

# Hempcrete – The Evolutionary Building Material

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**Abstract:** Due to increase in carbon emissions and its side effects, it is critical to reduce carbon footprints or focus on carbon-negative technologies. Plant-based construction materials with little environmental effect are quite advantageous in terms of preventing pollution. Bio-aggregate concrete provides not only multi benefits of low density, greater thermal insulation and low embodied energy, it can also make use of industrial wastes such as fly ash, slag, etc. One such material is hemp concrete. It is a composite made of hemp shives, hemp fiber and fly ash, slag, lime as binder. Hemp is one of the world's oldest cultivated crops and has a wide range of applications, including construction. This paper discusses the mechanical properties and applications of hemp and hempcrete such as mechanical properties and durability, with a focus on its carbon negative ability and it focuses on its possible contribution towards solution of climate change problems.

**Keywords:** bio-aggregate concrete, carbon emission, carbon negative, hemp, hempcrete.

## 1. Introduction

The rapid increasing interest in environmentally friendly growth, due to widespread and uncontrollable depletion of raw materials and resources, which has resulted in environmental degradation and various concerns. For example, the production of paper, power, and concrete has exploited natural resources such as trees, fossil fuel, and rock aggregates, respectively. Sustainable development focuses on conserving natural resources while ensuring that the society maintain a high level of life.

Concrete is one of the key components in the building sector that contributes to the depletion of natural resources leading to the vast volumes of aggregates needed during the manufacturing process. In addition, cement manufacturing adds to greenhouse gas emissions that contribute to global warming and climate change, with each tonne of cement produced resulting in about one tonne of emissions.

The present tendency is to make a high-performance, long-lasting concrete rather than a high-strength, short-lasting concrete. Concrete that is more durable is intended to endure longer and maintain its quality. Long-term cycle cost and durability are characteristics of sustainable materials and structures. Concrete building causes quick material depletion and has a significant environmental impact on nature and the environment. Similar to hemp-fiber-reinforced concrete, adding industrial hemp fibers and hurds to concrete masonry

blocks would result in a decrease in aggregate material utilized and an increase in thermal characteristics. In the current study, hemp is used as a raw material, with no treatment, in order to streamline the production process. The use of industrial hemp as an agricultural waste material in concrete masonry blocks would expand the market for industrial hemp.

The aim of this study is to look at some of the compressive strength, density, water absorption, and thermal conductivity properties of industrial hemp reinforced concrete masonry blocks. The output may set a corner stone for further research.

## 2. Hemp

Hemp (*Cannabis sativa*) is an agricultural crop that, when combined with lime and cement, may be used as a construction material. Hemp is a fast-growing annual crop (1.5 - 4m tall) that is primarily produced for the high tensile strength natural fiber that forms in the stem surrounding the plant's woody core. The plant's woody core is cut into small pieces (hurd/shives) and combined with lime, fly ash or slag and water to make hempcrete, a bio-composite mix.



Fig. 1. Hemp

## 3. Applications of Hemp

Some of products refined from hemp that are perfected over time are as following:

1. Hemp seed flour
2. Hempseed edible oil
3. Oil, resin and wax for industrial applications like lubricants.
4. Medicines for various pains and psychological ailments, additionally as cancer treatment.
5. Personal care products derived from hempseed oil

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6. Textiles products like apparels and technical textiles
7. Cordage
8. Biofuel
9. Cellulose plastics
10. Paper
11. Defense applications like bullet-proof vests and bunkers
12. Hemp concrete
13. Hemp composite boards for construction

With the rising popularity of hemp and its eco-friendly properties being recognized, more and more researchers and private organizations are exploring various applications for the products of this plant.

Hemp has been used for about 25000 years and is one of the earliest cultivated crops, dating back to 8000 BCE. Cannabis is one of the oldest household plants in human history, having been used for more than 10,000 years, or since the Stone Age. Cannabis has played an important role in preserving the priceless artworks found in Ellora's ancient cave. Ancient Indian experts were most likely the first in the world to use hempcrete technique, which involves combining Bhang with clay/lime plaster for building.

The usage of hemp in construction by ancient Indians in the 6th century Ellora caves was built about 1500 years ago. Hemp is more resilient and long-lasting than other types of vegetal fibers found in clay plaster, and ancient Indians took use of this feature in the Ellora cave paintings.

Hemp fibers also act as natural insecticides and pesticides, retain heat, are water resistant, control moisture, sequester carbon dioxide, are non-toxic, fire resistant, and have insulating characteristics, absorbing 90% of natural noise. In the 6th century of our period, the architects and residents of Ellora Caves were aware of all of hemp's characteristics. The experts at Ellora produced an extremely quiet, healthful, pleasant, and artistically beautiful atmosphere for Buddhist monks/priests by incorporating hemp into the clay plaster. Not only in the ancient cave paintings of Ellora dating from the 6th century CE to the 11th century CE, but also in the massive Daulatabad fort lime plaster work, Indians employed hempcrete technique (mixing hemp with a binder like lime, cement, clay, etc.).

#### 4. Hempcrete



Fig. 2.

Hempcrete is a bio-composite material comprised of hemp fibers, lime, cement, and water. The thermal, acoustic, and

mechanical qualities of hempcrete have all been studied extensively. It has a low density, excellent thermal and acoustic insulation, and the ability to manage humidity in a constructed environment passively. However, it has a poor compressive strength and elasticity modulus. As a result, hempcrete is not suitable for direct load bearing, although it can be used as an infill material in timber stud walls.

#### 5. Properties of Hemp

The hemp stalk/straw is separated into two primary parts: bast and hurd. The bast fibers are removed from the hemp straw during the retting process and woven into fabrics, cords, and ropes, among other things. The plant's hurd has formerly been used for insulation, animal bedding, and other purposes. The cellulose aggregates utilized in hemp concrete, however, are hurds, sometimes known as shives. The retted hemp stalks are milled in a blade mill, where the aggregate size may be selected and sorted into a size group. A decorticator is a machine that creates hemp shives of various diameters from intact hemp straws in large hemp factories that process hemp stalks for bast fibers.



Fig. 3. Hemp fiber and hemp shives

#### 6. Mechanical Properties

Hemp concrete is a lightweight concrete that is presently utilized in non-structural applications as an infill material. It is normally cast in between timber studs as an infill material, playing the double function of a wall and insulation hence, mechanical performance of hempcrete is not a matter of major concern, majorly focusing on thermal conditions.

#### 7. Compressive

Compressive strength is one of the most essential characteristics of a construction material used as a walling material. Researchers that have experimented with hemp concrete all around the world have found compressive strength values ranging from 0.2 to 6.94 MPa. The aggregate size and chemical composition of the binder impact the compressive strength of the hemp concrete mix.

#### 8. Carbon Negativity

Hemp shives have 45 percent carbon, according to 2016

research, which means that 1 kilogram of hemp shives sequesters roughly 1.6 to 1.8 kg of CO<sub>2</sub> through photosynthesis throughout the plant's development. Hemp concrete must be used in large quantities to offset carbon emissions if the objective is to produce a carbon neutral construction.

### 9. Conclusion

While hempcrete has been in use since several centuries, it has acquired a futuristic status considering its carbon negative nature and various mechanical properties. However, competing against technologies that enable rapid construction would be challenging and would require research efforts. Studies for improving mechanical properties like compressive strength, flexural strength and dimensional stability must be undertaken.

Hempcrete is ensuring a building envelope, which might be used in the wall, roof and floor. Although the water content in the hempcrete production can't be standardized, mixture proportions should be calculated properly consistent with the application area, so to avoid unexpected results.

Hemp could be a suitable plant for growing in environments

other than extreme desert climates and high mountain regions. The best growing conditions for hemp, however, are warm-weather areas with well-drained soil rich in organic matter. Therefore, hemp agriculture should be expanded.

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