



## AN ANALYSIS ON HEMPCRETE

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### ABSTRACT

International Conference on Advances in Construction Materials and Structures (ACMS-2018) IIT Roorkee, Roorkee, Uttarakhand, India, March 7-8, 2018 1 Hemp Concrete – A Traditional and Novel Green Building Material Tarun Jami<sup>1</sup>, S R Karade<sup>2</sup> and L P Singh<sup>3</sup> 1Research Scholar, AcSIR, CSIR-Central Building Research Institute, Roorkee, tarunjami@gmail.com 2Sr. Principal Scientist, CSIR-Central Building Research Institute, Roorkee. srkarade@cbri.res.in 3Principal Scientist, CSIR-Central Building Research Institute, Roorkee, lpsingh@cbri.res.in ABSTRACT With the alarming global increase in carbon emissions and its implications, the need for carbon neutral or carbon negative technologies is of utmost importance and urgency. Cellulose aggregate concrete (CAC) or bio-aggregate concrete has not only the multi-benefits of low density, better thermal insulation and low embodied energy, it can also make use of industrial wastes such as fly ash, slag, etc. One such CAC is called hemp concrete, which is a composite made of hemp shiv and lime based binder. Hemp is one of the world's earliest cultivated crops and has a variety of applications including construction. This paper discusses various properties and applications of hemp and hemp concrete such as mechanical performance and durability, with a focus on its carbon sequestration ability and carbon negativity, and the current research interest as well as its possible contribution towards solution of climate change problems.

**Keywords:** Hemp Concrete; Carbon Negative; Carbon Sequestration; Green Building Material; Sustainable Materials

### INTRODUCTION

World leaders at the Paris Climate Accord, 2016 had committed to limit the global rise in temperature to less than 1.5°C. Understandably that is a tall order as the global greenhouse gas emissions are over 49.3 billion tonnes of CO<sub>2</sub> equivalent (Olivier et al., 2017). Hence, researchers and scientists have put forth a possible solution involving the deliberate and large-scale modification of the Earth's environment in an effort to negate some manifestations of anthropogenic climate change, called geoengineering (Sandler, 2018). Geoengineering is not a relatively new concept and has been a topic of discussion since early 2000s. Some strategies that accomplish geoengineering are the large-scale removal of carbon dioxide from the earth's atmosphere, called Carbon Dioxide Reduction (CDR), and the large scale modification of the earth's atmosphere such as seeding large amounts of chemicals

into the atmosphere in an attempt to prevent solar warming of the earth's surface, called Albedo Modification (AM) (Sandler, 2018).

### **Advantages of hempcrete**

- Hempcrete has a negative carbon footprint of  $-72\text{kg}/\text{m}^2\text{m}^2$ , making it an eco-friendly and energy-efficient construction material.
- Hempcrete blocks exhibit good resistance to fire.
- The moisture-handling capacity of hempcrete blocks is exceptionally high.
- Available in various sizes (widths), hempcrete blocks offer versatile applications.
- Hempcrete blocks are characterized by strength and durability.
- Their lightweight nature facilitates easier transportation.
- Hempcrete blocks contribute to [temperature](#) regulation within the structure.
- Additionally, these blocks find use in decorative construction.

### **Disadvantages of hempcrete**

- Hempcrete exhibits lower compressive strength, making it unsuitable for building foundations.
- Not recommended for elements subjected to heavy loads, limiting its application in certain constructions.
- Limited popularity in many countries results in overall reduced usage of hempcrete.
- Availability and cultivation of hemp are not universal, leading to difficulties in sourcing hemp.
- Lack of widespread popularity contributes to a dearth of knowledge among builders, engineers, and architects regarding hempcrete construction.
- Relatively higher cost compared to traditional concrete.
- Hempcrete blocks have larger dimensions than regular concrete blocks and [brickwork](#), leading to increased space utilization and reduced [carpet area and build up area](#).

## **MATERIALS**

The materials used in the study were hemp, lime, water, fine aggregates, Ordinary Portland Cement (OPC) as per the standard mix design.

- Hemp
- Lime
- Water

- *FineAggregates*
- *(OPC) Ordinary Portland Cement*

## **METHODOLOGY**

*The process of building with Hempcrete involves mixing hemp hurds with a lime binder and water. This mixture is then cast around a load-bearing frame, either by hand or using a pump. After casting, the Hempcrete needs to dry out before applying a lime render to the external walls.*

*While the process is simple, it requires some specific skills and knowledge. For instance, achieving the right mix of ingredients is crucial, as is ensuring the Hempcrete is dry before applying the render.*

### **Mixing of Hempcrete**

*The raw materials like hemp shives, lime and water are mixed properly in the right proportion.*

### **Moulding of Hempcrete**

*The mixed Hempcrete is then filled in the mould and compacted properly so that the air voids get removed.*

### **Curing of Hempcrete**

*After that, the blocks are kept for curing in the open air. Curing is very important, which gives strength and hardness to the Hempcrete blocks.*

## **MIX DESIGN**

*Hempcrete was moulded for 3 different types of samples. the samples were mixed at different mix ratios. the mix ratios are given at table below. the 1st sample was moulded with low water ratio. 2nd sample was moulded with highwater ratio. OPC was added in 3rd sample.*

<i>Materials</i>	<i>Sample 1</i>	<i>Sample 2</i>	<i>Sample 3</i>
<i>Hemp fiber</i>	1	1	1
<i>Water</i>	1.5	2.9	2.9
<i>Lime</i>	1.5	2.5	1.5
<i>Cement</i>	-	-	1

### *MIX DESIGN (Sample 1)*

<i>Material</i>	<i>Ratio</i>	<i>Quantity (kg)</i>
<i>Hemp</i>	1	2
<i>Water</i>	1.5	3.1
<i>Lime</i>	1.5	3
<i>Cement</i>	-	-

### *MIX DESIGN (Sample 2)*

<i>Material</i>	<i>Ratio</i>	<i>Quantity (kg)</i>
<i>Hemp</i>	1	3
<i>Water</i>	2.9	8.71
<i>Lime</i>	2.5	7.5
<i>Cement</i>	-	-

### *MIX DESIGN (Sample 3)*

<i>Material</i>	<i>Ratio</i>	<i>Quantity (kg)</i>
<i>Hemp</i>	1	2
<i>Water</i>	2.9	5.81
<i>Lime</i>	1.5	3
<i>Cement</i>	1	1

## RESULT AND DISCUSSION

### 1. WORKABILITY

*Due to low mechanical performance, the material should not be used for load-bearing structures.*

*Although it is not known for its strength, hempcrete provides a high vapor permeability that allows for better control of temperature in an indoor environment.*

### 2. COMPRESSIVE STRENGTH

*The test method covers determination of compressive strength of cubic hempcrete specimens. It consists of applying a compressive axial load to molded cubes at a rate which is within a prescribed range until failure occurs. The compressive strength is calculated by dividing the maximum load attained during the test by the crosssectional area of the specimen.*

## CONCLUSION

- *With enough emphasis laid on the carbon negative nature and the various mechanical properties of the material, it can be concluded that while hemp concrete has been in use since several centuries ago, the traditional material has freshly acquired a futuristic status.*
- *However, competing against technologies that enable rapid construction and reduce cost would mean that considerable research efforts would need to be undertaken.*
- *Currently, only one variety of hemp construction is being explored, which is the application of hemp concrete in combination with timber studs in walls and columns.*
- *For wider distribution of the material, hemp concrete blocks must be researched and developed that can be enabled to take larger loads.*
- *Hence developmental studies for improve the mechanical properties such as compressive strength, flexural strength and dimensional stability must be undertaken.*
- *Further, the durability issues arising out of the mould growth must be addressed as it affects the health of the residents.*

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