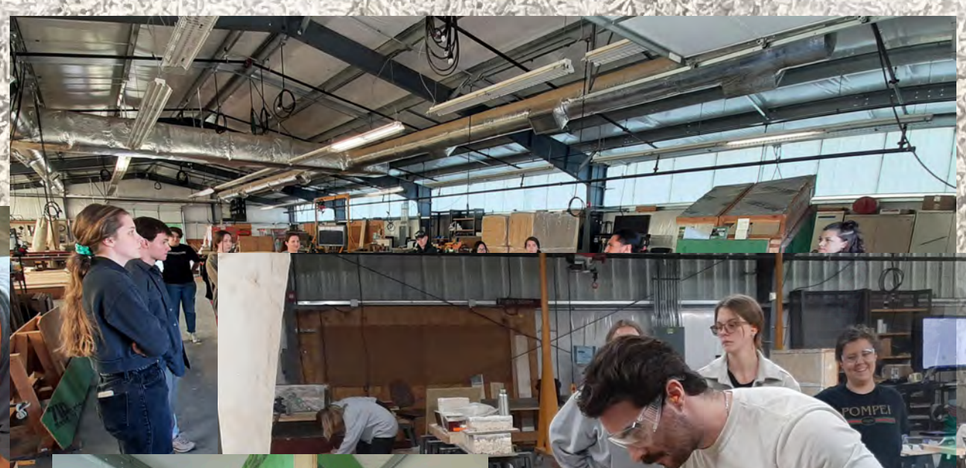
The Hemp Casita

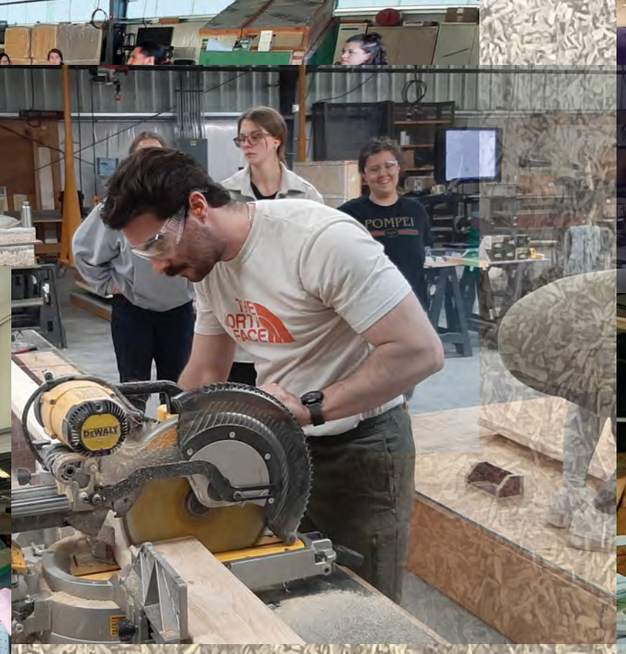
Hempcrete is a much more common form of construction in Europe, and some of the first homes made of hempcrete in U.S. adopted the European approach to hempcreting a structure in place, often using two forms (AKA shuttering) that moves with the placement of hempcrete. It can be a slow process and in order to finish a traditional hempcrete building in plaster, all of its structure must be contained in the middle of the wall.

At K-State, research done in the seminar sought to propose a “hybrid” approach to using hempcrete that could make construction faster while also making building with hemp more compatible with current building codes and practices, which today emphasize wind and seismic resistance using structural sheathing. Our hypothesis was that a hempcrete building could perform similarly to modern, high performance houses that use petro-based foams extensively for insulation. Foams are very common in passive homes as well as Net Zero homes, which offset the energy they generate in a year with onsite renewable energy. We also believed an easier-to-construct 8” hempcrete wall could perform similarly to a 12” concrete wall with the use of lighter weight HempWool in the roof and adding hempcrete insulation to the floor slab.

To build the walls of the Casita, the walls were framed with studs on the outside rather than in the middle of the wall, and a semi-vapor permeable sheathing product called ZIP, which also protects the structure from rain during and after construction. We then formed hempcrete right against the inside of the ZIP. Approx. 5 months later, investigations showed the hemp was able to adequately dry against the ZIP sheathing and the ZIP was not harmed by the placement of the wet hempcrete. In the Casita, HempWool (from Hempitecture) was used throughout as a fiber insulation in the framing of the floors and roof; HempWool installs similarly to many fiber insulations and has slightly better thermal performance than fiberglass.

A comparison of annual energy used in a 1,200 ft2 house shows that the “Hybrid” combination of 8” hempcrete, hempcrete-over-slab insulation, and HempWool could perform within about 5% of the energy efficiency of a hypothetical net zero home using foam insulation. The Hybrid system also nearly matched the energy efficiency of a traditional 12” thick hempcrete wall and roof. Most importantly, the slightly less efficient hemp homes could operate as net zero homes with the addition of another PV module. In conclusion, this is strong evidence that hemp structures should be part of our move to net zero homes. Hemps carbon-sequestering status (it has negative carbon content!) makes it all the more logical to keep learning about how to use hemp today in home construction.




HEMPCRETE

Hemp hurd is a material that is sourced from the Hemp Plant. Although we are only using the 'waste' of the plant for this build, by looking at the diagram below, you can see where the other parts of the plant can be used for so many common uses.

Some really great aspects of this material, is that it is generally healthier for you, it is more cost effective, holds an increased energy performance, as well as a high fire resistance.

Making Hempcrete

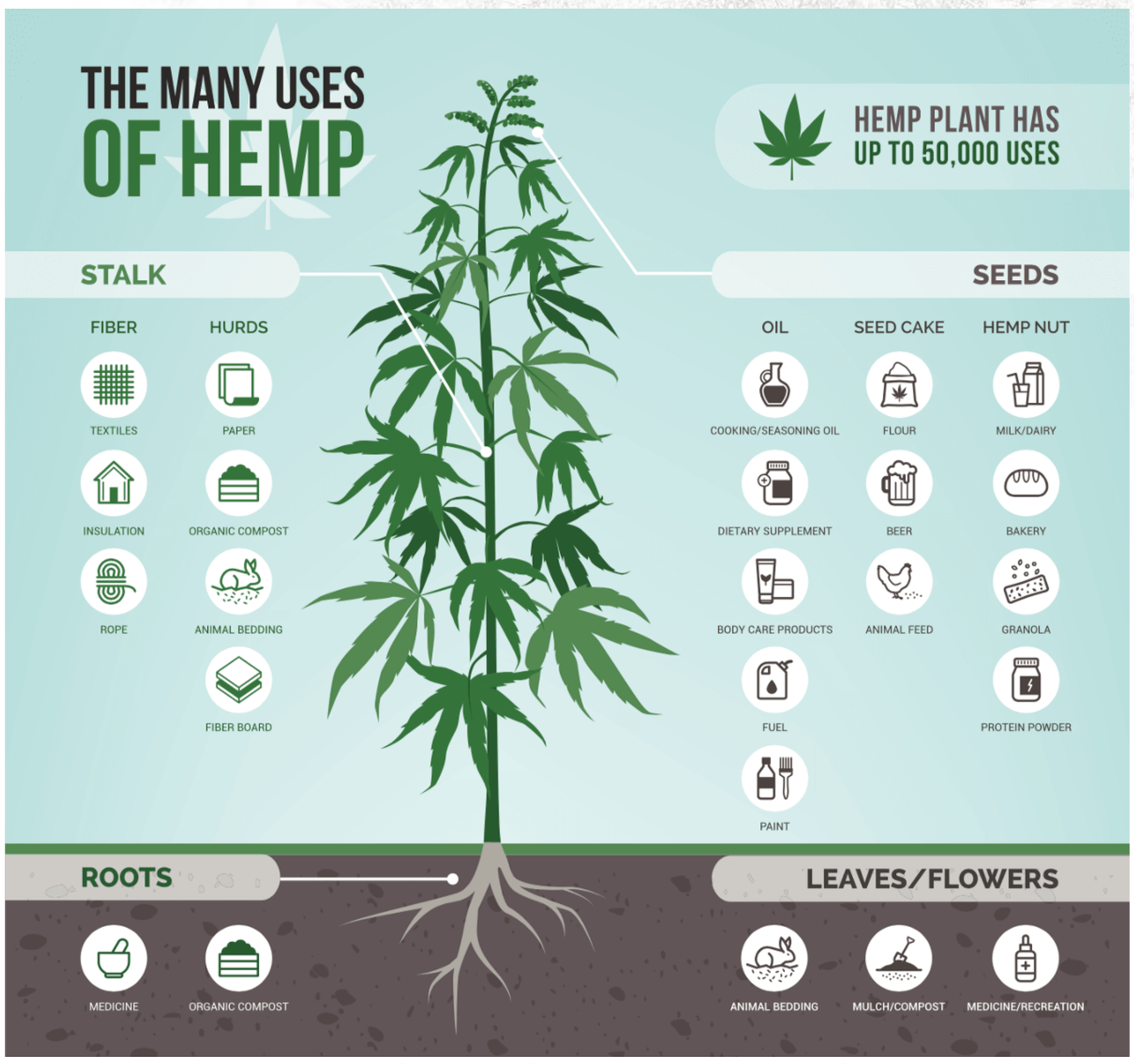
Similar to concrete, hempcrete is made up of only a few elements. It is may by simply mixing together hemp hurd, with water and a binding material.Hempcrete does not share the same structural benefits of concrete, however, there are several other benefits that make it an under utilized building material.

Hurd

Water

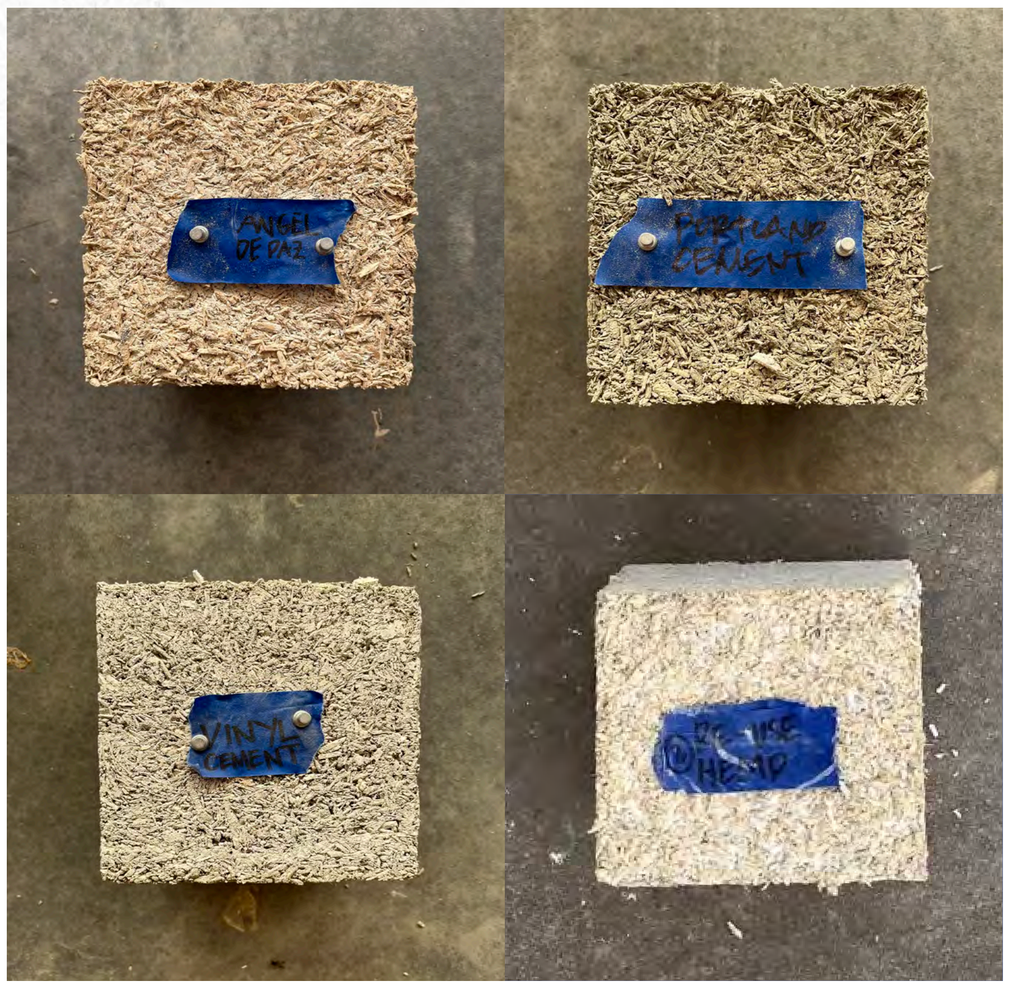
Binder

Mix



Vivek, V. (2022, January 14). The usages of every part of Hemp Plant. Ukhi. https://hempfoundation.net/the-usages-of-every-part-of-hemp-plant/

Hempcrete Binder Study:



While researching hempcrete early on in our study we used a variety of different binders to test out the properties of the hempcrete.

Benefits of Hempcrete

Health

"Hempcrete prevents SBS as a chemical-free material allowing water vapor passage, ensuring healthy airflow and preventing mold and toxic gas build-up."

Thermal Properties

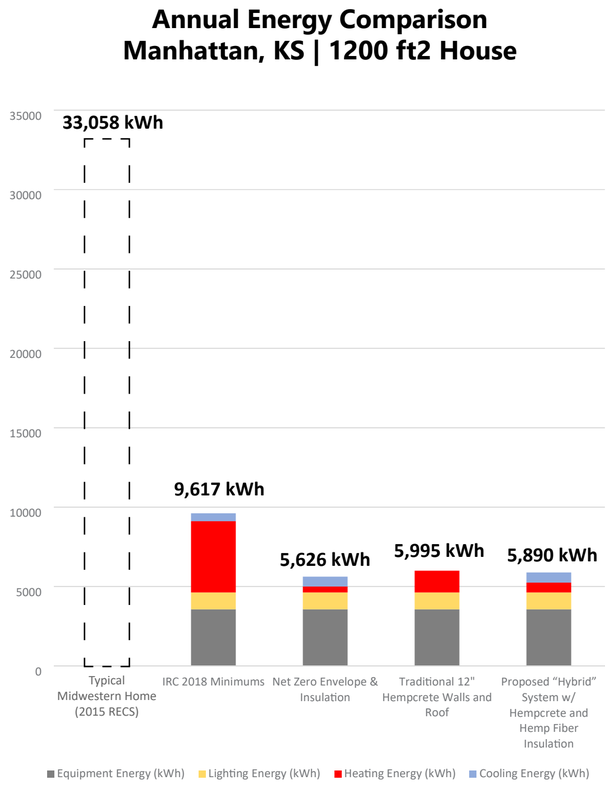
"Research on hemp insulation shows its thermal performance varies with density, influenced by mix composition and application. Denser hempcrete typically insulates less effectively due to higher thermal conductivity."

Acoustic Properties

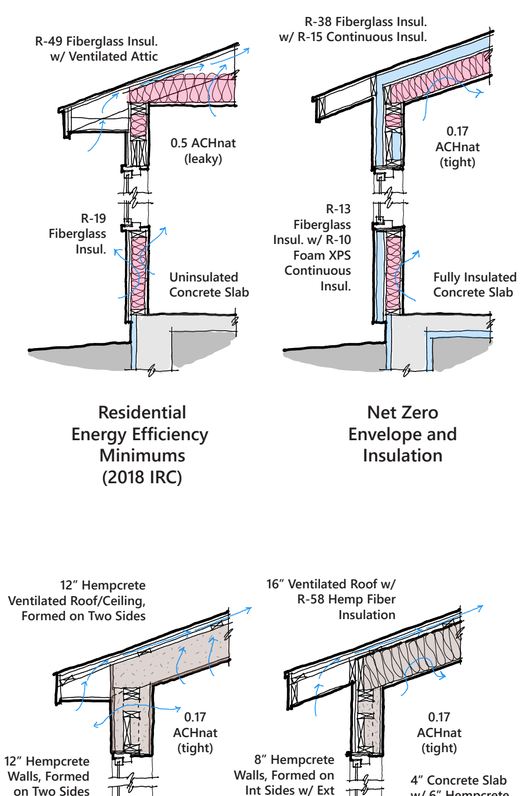
"A UK test revealed hempcrete's sound reduction at 58 dB, surpassing the 53 dB code. Hempcrete combines acoustic and thermal qualities in one airtight material, with fiber-based compositions achieving 90% absorption at 1500 Hz."

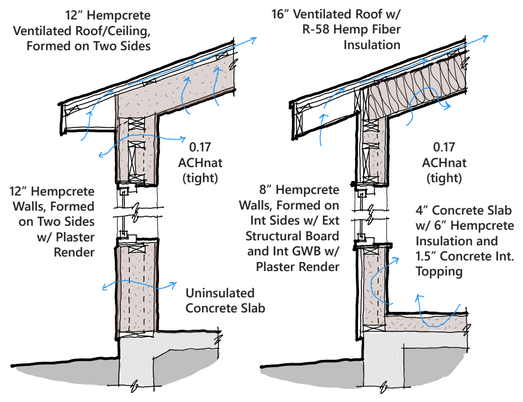
Hempcrete Thermal

A comparative analysis of the thermal capabilities of two 1200 SF houses with varying insulation was completed. One analysis was of a house with 8" thick hempcrete within the walls for insulation and R-49 insulated roof using 14" of hempwool insulation. The other had insulation that would be typical for code-compliant new construction, with R-20 fiberglass insulated walls and an R-49 fiberglass insulated roof. The means to complete the analysis was by use of a program called Climate Studio, an environmental performance analysis software. As seen in the results of the Climate Studio analyses, the model with hempcrete walls had a lower site EUI total calculation. Site EUI translates to Energy Use Intensity when energy is measured at the site, which measures the total amount of energy used with a building/house divided by its area. Additionally, the house with hempcrete insulation had a total energy use of 5911 kWh while the house without the hempcrete had a total energy use of 6874 kWh, which amounts to an improvement of 14% in total energy improvement. Meaning that the hempcrete house had much lower energy usage as a whole.



The overall simulation guarantees that the hempcrete house not only uses less energy than a typically insulated house, but it lowers the overall LCA (Life Cycle Assessment) of the building, creating a more ecofriendly and cost-effective house. The hempcrete house also reduces more emitted carbon than typical insulation materials.



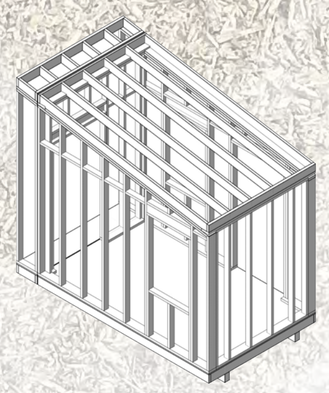


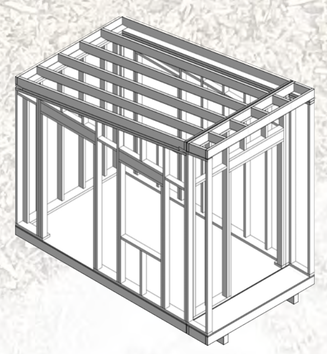
DESIGN & CONSTRUCTION

As a class, we were tasked with creating a small structure that initially would be mobile and then in the future a permanent structure. The structure had to withstand being transported from state to state. Collectively as a group we made various design choices in order to celebrate the sustainable building material and showcase the versatility of hemp. Aiming for a minimal and modern look allows for the design to exemplify the construction process and demonstrate aspects of emerging new construction methods alongside traditional ones.

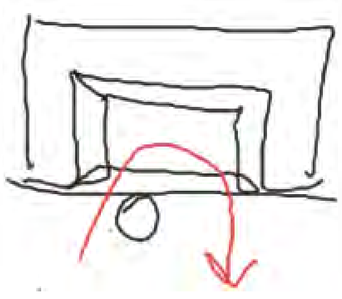
To initiate the design process and allow the class to have a say in the design, the class was divided into 3 groups. Each groups was tasked with constructing preliminary designs to be presented to the client. Each design featured unique structural and design qualities. Each was evaluated on its ease of construction and ability to integrate hempcrete.

Initial Framing Model of Building

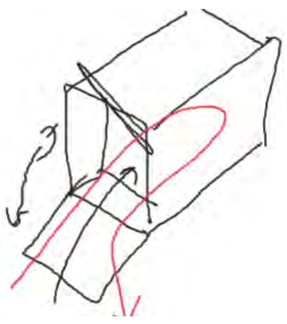




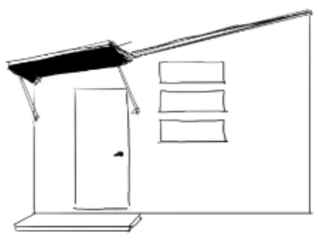
Initial Concepts



Apple Store
This proposal was inspired by the design of Apple stores. This idea promotes the display of hempcrete as it is an innovative technology in construction similar to how Apple revolutionized the digital world. The large opening creates apparent circulation



The Porch
The Porch design focused on the importance of entry. The slanted roof and opportunity for sky openings would be beneficial for cross ventilation and daylighting all while giving the occupant of the structure privacy.



La Casita
This strategy put an emphasis on privacy and circulation. This proposal includes two door openings as well as windows on each long side of the structure. The placement of the openings is beneficial for cross ventilation. The generic design is flexible for future uses.

Hempcrete Insulation Process

Developing Structural Model

Structural Framing
- 2x4 walls were used with 5 1/2" of hempcrete
- Less than what is typically used in a house (normal is 8")

Hemp Application
- The hempcrete was made thinner to save on weight
- Reducing it from 8" to 5 1/2" allows for maximization of interior space

Final Material Placements
- Underneath the structure, structural ZIP is continuously sheathed
- ZIP acts as weather resistant along side metal siding
- Sheathing aids in resiting wind and keeps wall cavities unobstructed by bracing

Mix
By mixing together hemp hurd, water, and lime, we created our mix of hempcrete.

To create enough hempcrete for the Casita we had to mix in multiple batches.

Each batch consisted of
- 38lbs Hemp
- 50lbs Hydrated Lyme
- 1g Water
- 7g to 9g Water during mixing

Place
Once the mixture was fully combined, we transferred it to the structure, and began pouring the wet mixture into the wall cavity, tamping the mixture down to form the walls.

Dry
Hempcrete can vary on drying times due to weather and other factors. Ours seemed to dry pretty quickly, over a couple weeks. Once dry, finishes can be applied.

Patching

During the drying process there were some imperfections that occurred where the hempcrete needed patching. On another wall, the hempcrete fell out and had to be tamped into place again and re-patched. The walls have various colors which demonstrates how the hempcrete dries during each process.

PROCESS & DETAILS

During the semester, this project has proven itself to be both a wonderful experience, yet challenging in many different ways. As a class, working with a new material as well as in large groups in a nearly self-sustaining class setting. As most students in this glass were Graduate level students, time was split heavily across many other classes, which left this project straggling some weeks more than others. Despite some of these challenges, the class was able to govern itself into organizing, and completing tasks in generally decent time. In regards to the detailing and culmination of work this semester, the class has treated the completion of this project like a passion project. With so many hands involved with the conception, design, and construction of this building, nothing less would be expected. For many students, this is the first time that they are able to see their design work become real, and it only aided this experience that this class of students were the ones building it. Some of our most difficult challenges came from having to distinguish the separation of work, and although solutions were not perfect, the end result leads us to what is presented to you today - a structure designed and made by dedicated students and educators, who are willing and ready to bring Hemp to the forefront of the design and construction world. It is our hope that this project inspires future designers and builders to utilize

Metal Siding - Agricultural
The choice of this particular siding was considered to be the best surface to protect the structure beneath. As a whole, the color was chosen as a nod to the natural material within.

Hemp Insulation - Midwest Hemp
Hemp Insulation - Midwest Hemp
The use of Hemp Insulation was the main focus of the project. By mixing hurd, water, and lime to create this mixture.

Hemp Wool - Hempitecture
Hemp wool insulation was purchased to be installed in the floor and ceiling framing panels. This material is made from the fiber within the Hemp plant.

Hemp Wood Floor - Hemp Wood
With the desire to showcase the many uses of Hemp in Design, the decision to install the Granite color gives an example of color finishes that give more depth to the space.

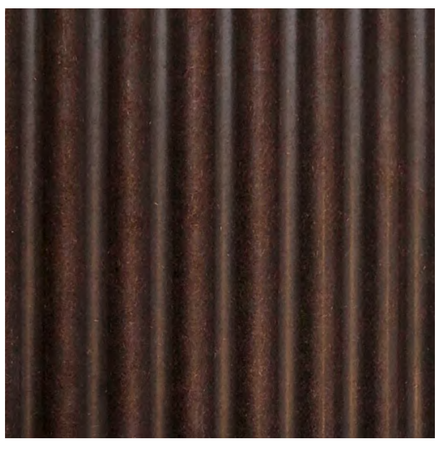
ZIP Structural Sheathing
Vapor permeable sheathing used on exterior is durable water control layer and permits hempcrete to dry.

Plywood Boards
Plywood is renewable and offered a breathable finish free of volatile organic compounds

Construction Process

Additional Uses For Hemp in Construction

Hemp Rebar
This hemp rebar from Bulk Hemp Warehouse uses natural and synthetic fibers bound together with a resin made of hemp seed oil. Hemp rebar is non corrosive and free from VOCs, which not only make it a suitable replacement, but rather an improvement on traditional rebar.
https://bulkhempwarehouse.com/5-hemp-rebar-0-625-inch-x-4-feet/



Hemp Corrugated Panels
These hemp fiber corrugated sheets are made of hemp fiber bound together with farm biowaste resin. These sheets can be used as a rainscreen in place of corrugated steel, PVC, or they can be used as an acoustical treatment.
https://www.margentfarm.com/about-us/hemp-fibrecorrugated-panels

Hemp Sheathing
Hemp Sheathing is stronger, lighter, and more moisture resistant than traditional building materials. This can be used for wall sheathing, roof decking, and subflooring.
https://www.plantdmaterials.com/#product

The Hemp Casita was made possible by:

Right Coast Hemp
Manahawkin, NJ | Project Sponsor

Stuc - Go - Crete
Educational Collaborators

HempWood
Murray, KY | Hemp Based Flooring and Finishes

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