the rapid and over-development of Honolulu that resulted in a large assortment of rushed architecture.³²

Figure 49: Original Outrigger Canoe Club (Early 1920's)
Source: History of Outrigger Canoe Club

³² Anya Ventura, "The Architect Who Brought Modernism to Hawaii's Tropical Landscape," Artsy, January 08, 2019, , accessed January 12, 2019, <https://www.artsy.net/article/artsy-editorial-architect-brought-tropical-modernism-hawaii>.

The original Outrigger Canoe Club was established long before Ossipoff's arrival to Hawaii. Its original all wood build on the acre of land in Waikiki fell victim to the elements, being attacked by the sea water, termites, and even fires. In the late 1930's Ossipoff was able to execute his war plans on one of the oldest builds on the Waikiki shoreline. Vladimir set out to design architecture in Hawaii that was environmentally sensitive, culturally contextualized and appropriate to the unique characteristics of the landscape with an emphasis on its light and microclimates. When it was completed in 1941, Ossipoff's new Outrigger Canoe Club utilized the surrounding environment by reinvigorating the traditional lanai space. He was also able to connect to Hawaii through his materiality choices and building materials. Within the exposed concrete structure, Ossipoff included natural aggregates from Hawaii, including pieces of coral rock and even basalt gravel, much like the products offered from Grace Pacific.³³



Figure 50: Outrigger Canoe Club Coral Column
Source: Author

³³ Digs, "Vladimir Ossipoff Changes the Hawaiian Landscape » Digs.net," Digs.net, July 31, 2018, , accessed January 12, 2019, <https://digs.net/vladimir-ossipoff-changes-the-hawaiian-landscape/>.

Takeaway

Almost 80 years after its completion, the Outrigger Canoe Club serves as one of the prime examples of why Vladimir Ossipoff is regarded as the master of Hawaii architecture. Much like Jefferson Hall, having the opportunity to experience the Canoe Club first hand allowed me to feel the goal that Ossipoff set out to accomplish. The open floorplan allows for constant airflow and open sites of the surrounding environment. The exposed concrete reveals the natural Hawaiian aggregates and how they have stood the test of time. The concrete walkways are lined with foliage and shows just beautifully the concrete, the natural elements compliment each other even if concrete is not considered a local material to the public. Lastly the use of wood as infill items, brings a sense of warmth while paying homage to the wood structures that the original Outrigger Canoe Club was built on.

6.3 Alejandro Aravena & Half a Good House

Along with selecting precedent studies from Hawaii's architectural past, there was a large inspiration that comes from modern architect, Alejandro Aravena and ELEMENTAL. Alejandro Gaston Aravena Mori was born on June 22, 1967 in Santiago, Chile. Not long after his graduation from Pontifical Catholic University of Chile in 1992, Aravena started Alejandro Aravena Architects. He then became a visiting professor at Harvard

Figure 51: Alejandro Aravena
Source: ELEMENTAL

Graduate School of Design from 2000 to 2005. In 2006 he became the executive director of ELEMENTAL.³⁴

The ELEMENTAL team, led by Alejandro Aravena, were commissioned to draw up a new master plan for Constitución, Chile, after it was devastated by an earthquake with a magnitude of 8.8 in 2010. This was the second largest earthquake in the world over the last 50 years, claiming the lives of over 500 people and destroying 80% of the buildings in the city. Within that master plan was the challenge to create affordable housing for the different economies of people. One of the areas, Villa Verde, was designed as an entire area populated by two-story half houses. Half of the houses are identical, and the other halves are completely unique.³⁵

³⁴ "Biography: Ale-jan-dro Ara-ve-na," The Pritzker Architecture Prize, , accessed July 20, 2018, <https://www.pritzkerprize.com/biography-ale-jan-dro-ara-ve-na>.

³⁵ Alejandro Aravena, *Elemental* (Berlin: Phaidon, 2018).

Figure 52: Half Good House
Source: ELEMENTAL

The first floor of the finished half is made up of unfinished concrete floors, and the second is covered in unfinished plywood. The amenities are simple, for example there is only one sink in the kitchen, with no other appliances, making the homes cheaper and more practical than luxurious. The infrastructure that families would have a difficult time building and paying for alone, such as concrete foundations, plumbing, and electricity, has been installed and primed for them with the assistance of the Chilean government. The residents would just have to provide their time, labor and any extra materials that would be used to create the other half of their home if and when the time had come. Every half home comes with a manual explaining possible ways to expand using standard building materials, avoiding the need for anyone to buy expensive custom resources. The residents were also given the opportunity to take part in building workshops facilitated by ELEMENTAL. This entire concept comes from Aravena and the team at ELEMENTAL who try and reinforce the idea that one small house can equal half a good house. Aravena says "If the money can only pay for around forty square meters, instead of thinking of that size as a small house, why

don't we consider it as half of a good one?"³⁶ The architectural community has recognized Alejandro for his successful work with the half good home concept, by honoring him with the Pritzker Prize in 2016.

Takeaway

Researching ELEMENTAL's methodology behind the solution to the lack of social housing in the wake of the 2010 hurricane in Chile, I believe that this can also be applied to the issue of housing in Hawaii. My generation that currently live with their family are facing the dilemma of taking their first steps into homeownership in the number one ranking state for highest real estate costs resulting in home extensions being the common alternative. The home extension alternative is still a very expensive due to the heavy retrofitting that is needed to be done to the original single-family home. With the half good home idea in mind, I propose that we design these single-family homes with a growing home already planned. Using local materials and local companies, we are able to design a single-family home with the appropriate infrastructure to support and encourage growth over time.



Figure 53: Half Good House Diagram
Source: Author

³⁶ Alejandro Aravena, *Elemental* (Berlin: Phaidon, 2018).

Chapter 7 | Les Kempers & The Return to Grace Pacific

Chapter 7: Les Kempers & The Return to Grace Pacific

After making a selection of the main type of building material I wanted to use to construct a new single-family home and creating a school of thought based on great architect methodologies of the past it was time to start coming up with some initial concept designs. I had scheduled a meeting with Les Kempers, the Vice President of Grace Pacific Prestress and I wanted to have some form of a design documentation so that we could discuss how their basalt concrete product could help bring that design to life.



Figure 54: Meeting with Les Kempers
Source: Author

7.1 Concept Design

The following images and diagrams are the combination of conclusions gathered from creating a school of thought. There are elements pulled from all three of the precedents that I selected. Creating this starting point allowed me to communicate my ideas with Les in an effective manner thus allowing valuable progress to take place.

This exploded axonometric shows the first basic concept of the breathing growing single-family home. It highlights the main concrete structure, a wooden louver infill, a central core, and room for growth. These are the four main elements that would guide the design throughout the entirety of the project. These are the documents that Les Kempers and I went over to discuss what structural solutions the basalt concrete product could provide.

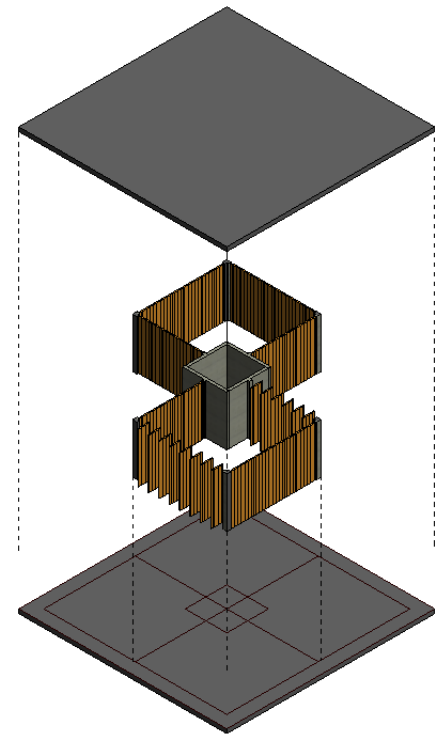


Figure 55: Conceptual Axon
Source: Author

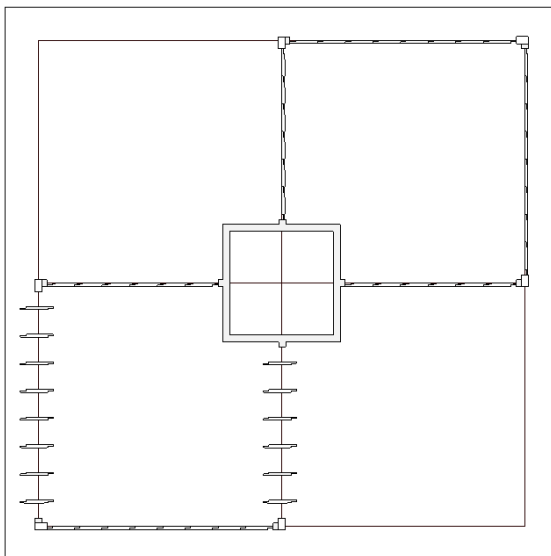


Figure 56: Concept Floor Plan & 3D Line Work
Source: Author

Simple renderings were also very helpful in our discussion.



Figure 57: Concept Render 1
Source: Author



Figure 58: Concept Render 2
Source: Author

7.2 Structural Studies

At the end of the meeting with Les Kempers, we had four different structures that would help achieve the four main goals of our single-family home design. We spoke for hours, sketching over the drawings I had brought in.

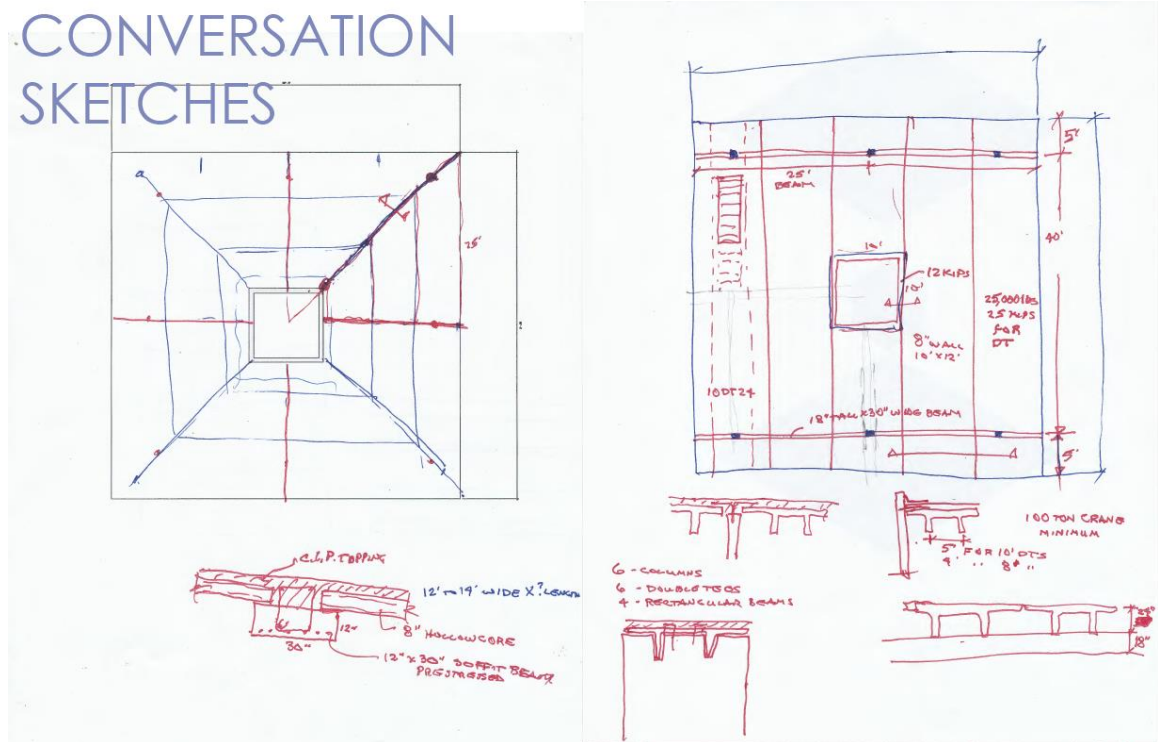


Figure 59: Structural Sketches
Source: Author

With these sketches and the conversations had with Mr. Kempers, I built four tectonic study models to observe which structure will best fit the needs and goals of the breathing growing home.

7.3 Model Talk



Figure 60: Tectonic Model 1
Source: Author



Figure 61: Tectonic Model 2
Source: Author



Figure 62: Tectonic Model 3
Source: Author



Figure 63: Tectonic Model 4
Source: Author

Chapter 8 Working Within the System: DHHL Kanehili, Kapolei

Chapter 8: Working Within the System: DHHL Kanehili, Kapolei

After learning from the tectonic models and pushing the single-family home design forward, it was time to ground our thoughts within a site. Learning from the mistakes of the past, especially with the displacement of the working population in Honolulu, we hope to develop this home for the future of Oahu. Kapolei is to be one of the largest up and coming cities in Hawaii, creating new job opportunities.³⁷ We want to ensure that amongst this new development there are homes developed for the people that work there. For this single-family home, I propose improvements to an existing Department of Hawaiian Home Lands development plan located in Kapolei. Before diving into the site, it is important to understand the history of the Department of Hawaiian Homelands and how it came to be.

Figure 64: Department of Hawaiian Home Lands
Source: Department of Hawaiian Home Lands

8.1 The Hawaiian Homes Commission Act of 1921

Amongst the aftermath of the 1893 overthrow of the Hawaiian Kingdom and Queen Liliuokalani, the idea for Hawaiian Homelands was first spoken into existence. In his testimony before Congress regarding the future of the Hawaiian Islands on January 3, 1894, William Alexander reported, "President Dole and his colleagues have elaborated a plan for giving the Kanakas (Native Hawaiians) homesteads out of the Crown lands, not transferable, and further this condition of occupation"³⁸ When it was finally written and passed by the U.S. Congress on July 9, 1921, The Hawaiian Homes

³⁷ "Kapolei," Long Range Master Plan - The City of Kapolei, , accessed January 28, 2019, <http://kapolei.com/pages/long-range-master-plan>.

³⁸"Hawaiian Homelands," October 23, 2013, , accessed January 07, 2019, Reports of Committee on Foreign Relations. Volume 6. 1789–1901. p. 672.

Commission Act set aside over 200,000 acres of land in the then Territory of Hawaii as a land trust for homesteading for Native Hawaiians. The act set out with the purpose of enabling native Hawaiians to return to their lands in order to fully support self-sufficiency for native Hawaiians and the self-determination of native Hawaiians in the administration of this Act, and the preservation of the values, traditions, and culture of native Hawaiians. The Hawaiian Homes Commission Act defined "Native Hawaiians" as people with 50% or more Hawaiian blood.³⁹ The Hawaiian Homes Commission were the primary agency responsible for administering and monitoring the trust until 1960. After officially becoming the 50th state in 1959, these responsibilities were developed into a state agency as opposed to the federal one it had belonged to since 1921. This state agency would be named the Department of Hawaiian Home Lands and are still responsible for all aspect of the Hawaiian Homelands to this day.⁴⁰

Figure 65: Lands Owned by the Department of Hawaiian Home Lands
Source: Department of Hawaiian Home Lands

³⁹ "About," NextGEN Gallery RSS, , accessed January 22, 2019, <http://dhhl.hawaii.gov/about/>.

⁴⁰ *ibid*

8.2 Department of Hawaiian Home Lands Strategic Goals & Values

The following section includes the most recent strategic goals and objectives of the Department of Hawaiian Home Lands as stated on their website.

Value Statement

To ensure the Hawaiian Home Lands Trust is on a solid foundation with sound policies and procedures, a long-term sustainable financial plan, a commitment to serving beneficiaries, and an organizational culture that honors the spirit of its founder, Prince Jonah Kūhiō Kalanianaʻole. With the foundation firmly rooted, administrations going forward will be prepared to work side-by-side with beneficiaries and other partners to create and maintain vibrant homestead communities.

ASSERT: REAFFIRM & ASSERT TRUST STATUS

Objective 1: Determine & commit to meeting the Trust Kuleana

Objective 2: Protect the Trust

Objective 3: Advance the Hawaiian Homes Commission Act

The mission of the Hawaiian Home Lands Trust is implemented by a state department, the Department of Hawaiian Home Lands. The Hawaiian Homes commission Act provides clear roles and responsibilities to implement the act, while our state administrative rules provides for implementation. The difference and the roles of each kuleana must be articulated.⁴¹

⁴¹ Department of Hawaiian Homelands, Strategic Goals & Objectives, PDF, Honolulu Hawaii: Department of Hawaiian Homelands, 2016.

PROTECT: ENSURING THE FINANCIAL WELL-BEING OF THE TRUST

Objective 1: Improve Efficiency and Effectiveness Of Internal Operations.

Objective 2: Create Synergistic Partnerships and Alliances

Objective 3: Diversify and Increase Revenue Streams

The trust has a finite amount of land and resources. Not only is the trust expected to provide “new” homesteads for 40,000 waitlist applications, it must continue to serve the existing 10,000 lessees by way of repair and maintenance of utilities, traffic, roads, water, wastewater, health and safety requirements. The trust must also use its lands to generate revenue to financially support the trust’s work of serving beneficiaries. Current economic times must be considered in the development of new strategies that produce optimal performance of the trust. Developing partnerships and alliances that provide mutual benefit will enhance the opportunities for success. The trust must also consider alternative revenue streams that will help to meet the ever-growing waitlist.⁴²

SERVE: PROVIDE EXCELLENT CUSTOMER SERVICE

Objective 1: Increase Communication and Access to Information

Objective 2: Develop Transparent Policies, Procedures and Practice

Objective 3: Provide Professional Development Opportunities and Support for All Staff Members.

During both the beneficiary and staff retreats, opinions centered on the trust’s ability to provide for and support beneficiaries and employees. One comment in particular came from the staff retreat: “Good customer service benefits both beneficiaries and employees/DHHL.” Both groups also expressed the desire for consistent and clear policies – procedures and practices that would withstand the

⁴² Department of Hawaiian Homelands, Strategic Goals & Objectives, PDF, Honolulu Hawaii: Department of Hawaiian Homelands, 2016.

changing of new administration over time. Through the objective above, the trust will focus on laying the foundation for consistency, providing communication and creating methods for beneficiaries, staff and the broader public to access information. Further, the goals will provide for staff professional development support which leads to strong customer service and high performance while incorporating our Hawaiian values and understandings.⁴³

DELIVER: DELIVER DIVERSE HOMEASTEDING OPPORTUNITIES

Objective 1: Expand the Variety of Residential Homesteading Opportunities

Objective 2: Implement Agricultural Homesteading Opportunities

Objective 3: Implement Pastoral Homesteading Opportunities

Objective 4: Implement Aquaculture Homesteading Opportunities

Objective 5: Seek Alternative Financing for Homesteading Opportunities

The trust has mainly focused on single-family homes over its lifetime. Driven by the economic times and the needs of beneficiaries and applicants, the trust must seek to expand the breadth and depth of its homesteading opportunities overall. The trust has over 40,000 applications for families waiting to be returned to the 'āina. Expanding residential homesteading opportunities into areas such as Kauhale, multi-family homes, rental and transitional units will provide relief to applicants who continue to wait for a home to meet their needs. The trust will strive to implement agricultural, pastoral, and aqua cultural homesteading opportunities to fit today's family. Considerations will be given to cluster-lots, community use lots and rural homesteading. To support these objectives, the department must step out of the box to create alternative financing models to service these beneficiaries.⁴⁴

⁴³ Department of Hawaiian Homelands, Strategic Goals & Objectives, PDF, Honolulu Hawaii: Department of Hawaiian Homelands, 2016.

⁴⁴ *ibid*

8.3 Department of Hawaiian Home Lands: East Kapolei Development

After gaining an understanding of the Department of Hawaiian Home Lands history and their core values, it was determined that this would be an appropriate system to ground the single-family home design within. It was then time to consider the what specific developments within the DHHL roster would be most appropriate for our overall design methodology. Combining the conclusions drawn from our research of the history of development in Honolulu with the acreage owned by DHHL, it was determined that the development plan for East Kapolei would be the most appropriate site.

Figure 66: Kanehili Location Map
Source: Department of Hawaiian Home Lands

8.4 Kanehili, East Kapolei, Oahu

It was time to dive deeper into what specific site amongst the East Kapolei developments that we would be proposing our single-family homes to be constructed on. Kanehili is a 92-acre parcel located in East Kapolei, on the Ewa Plains, adjacent to the University of Hawaii – West Oahu Campus. Surrounding this location is the existing

Kapolei Golf Course, schools, shops, health care facilities, public transportation, and recreational facilities. Construction and site preparations began for Kanehili in early 2009, with the homes being released to owners in early 2011. The minimum size of each lot is 5,000 sq. ft., consistent with DHHL's typical lot layout of 50' x 100'. On each of these lots stood one of the five different styles of single-family homes developed by Gentry Kapolei Development, LLC. Because of the special grants given by the DHHL, the turnkey single-family homes were sold its native Hawaiian beneficiaries at prices ranging from \$227,300 to \$300,000.⁴⁵ The current value of these same homes have doubled since their original turnkey sale price, sitting currently at \$600,000. Even though this price sits lower than the states median price of \$810,000, it still boasts a scary situation for my generation. Before redesigning the new single-family homes, it is important to understand what is happening at the site.

Figure 67: Kanehili Render
Source: Department of Hawaiian Home Lands

Climate & Physical Characteristics

The average temperatures throughout Kanehili range from 65 to 84 degrees over the year and as noted falls just outside of the dry western area of Oahu. Eastern Kapolei also experiences about 20 inches of rainfall per year as it is not very high up on the mountains sitting at 50 to 80 feet above sea level with a slope less than 2 percent. Some portions of Kanehili are located just outside a 500-year-old flood plain

⁴⁵ "WELCOME NEW KĀNEHILI HOMESTEADERS!" NextGEN Gallery RSS, , accessed February 03, 2019, <http://dhhl.hawaii.gov/icro/ka-nu-hou/ka-nuhou-2012/kauwela/new-kanehili-homesteaders/>.

but has not been affected since its development, especially with additional site grading and drainage facilities that provide appropriate and adequate water disposal. This also includes adequate infrastructure for sewer and waste provided by Honouliuli Waste Water Treatment Plant.⁴⁶

Figure 68: Kanehili Under Development
Source: Department of Hawaiian Home Lands

Community Amenities

It is also important to understand the surround community elements that come with our site, as they are all important for a functioning communal system. There are ample amounts of emergency services within the surround Kapolei area including the Honolulu Police Department: District 8 Kapolei Regional Police Station. There are also three fire stations including Kapolei Fire Station, Makakilo Fire Station, and the Ewa

⁴⁶ Department of Hawaiian Homelands. Kanehili, East Kapolei, Vacant Lots. PDF. Honolulu Hawaii: Department of Hawaiian Homelands.

Beach Fire Station, with an East Kapolei Department to be opened soon. There is also St. Francis Medical Center, Pali Momi Medical Center, and Kaiser Permanente Punawai Clinic. There are six surrounding public schools including Kapolei Elementary, Middle, and Highschool. With East Kapolei on the rise of becoming a major city on Oahu, there are already large economic drivers that have been completed in the last couple of years.⁴⁷ In 2015 Phase one of the 1.4 million sq. ft. regional mall, Ka Makana Alii, was completed and features more than 100 retail stores, restaurants, a Consolidated Theatres and the state's first Hampton Inn & Suites on property. This also presents opportunities for a larger labor force in East Kapolei that can be fulfilled by those who live there, reinforcing the work where you live mentality. In addition, through a partnership between DeBartolo Development and the Department of Hawaiian Home Lands, Ka Makana Alii will financially support programs benefiting Native Hawaiian interests statewide for decades to come.⁴⁸

Figure 69: Future of Ka Makana Alii
Source: Department of Hawaiian Home Lands

⁴⁷ ibid

⁴⁸ "About About Us The Royal Gift Developer FAQ," Ka Makana Ali'i ::: Kapolei ::: HI, , accessed February 16, 2019, <https://www.kamakanaalii.com/news/about-us/2129998235/>.

8.5 Current Site Layout of Kanehili

The following diagrams were created by the Department of Hawaiian Home Lands for the potential home owners to see the availability of the homes and their layouts on the site.

Figure 70: Kanehili Site Layout
Source: Department of Hawaiian Home Lands

Figure 71: Kanehili Site - Street View
Source: Department of Hawaiian Home Lands

8.6 Ilima: A Case Study of the Current Kanehili Single-Family Homes

Acting as one of the five models available in the Kanehili development, the Ilima Model sits as the median design. This model includes 1200 sq. ft. of living area, with a 480 sq. ft. attached garage and an option for an extra 300 sq. ft. family room or covered lanai. The homes are single story, consisting of, three bedrooms, two bathrooms. The homes utilize the same design methodology as most of the DHHL single-family homes, with the bedrooms connecting to a small central living space through hallways which segregate social interactions to one space. When looking at the Ilima in comparison with other homes in the DHHL roster throughout the Hawaiian Islands, there is little to no difference between their architectural design. If you took this home design and placed it amongst another DHHL development, you would not be able to tell the difference. Most of the DHHL, single family homes throughout the state are designed in the same neo-plantation style. The best way to explain this anomaly is with the infamous quote from Bert Lance, "If it ain't broke, don't fix it." This meaning that the DHHL has nearly perfected their production and construction methods with these homes, and its consistency has resulted in the homes being cheaper and easier to build each time.⁴⁹

The Ilima home along with all the Department of Hawaiian Home Lands single-family home construction follow the same building methodology. Starting with the cast in place concrete slab on grade.

On top of the concrete slab sit the standard American dimensional lumber for the walls covered in gypsum drywall sheets and finished paint. The roof construction consists of lumber trusses that build up a low slope hip style roof with asphalt shingling on the exterior roof.

⁴⁹ http://dhhl.hawaii.gov/wp-content/uploads/2011/06/Kanehili-Plan2-1_111408.pdf

The exterior siding is meant to give off the neo-plantation style, with board and batten T1-11. The DHHL homes also include vinyl windows and doors typical in the standard American home. The interior materials include manufactured and composite flooring, cabinets and countertops.⁵⁰

Figure 72: Ilima Model Floor Plan
Source: Department of Hawaiian Home Lands

⁵⁰ *ibid*

Figure 73: Ilima Model Render
Source: Department of Hawaiian Home Lands

Takeaway

With the exception of the concrete, all of the materials used in the construction of the DHHL single-family homes are imported from outside of the Hawaiian Islands. Even the concrete contains imported additives and uses imported steel for reinforcement. The foreign materials just add to the overall cost of construction, they also increase the duration of the construction process due to the waiting periods of each ordered material. It is apparent that each single-family home design does not take the site into account, with its ability to be put anywhere in Hawaii or even the larger continental U.S.. With all of the research of the history of home making in Hawaii and the material studies conducted it is important to understand how we can use more local materials to construct these single-family homes. We must also learn how to make better use of the unique climate that Hawaii is offering.

Chapter 9 | Research Application: A Growing Breathing Home

Chapter 9: Research Application: A Growing Breathing Home

9.1 Structure

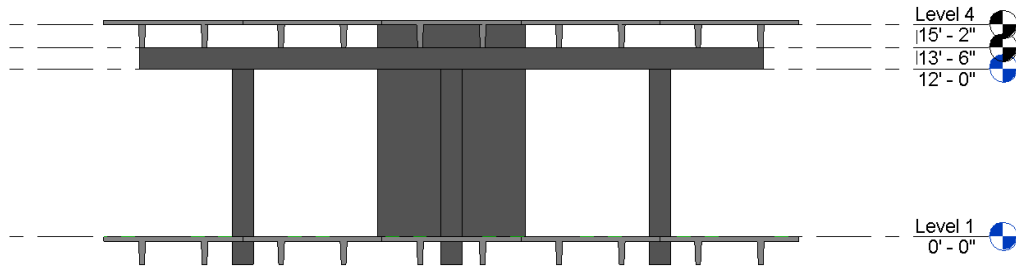


Figure 74: Basalt Concrete Structure Model Elevation (North & South)
Source: Author

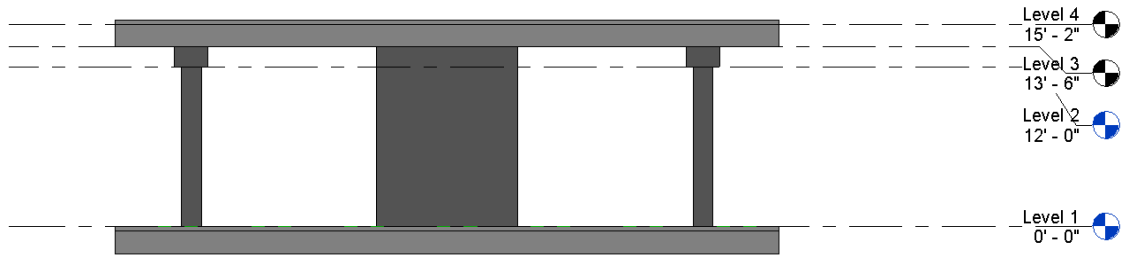


Figure 75: Basalt Concrete Structure Model Elevation (North & South)
Source: Author

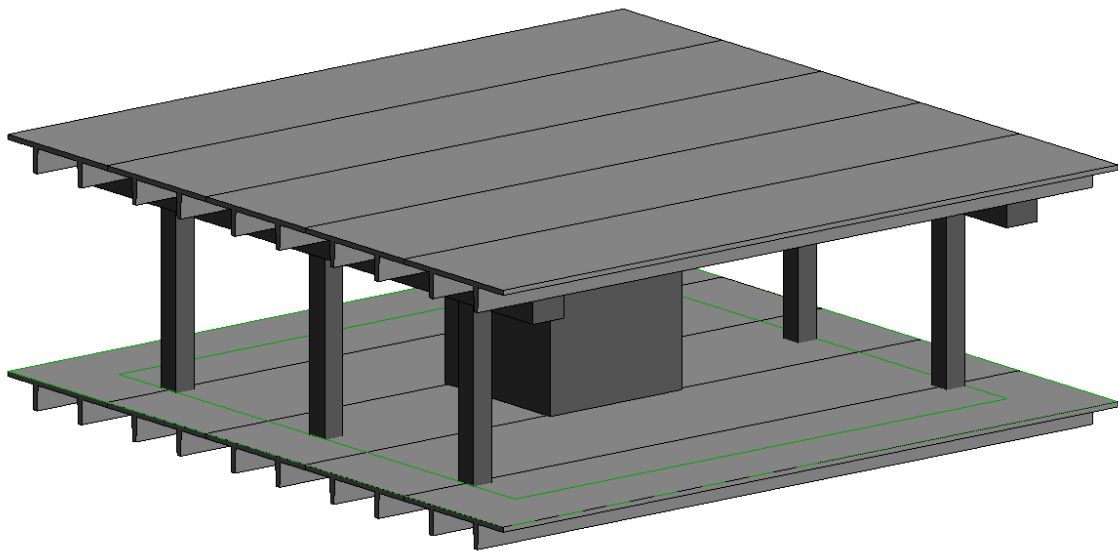


Figure 76: Basalt Concrete Structure Model 3D
Source: Author

STRUCTURE TYPE	MEASURMENT TYPE	COST PER	TOTAL MEASURMENT	COST
Double T Members	cost per square foot	\$16	5,000 sq. ft.	\$80,000
8" Hollow Core Units	cost per square foot	\$10	480 sq. ft.	\$4,800
18" x 36" Beams	cost per linear foot	\$200	96 linear ft.	\$19,600
18" x 18" Pillars	cost per linear foot	\$150	120 linear ft.	\$18,000
			Total Cost =	\$122,400
			*erection costs 20% of total =	\$24,480
			Grand Total =	\$146,880

Figure 77: Basalt Concrete Cost Estimate
Source: Author

9.2 Eucalyptus Degulpta & The Wooden Louvers



Figure 78: 3D Single Eucalyptus Louver
Source: Author

In the search of more locally found building materials, there are two types of wood that is always the topic of discussion, albizzia and eucalyptus. For the surrounding exterior walls, we will be designing a series of large vertical louvers that rotates on its center axis, acting as an air passage system, but also acting as a way to access the single-family home. These louvers will be crafted from the abundant eucalyptus wood found here on the islands. These louvers are non-structural within the single-family home, so the strength of the eucalyptus will not be a large issue. The eucalyptus degulpta or

rainbow gum tree as it is more commonly known, can grow anywhere from six to twelve feet per year when grown properly. This growth also occurs in a rather straight line, making it easy for fabrication. When at its full growth, the eucalyptus tree can grow up to six feet in diameter and over 200 feet tall. This fast and effective growing tree is abundant in the Hawaiian Islands and just because they are not the best for structural building does not mean their use is nonexistent.

Figure 79: Eucalyptus Degulpta in Hawaii
Source: Hawaii Travel Guide

The following diagrams display the two-tiered vertical louvers in multiple situations, ranging from all closed to all open. It also show cases the core of the home that acts as the bathroom area as well as a suitable storm shelter for the home.

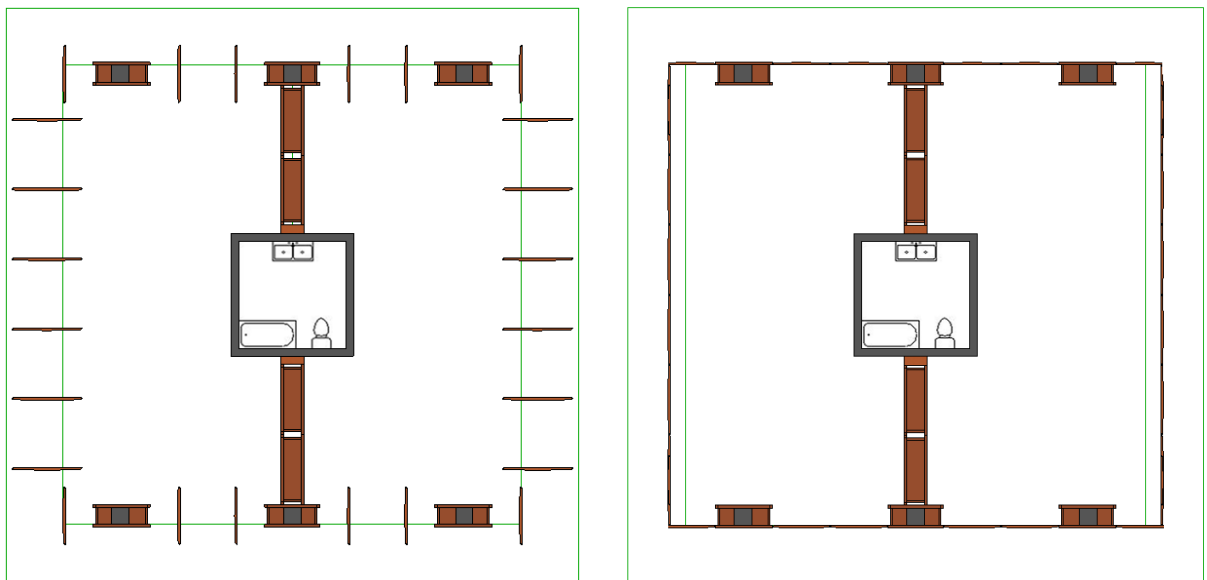


Figure 80: Floor Plan Louvers Closed & Open
Source: Author

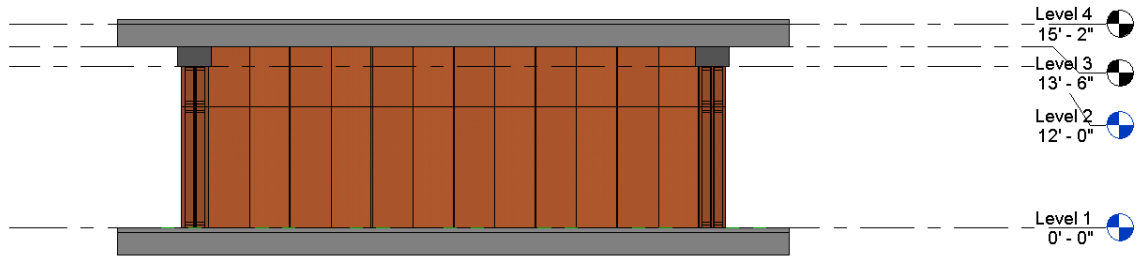


Figure 81: All Closed Exterior Elevation East & West
Source: Author

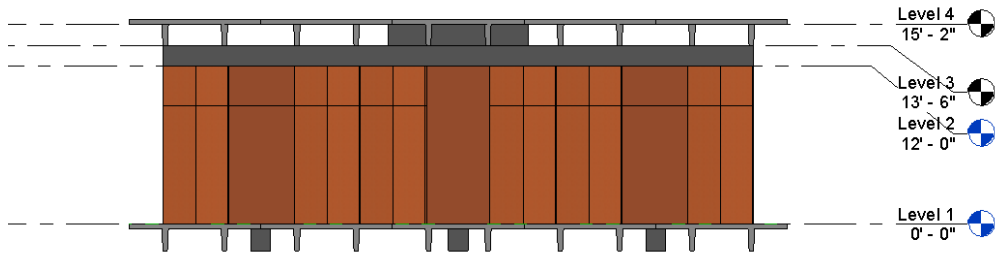


Figure 82: All Closed Exterior Elevation North & South
Source: Author

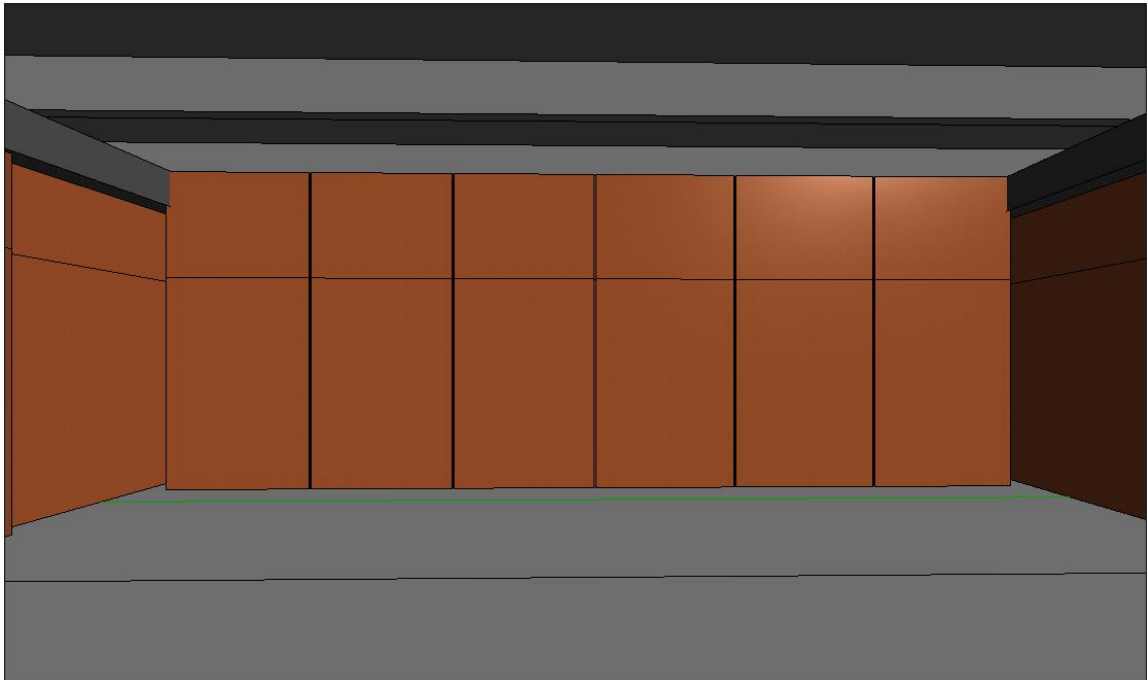


Figure 83: All Closed Interior Elevation
Source: Author

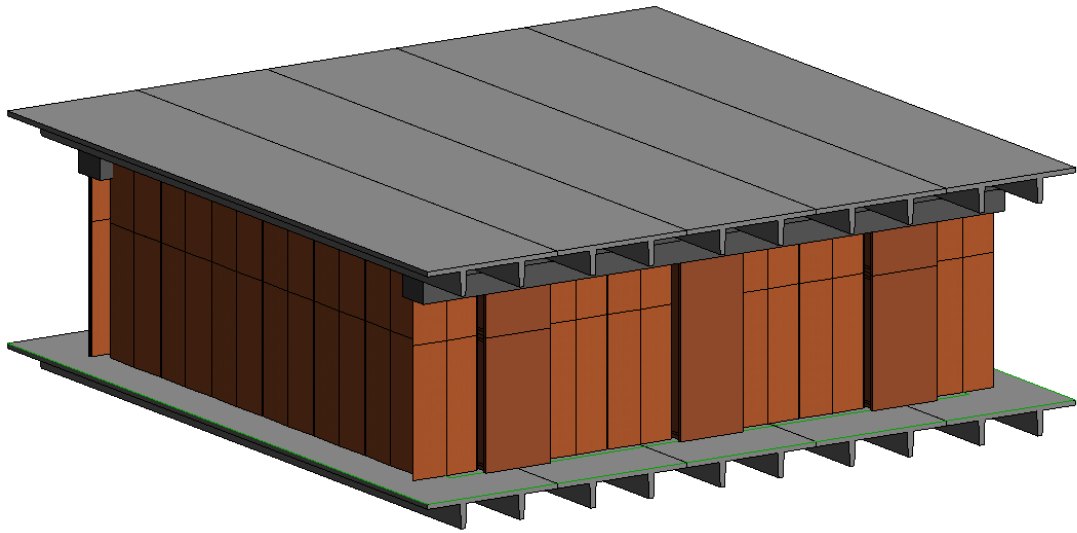


Figure 84: All Closed 3D View
Source: Author

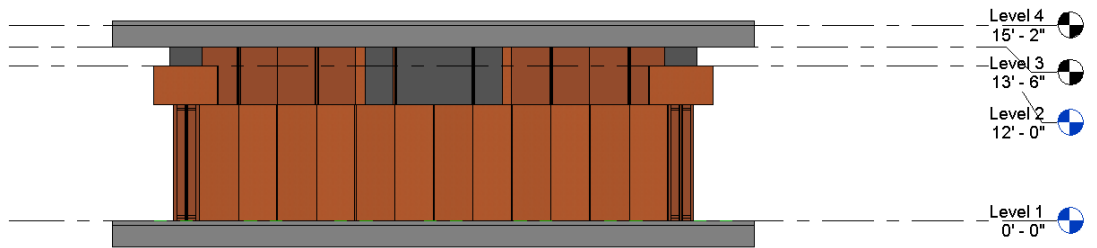


Figure 85: Tops Open Exterior Elevation East & West
Source: Author

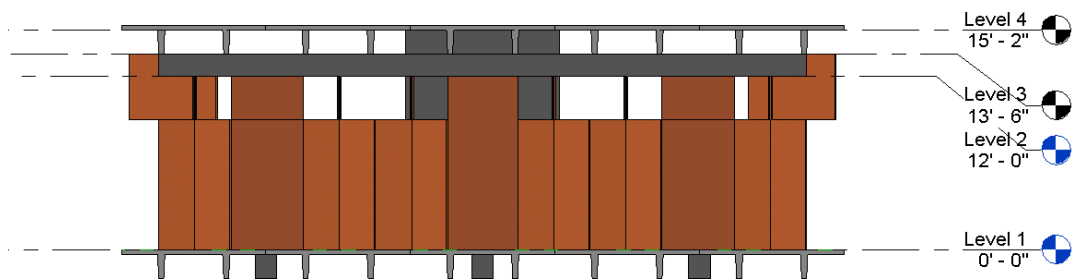


Figure 86: Tops Open Exterior Elevation North & South
Source: Author

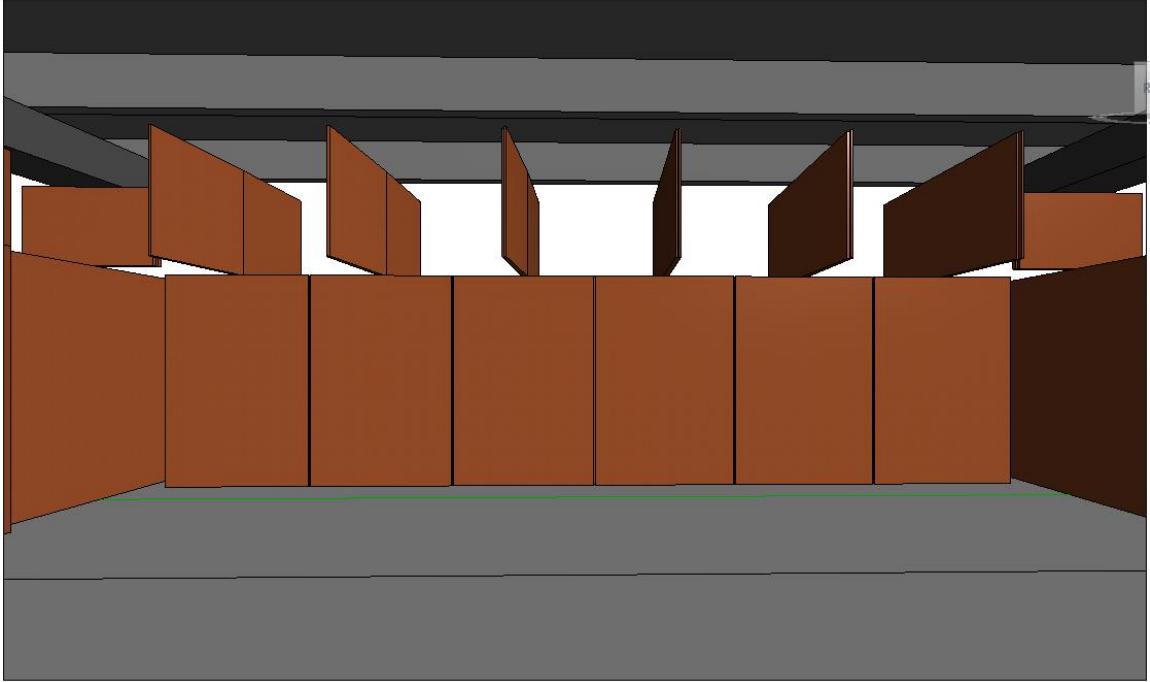


Figure 87: Tops Open Interior Elevation
Source: Author

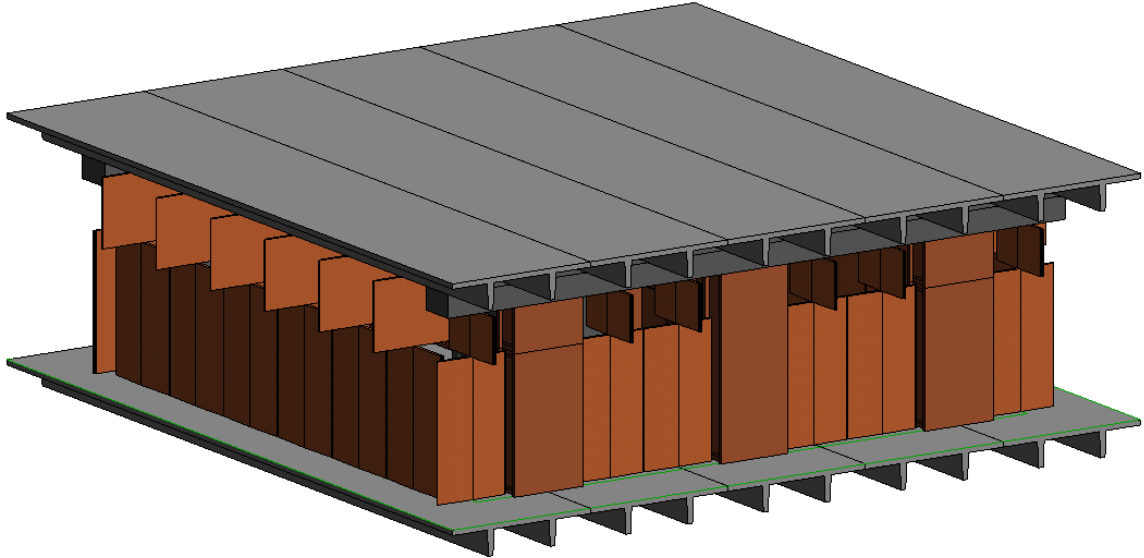


Figure 88: Tops Open 3D View
Source: Author

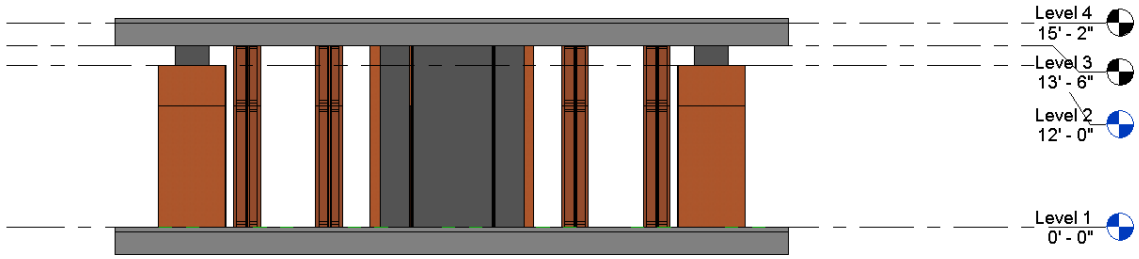


Figure 89: All Open Exterior Elevation East & West
Source: Author

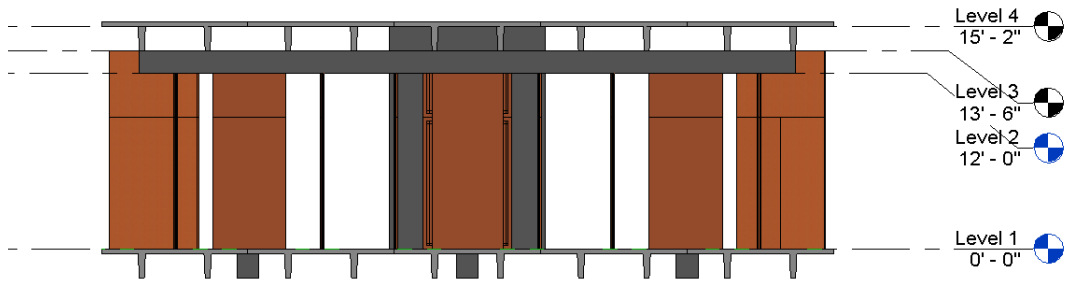


Figure 90: All Open Exterior Elevation North & South
Source: Author

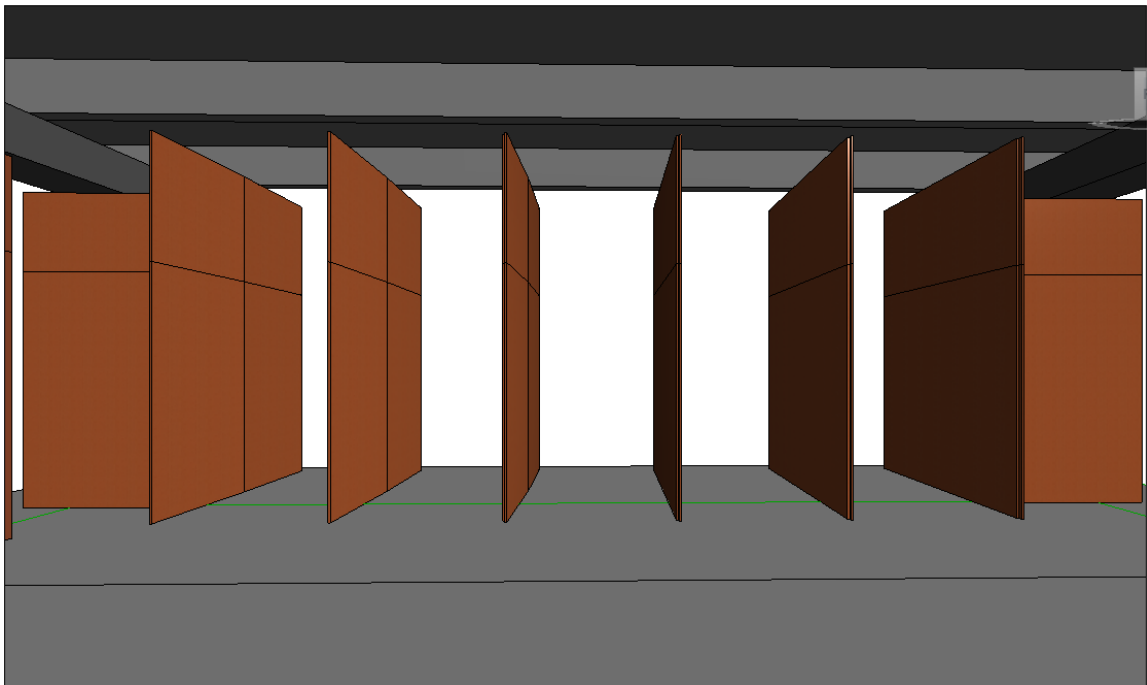


Figure 91: All Open Interior Elevation
Source: Author

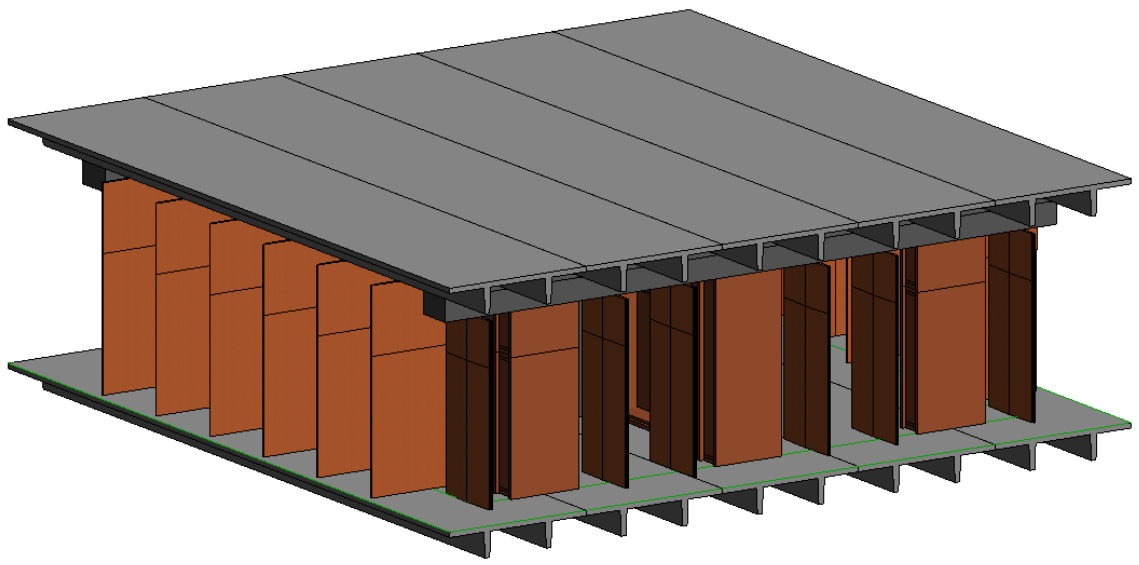


Figure 92: All Open 3D View
Source: Author

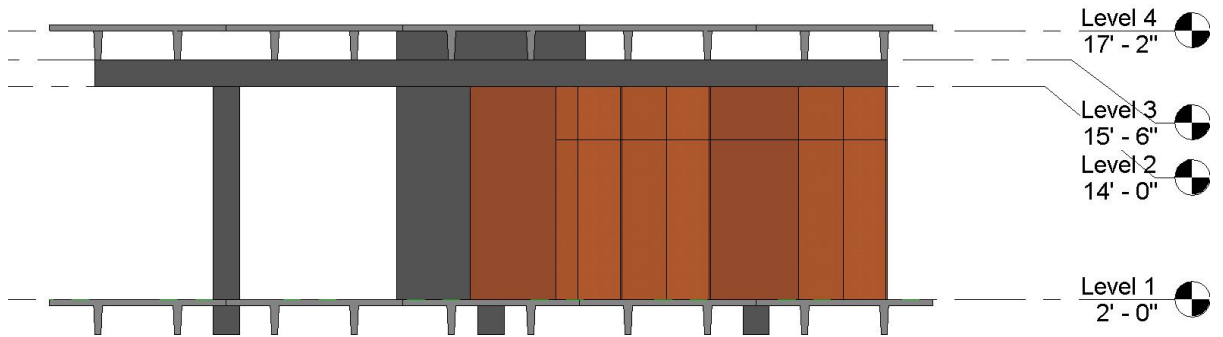


Figure 93: Half Build South
Source: Author

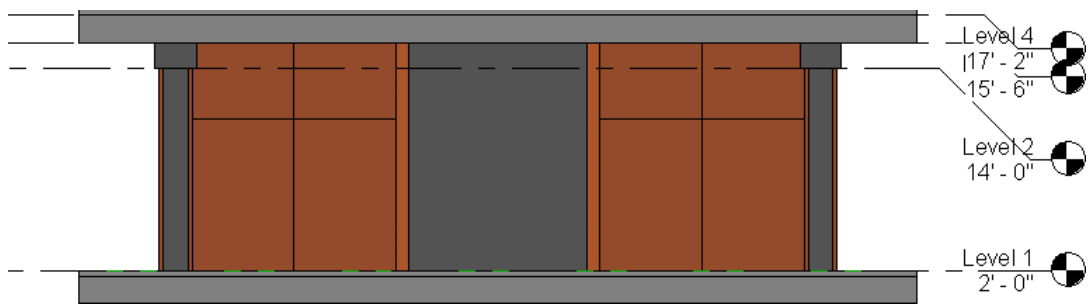


Figure 94: Half Build West
Source: Author

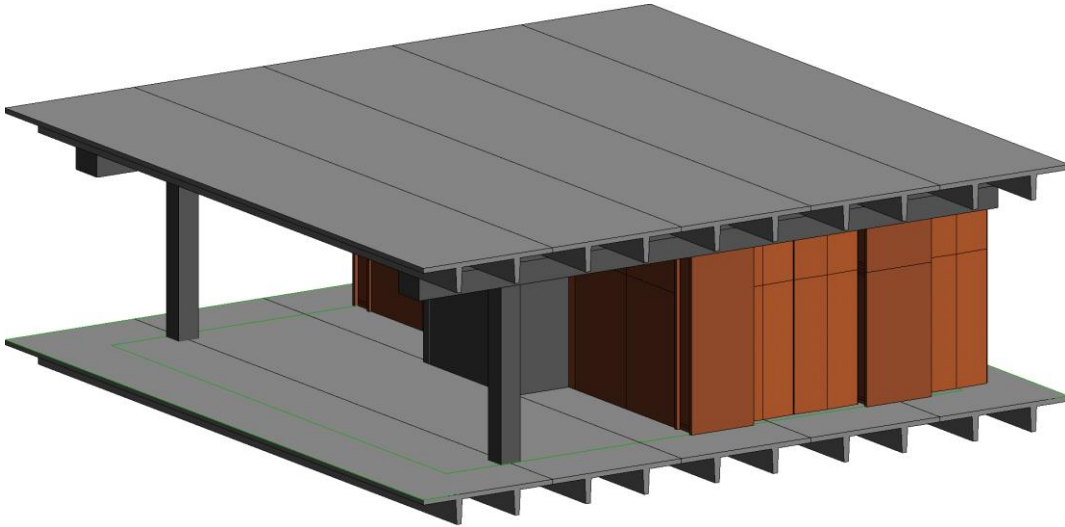


Figure 95: Half Build 3D
Source: Author

9.3 Site Improvements to Kanehili

Along with creating a new single-family home for east Kapolei and Kanehili, there are a few improvements that can be made to the site as a whole that will make the community and the neighborhood a greener and more energy efficient place to live in.

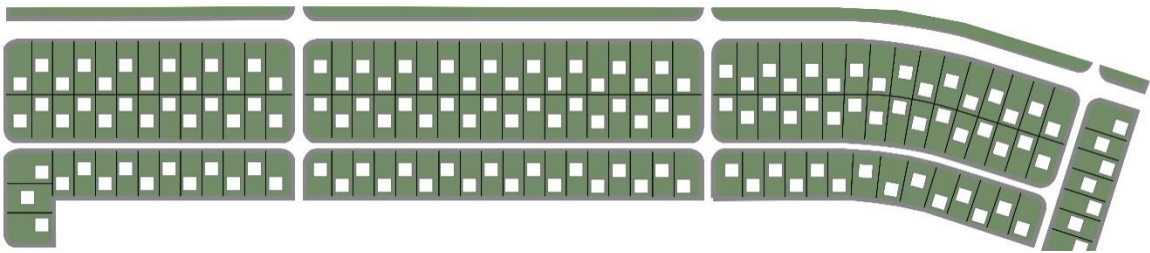


Figure 96: Single-family Home Site Layout 1
Source: Author

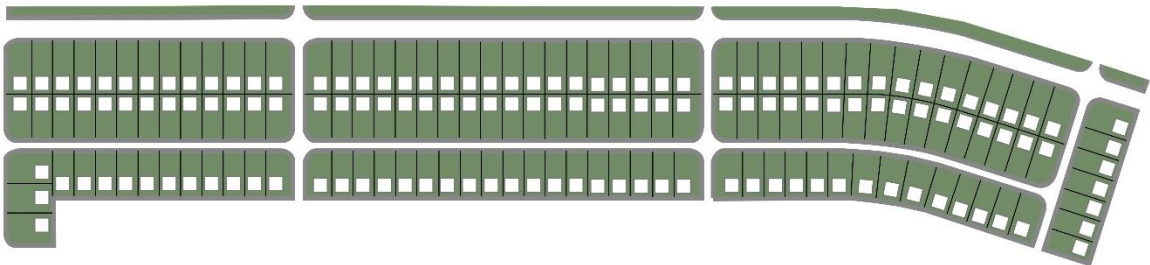


Figure 97: Single-family Home Site Layout 2
Source: Author

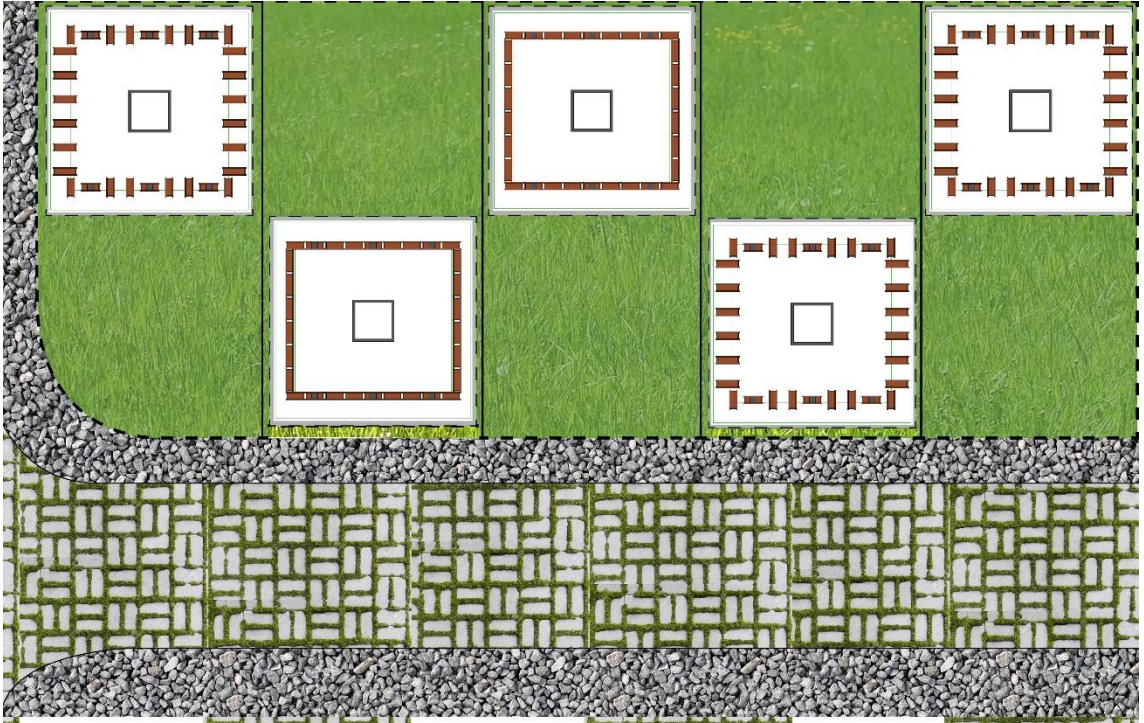


Figure 98: Single-family Home Site Layout 1 Zoom
Source: Author

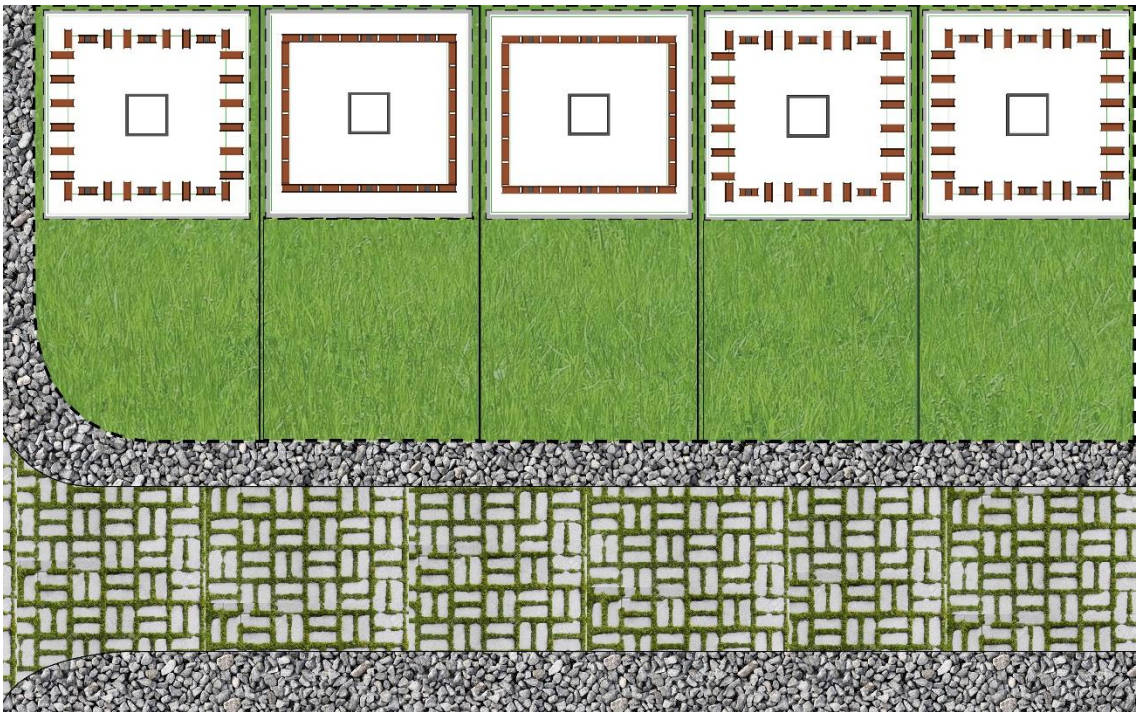


Figure 99: Single-family Home Site Layout 2 Zoom
Source: Author

9.4 Final Renders



Figure 100: Render 1
Source: Author



Figure 101: Render 2
Source: Author



Figure 102: Render 3
Source: Author



Figure 103: Render 4
Source: Author



Figure 104:Render 5
Source: Author

Chapter 10 | Conclusions

Chapter 10: Conclusions

With Hawaii ranking number one for the highest real estate costs in the United States my generation faces a dilemma when thinking about our first steps into home ownership. After investigating the current real estate issues in Hawaii and understanding the history of home making in Hawaii, we concluded that Hawaii's isolation, limited space, and constant influx of people are the driving force of the rising real estate costs. Hawaii's limited local resources also result in the islands dependence on importing building materials ranging from lumber to steel and everything in between.

To combat the massive carbon footprint brought on by the import of building materials we have determined that using a local building material would be best. After investigating what local materials are available in the islands, it was concluded that Grace Pacific's basalt concrete would be the primary building material in the design of the single-family home. After multiple meetings and studies of the basalt concrete, a structure was developed that would reinforce our design goals. This design is responsive to Hawaii's unique climate and encourages growth over time.

In order to ground the project into reality, we researched and proposed improvements to an existing Department of Hawaiian Home Lands development plan located in Kapolei.

This dissertation concludes in the design of a new single-family home that is constructed using local materials, and is developed by local companies., therefore sustaining the local economy and decreasing reliance on imported building materials. This breathing home supports and encourages growth for my generation and the generations to follow.

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