



Section A-Research paper

CHARACTERISTIC OF HEMPCRETE IN LOW RISE BUILDING CONSTRUCTION IN INDIA

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Abstract—

This document provides a brief overview of hemp and hemp product, explaining the advantage of hemp as a building material for achieving sustainability rather than a traditional building material. It also provides a preliminary introduction to the construction methods of hemp buildings to show the advantages of hemp not only in terms of the technical properties of the building material, but also in terms of how good the material is for sustainable development. The objective of the study is to test the condition of hemp concrete in Indian condition.

Keywords—*natural building material, hemp, thermal insulation, sustainability, etc.*

INTRODUCTION-

The construction industry must deal with several problems affecting the environment. Traditional building materials such as wood, concrete is usually mined from the ground or harvested from rapidly depleting forests. With construction demanding 40% of the world's global energy and resources are essential to architectural industry is moving towards more sustainable practices in the face of climate change threats. Natural building material therefore becomes a better choice for its substantiality and reproducibility. In Holland, hemp is a popular natural material with extensive production. And many cannabis figures will support it as a universal natural building material in the coming days.



Review of Literature

Waha zuabi and ali M. memari (2016)

Concluded “With hemp’s nutritional benefits, along with its high stake in retail and lime’s multitude of chemical benefits, hempcrete becomes an important material in building construction practices. Hempcrete has a significant contribution to the construction industry as it involves planting, building, installing, and more, in still in opportunities in other sectors of business. Making hempcrete can be straight forward without the need of complicated technologies and processes, from its initial stages of growing to its final stages of constructing. Growing the durable material requires limited use offer utilizer, while offering various construction methods such as in-situ, wet-mixed hempcrete pouring, hempcrete bricks and blocks, structurally insulated panels, and spraying hempcrete. Hempcrete is at a great disadvantage in it is not suitable for being a load-bearing material like concrete; however, its ability to resist fire, mold, fungus, and moisture along with its carbon-negative properties compensates for that. The material’s ability to absorb carbon dioxide makes it an ideal eco-material in lessening the negative environmental impact of the construction sector. It displays the good economic value as well as excellent thermal and insulative properties, ensuring comfortable living atmospheres. It holds an excellent life span and offers a low maintenance cost. Seeing a shift in the global selection of concrete as a building material to utilizing hempcrete will be contingent on costs, hemp availability, awareness, and project suitability. Advocates must remember to take advantage of hempcrete and use it in well-planned and well-designed.

Nayana Manohari T K, Sunil H G, Devika Rani, Akshay Kumar On July,2016

Concluded” Hempcrete has very low compressive strength and elastic modulus which does not make it suitable as a direct load bearing structural material. Compressive of hempcrete increases with time. These particles can absorb water and hinder in the hydration process of the binding materials and thus result in a lower strength. Another important property of hempcrete observed from the compression tests was the large deformation it can undergo after reaching the ultimate load. This shows hempcrete has a quasi-ductile behavior unlike the sudden brittle failure associated with concrete. When preparing the test specimens, it was observed that the specimens had a _hard shell ‘with a softer core. This generated the idea of creating perforations in the test specimens in order to increase the surface of the hard shell, and to reduce the amount of soft-core material. Creation of perforations in a test specimen reduces its weight and creates air cavities. This will most likely also affect its thermal insulation properties, an aspect not studied in this research. It is interesting to note that while the total amount of material in the test specimen decreased due to the perforations, the compressive strength stayed the same. That is to say even though less material was used it gave similar compressive strength results. For pre-mixed specimens generally, compressive strength was higher and. However, conclusive results regarding the influence of pre-mixing the binder with water before adding it to the hemp on final mechanical strength were not obtained. It is concluded that violent mixing does not have an important impact on drying, final density and final vapor permeability. For the sample 3, which also constituted OPC at 1:2.9:1.5:1 ratio the setting time decreased by 20% i.e., it could set 20 times faster than other samples. The sample also possessed slightly high strength compared to others Due to large usage of hemp in volume the block became



lighter and had low density. The average density of the block was found to be 0.817. Which was less than water hence, hempcrete blocks could float in water easily. Due to quasi-ductile behavior of hempcrete, it could be reused in the same form without much affecting its structural properties. It was also found that the density is affected by water content of the sample. For higher water content the density decreases due to volume of voids. But this has a good impact on compressive strength. As strength is more for less density.

3. Methodology

Hempcrete is prepared by mixing hemp husks, which is nothing more than the inner wooden core of hemp, water, and lime or OPC are required as a binder.

Step 1. Collect the stalks of the hemp herd of the specific size we required (Be careful, it should not contain fiber).

Step 2. Make sure the lime is of good quality i.e., non-hydraulic or hydrolysed/hydrated lime.

Step 3. Now prepare a vessel to mix all these materials with water. To prepare "Hempcrete" take one part water and

4 parts hemp shanks or shanks. Mix well and then drain well. No curing is necessary for hemp concrete to harden. Hemp concrete has a low density and excellent thermal and acoustic insulation properties.

There are many hems concrete products available on the market, but the one that stands out is the "Hempcrete Block".

The results obtained so that hemp concrete has high porosity and vapor permeability, medium low density, low thermal conductivity, Young's modulus, and compressive strength. Hempcrete is a lightweight insulation material ideal for most climates as it combines insulation and thermal mass.

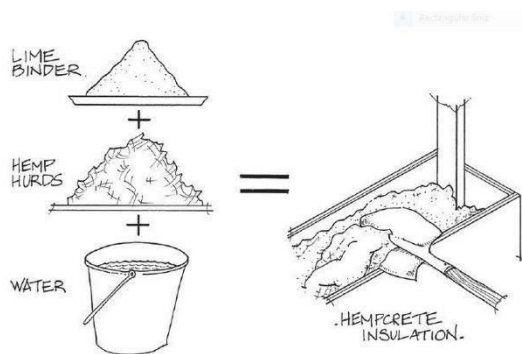


Figure 1 Steps to make Hempcrete



APPLICATION OF HEMPCRETE

I. Plastering

Hemp concrete can be sprayed on the interior or exterior of a building. It is suitable for areas prone to cracking and impact. It is also more suitable for patching and repairing existing plaster. Spray application reduces labour or formwork. However, there is a possibility of an increase in waste at the site. The most common practice is lime plaster applied directly to hemp concrete.

II. Form packing

The most common way to build hemp concrete is to wrap it around a wooden frame. Hemp concrete is compressed more toward the surfaces and looser in the middle to maximize insulation potential. The frame can be centered or to one side. Cladding is sometimes used to finish the exterior.



Figure 2 Foam Packing of Hempcrete

III. Bricks

Hemp concrete blocks have been used in various places, e.g., Monica Brummerová. For construction purposes, they are cast into the shape of bricks or blocks.



Figure 3 Hempcrete Block



WHY ONLY HEMP AS A POSSIBLE ALTERNATE FOR SMALL BUILDINGS

Compared to other traditional building materials such as concrete, wood, hemp, it shows better properties in many aspects:

1. Carbon Negative Product

Cannabis absorbs large amounts of carbon dioxide from the atmosphere as it grows. The production and use of a hemp product are very low carbon processes, and even when transportation and energy consumption are considered, the amount of carbon they absorb over their lifetime exceeds all of these processes and is greater than most traditional building materials.

Carbon-Dioxide Reduction:

As we all know every plant absorbs CO₂ during growth, similarly cannabis plants also absorb CO₂ through photosynthesis and capture it in the phloem. And thus, a lifelong construction of the building. According to research, 1 ha of hemp plants absorbs 4x more atmospheric CO₂ than the total area of forests. It has many uses, for example for the production of prefabricated blocks and ponds with higher density and lower thermal insulation. Due to its low bulk density, it results in high storage and transport costs. Local production minimizes the natural ecological footprint and associated CO₂ emissions.

2. Humidity Control

Hempcrete is super breathable and able to regulate moisture. This is because when the humidity rises, the hemp absorbs moisture from the air into the wall. Then, when the humidity drops, they are released into the air. It could prevent the growth of mold and avoid keeping the humidity at a suitable level that prevents the growth of bacteria. And it does not require a ventilation system to achieve this effect.

3. Thermal insulation

Hemp building material has very good thermal properties. Regardless of the weather, buildings made of hemp remain unchanged in temperature. This is due to a combination of its insulating effect and thermal mass. Houses made of hemp concrete are therefore very comfortable, warm in winter and cool in summer.



4. Low Density Material

Hemcrete has 1/6 the density of regular concrete, which greatly reduces the dead load of the building, which in turn reduces the need for heavy beams and columns, greatly reducing the cost of construction and the dead load of the building.

5. Fire protection

Hemp concrete blocks burn slightly when burned, but have better fire resistance than traditional houses. Depending on the size and thickness of the hemp brick, it will not ignite within two hours.

6. Acoustic absorption

Acoustic absorption adds to the economic value of the material. Having a Noise Reduction Coefficient (NRC) means reduced indoor noise and increased comfort by-

. By current standards, the perfect absorption coefficient is 1 NRC and the perfect thought is equal to 0 NRC. With an average NRC of 0.69 (Abbott, 2014), hemp stone is excellent for sound absorption. Picture below. The NRC of hemp stone has been compared to many other building materials.

Waste recycling

Cannabis production is not used in most cannabis production plants, it is considered a commercial product. Using this waste material, hemp material used in construction materials has become an effective solution for waste management.

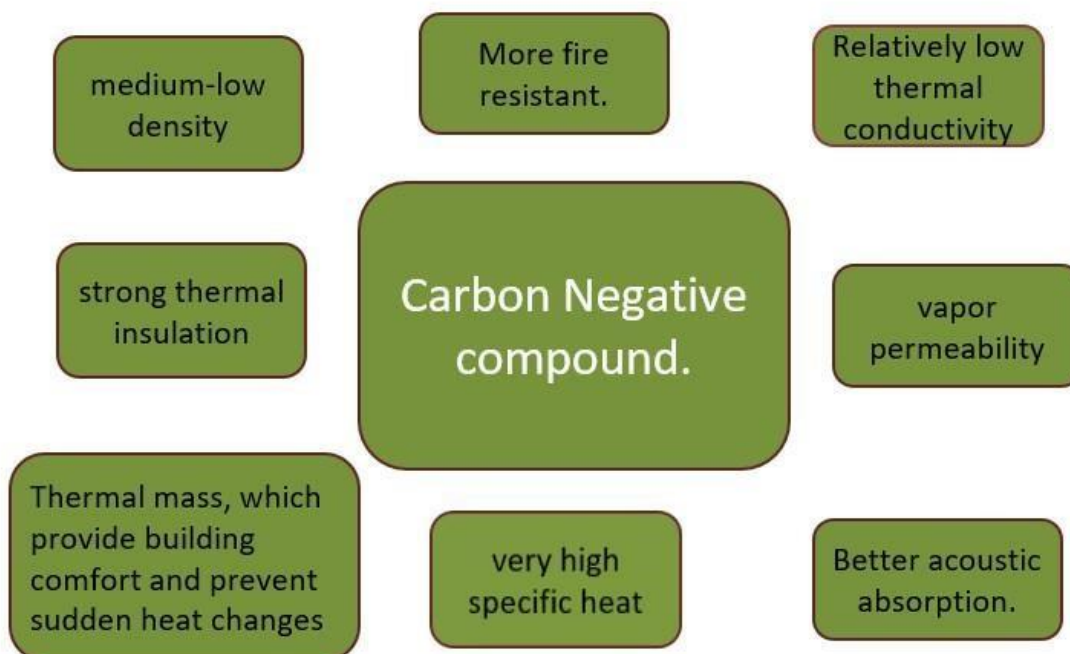


Figure 4 Properties of Hempcrete

Life Cycle Assessment

Hemp is considered a carbon store because, like all crops, it absorbs carbon dioxide from the environment as it grows. From production to the end of its life, hemp concrete continuously accumulates carbon dioxide, creating a positive impact on the environment. Using data analysis and Xray powder diffraction (XRPD) to perform a life cycle assessment (LCA) of hemp blocks, it was found at when the blocks were used, they stored large amounts of carbon through photosynthesis and carbonation as plants grew. The LCA of hemp concrete blocks considers seven processes: production of explosives and wraps, transportation of materials to factories, production of concrete blocks, transportation of hemp concrete blocks to the construction site, construction of the wall and use of the level.

Industrial Hempcrete Market Size

World Industrial Hemp Market size is estimated to be 4 USD.

It will reach 74 billion by 2022 and is expected to grow at a compound annual growth rate (CAGR) Of 17.1% from 2023 to 2030 animal care around the world. Increasing demands for products such as fibers, seeds,



stems, herds, and oil is expected to fuel growth in the above-mentioned business applications. The cannabis industry is associated with many agriculture and environmental problems. With a fast-growing period of 120-150 days and significant biomass production, hemp makes good use of farmland. It can be used for carbon sequestration as it produces a large amount of biomass while giving good results for cultivation.

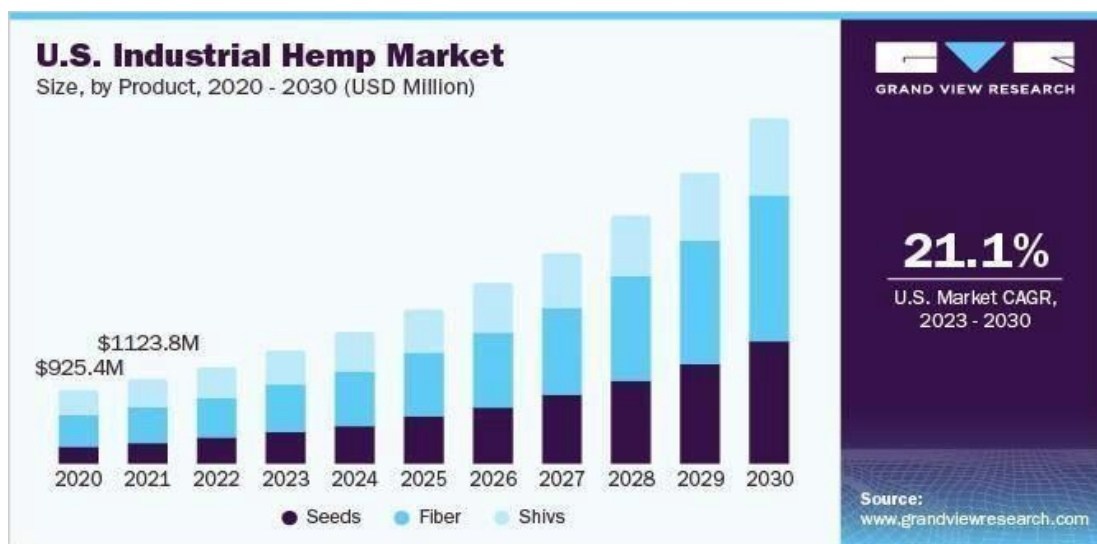


Figure 5 Market size acc to US CAGR

Disadvantages of Using Hemp Concrete

Despite its many benefits, hemp concrete has many disadvantages that make it not ideal equipment. For example, the porous structure of hemp stone reduces its mechanical properties and increases its water holding ability.

Although these problems are not severe enough to prevent the use of hemp-based concrete in the construction industry, they impose significant limitations on the use of hemp-based concrete.

- As a cannabis plant, it takes about 90-100 days to reach full length, which can slow down the production process if the negative properties of the bacterium are not maintained.
- Hempcrete takes 8-10 weeks to dry because it dries in direct sunlight.



- Because it is a new product, workers in India did not learn to make Hempcrete and use it in construction.
- Hemp stone has low compressive strength. So, it is not used in infrastructure.
- Hemp concrete is not suitable for the construction of heavy loads.
- Hempcrete is not very popular in many countries, so it is rarely used.
- Hempcrete is not found and grows everywhere. That is why cannabis is sometimes hard to find.
- Builders, engineers, and architects are not familiar with hemp stone making because hemp is not very popular.
- Hemp stone is also more expensive than other stones.
- Hemp concrete blocks are wider than concrete blocks and bricks. Thus, it takes up more space and reduces the carpet.

Advantages of Using Hemp Concrete

- Carbon negative compound
- Strong thermal insulation
- Very high specific heat
- Better acoustic absorption
- Vapour permeability
- Relatively low thermal conductivity
- More fire resistance
- Medium low density
- Thermal mass which provide building comfort and prevent sudden heat changes.

Technical Comparison of Concrete and Hemp Concrete Blocks.



In order to replace concrete as a material, we need to compare it with Hempcrete in terms of properties.

Hemp Concrete Technical Capacity

Characteristics	Hempcrete	Concrete
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Table 2. Hempcrete vs Concrete Technical Properties

Density	323 Kg/m ³	2400 Kg/m ³
Strength	3.5MPa	17MPa
Thermal Insulation	0.06-0.07W/mk	0.62-3.3W/mk
Heat Capacity	1450 J/Kg	1000 J/Kg
Mean acoustic Absorption Coefficient	0.53	0.2
Fire Rating	1Hr (BS EN 1365-1:1999)	1 Hr (EN 13501-1:2007)
Carbon Capturing Capacity	150 Kg CO ₂ /m ³ (Absorbed)	- 410 Kg/m ³ (Emitted)
R Value (for 6-inch-thick slab)	14.4-28.8	0.6-1.2

Conclusion

- The purpose of hemp for the application of this substance. Hempcrete is an effective material for reducing the environmental impact of the construction industry, while retains its benefits.
- Although hemp stone is not an ideal building material for as currently demanded, it has many different properties from traditional concrete in terms of economic and environmental benefits. Going forward, further research into improving's mechanical properties and reducing water absorption will go a long way toward unlocking the potential of hemp as a building material.



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