

Sustainable Construction with Hempcrete: A State-of-the-Art Review of Hempcrete Technology and Market

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Abstract

The increasing demand for sustainable construction materials has encouraged development of hempcrete, a bio-based composite well known for its environmental benefits, thermal insulation properties, and carbon sequestration potential. Despite its numerous advantages, the hempcrete industry faces challenges that hinder widespread adoption, including regulatory constraints, scalability limitations, and incomplete integration into mainstream building codes. The material is currently classified as a non-load-bearing component, limiting its structural applications. One objective of this study is to provide a comprehensive review of the hempcrete industry, highlighting key companies involved in material innovation, product development, and construction applications so that one can better understand the state of the technology for practical application and identification of the potentials for growth and widespread use. In particular, exploring the opportunities and barriers associated with hempcrete adoption helps emphasize its potential to contribute to global carbon reduction goals and sustainable building initiatives. The discussion underscores the necessity of regulatory support, investment in research and development, and industry collaboration to facilitate large-scale implementation. By examining leading hempcrete companies and their contributions, this study highlights the material/technology transformative potential in the construction sector, exploring for a more resilient and environmentally responsible built environment.

Keywords

Hempcrete, Bio-Based Concrete, Sustainable Construction, Home Building, Thermal Resistance, Hempcrete Industry

1. Introduction

As industries focus more on reducing their environmental footprint, as an emerging technology, hempcrete is becoming an attractive option for green builders and developers. The global shift from traditional construction materials toward sustainable construction practices has led to increasing interest in eco-friendly materials because of the growing concern of environmental impact studies [1]-[4]. Hempcrete is a natural, healthy, sustainable, and locally sourced mixture, offering low embodied energy compared to traditional construction materials. Its environmentally friendly characteristics have positioned it as a material that is potentially better than zero carbon, meaning it can offset more carbon than it emits throughout its lifecycle [1] [3] [5] [6]. Its use can significantly reduce carbon emissions and waste production, making it an environmentally friendly choice [7]. Furthermore, hempcrete's ability to improve indoor air quality and its potential for recyclability at the end of its useful life contribute to its status as a preferred material for sustainable construction. As awareness about hempcrete and its adoption in home building continues to grow, it represents a promising path toward achieving more sustainable and resilient built environments.

In recent years, a growing number of companies have entered the hempcrete market, offering innovative solutions and contributing to the advancement of sustainable construction. These companies (some will be discussed subsequently) span various sectors of the hempcrete industry, from raw material producers and hemp processors to construction firms and manufacturers of prefabricated hempcrete blocks. Their contributions are helping to shape the future of building materials, with hempcrete being viewed as a viable alternative to traditional options like concrete and brick.

This paper aims to provide an overview of some of the companies involved in the hempcrete industry, with a focus on those that develop hempcrete related products for home building. It explores the key products by selected companies, the attributes of the materials, components, and systems offered, their roles in the market, and the innovations they are driving. By examining these companies, we can gain a better understanding of the industry's potential for growth and the challenges it faces as it scales up for widespread adoption. Additionally, the paper will highlight the opportunities for further development in the hempcrete space, with an eye toward environmental sustainability and regulatory support.

2. Methodology for the Review

A board array of sources was reviewed to compile the information for this paper, focusing on both industrial and regional insights into worldwide hemp-based companies. The relevant data were retrieved from sources such as ScienceDirect, Google Scholar, industry reports, and company websites. The search was guided by terms including "hempcrete companies", "hemp products", "hemp-lime products", "sustainable building material", "hempcrete insulation", and "hempcrete application". A wide range of materials, including journal articles, market reports,

web publications, technical guidance manuals, and case studies were used to introduce and evaluate the hempcrete companies and their products.

The primary goal of this paper is to introduce hempcrete from the industry perspective, with the main objective of identifying the companies, introducing their products and technologies, exploring hempcrete applications, so that one can better understand the state of the technology for practical application and identification of the potentials for growth and widespread use. Measures considered in screening company data for relevance to this study include the company location information, diversity of product offerings, level of technological advancement, and responsiveness to growing demand for low-carbon construction solutions. Particular attention was given to identifying industry trends, unmet market needs, and optional areas for future research and innovation with hempcrete.

3. Hempcrete's Properties and Its Advantage in Construction

3.1. Physical Properties of Hempcrete

A bio-based composite material made from hemp shives and a binder, hempcrete has gained increasing attention in the construction industry due to its eco-friendly characteristics and beneficial thermal properties. As a sustainable alternative to traditional building materials, hempcrete demonstrates a wide variety of physical and mechanical attributes that establish its suitability and desirable performance in construction applications. The properties of hempcrete, such as density, thermal conductivity, mechanical strengths, specific heat capacity, and water absorption, can vary significantly based on numerous factors related to material composition, preparation methods, and curing conditions. Understanding these factors is crucial for optimizing hempcrete's performance in construction.

Hempcrete exhibits a dry density typically ranging from 200 to 800 kg/m³ [8]-[13], largely influenced by the hemp-to-binder ratio, compaction level, and water content. Its thermal conductivity usually varies between 0.06 and 0.18 W/(m·K), significantly affected by density, moisture content, and binder type [8] [14]-[16]. Compressive strength values commonly fall within 0.2 to 1.5 MPa, influenced primarily by density, compaction, and binder content [8] [10] [17]-[19]. The tensile (splitting) strength generally lies between 0.02 and 0.15 MPa, influenced by factors such as density and curing methods [9] [10] [13] [20] [21]. Additionally, hempcrete's specific heat capacity is observed in the range of 1000 to 1590 J/kg·K, dependent upon density, water content, and temperature [8] [13] [22]. Lastly, water absorption can significantly vary from 20% to 325% by weight, influenced by hemp shive treatment, binder type, density, composite formula, and curing time [17] [23]-[26].

3.2. Advantages of Hempcrete in Home Construction Sustainability

Given that over 95% of buildings are residential dwellings, for any meaningful

global impact on CO₂ reduction, locally sourced materials, and easy to construct methods are needed for energy-efficient and low-carbon residential buildings. One such promising material is industrial hemp [27]. Hempcrete, a plant-based biomaterial, is lightweight yet dense, and it can be cultivated in small areas with minimal pesticide use. It is fire-resistant, durable, acts as a carbon dioxide sink, is recyclable, energy-efficient, non-toxic, and insect-resistant due to its lack of protein content, making it both environmentally and construction-friendly [10] [28]-[30]. Hempcrete can be used in walls, floors, and roofs, and is available in blocks and panels that reduce construction time and cost [7]. Hempcrete has been shown to have potential in residential construction applications to improve thermal resistance of masonry walls, reduce consumption of carbon-intensive concrete, and reduce the weight of cement-based structures. [31] highlights a state-of-the-art review of hempcrete for affordable and sustainable home building and describes key research needed for this composite material to be a successful alternative to conventional wood-frame residential building construction.

3.3. Thermal Insulation

Hempcrete is a medium-density material that is relatively lightweight compared to other walling materials like stone, brick, or concrete due to its high air content and very lightweight hemp hurd as the bulk of the material. In a finished hempcrete wall, air is trapped within the microscopic pore structure of the hemp shiv and the air channels and pockets formed by the interlocking particles of hemp shiv. This trapped air gives hempcrete walls superior insulation compared to other general walling materials. However, compared to specific insulation products such as very lightweight fiber insulation like hemp or wood fiber, or sheep's wool, hempcrete performs less effectively at an equivalent thickness. Despite this, hempcrete is much cheaper than processed insulation materials and due to its medium density, it is often used to create the entire thickness of a monolithic wall. This wall typically includes only thin render, and plaster finishes or cladding on the exterior and normally plaster finish on interior surfaces. The thickness of cast hempcrete insulation is usually between 300 mm and 400 mm, providing a very high standard of insulation [5]. For dry hempcrete with densities between 200 and 400 kg/m³, thermal conductivity values range from 0.06 to 0.11 W/(m·K).

3.4. Fire Resistance

Hempcrete exhibits remarkable fire resistance due to its composition and physical properties, making it a safe choice for construction. Unlike many conventional building materials, hempcrete is non-combustible, meaning it does not ignite easily or contribute to fire spread. The lime-based binder in hempcrete creates a fire-resistant barrier that helps protect the hemp fibers from ignition. When exposed to fire, hempcrete can withstand high temperatures without losing structural integrity for extended periods. Its ability to resist flames and limit heat transfer can delay the progression of a fire, providing occupants with more time to evacuate

and reduce overall fire damage. Additionally, hempcrete does not release toxic fumes when exposed to heat, which further enhances its safety profile. These fire-resistant qualities make hempcrete an attractive option for sustainable construction projects where safety is a priority [5].

3.5. Moisture Regulation

Hempcrete is highly effective in moisture regulation due to its porous structure and vapor permeability. Its ability to absorb and release moisture helps maintain a stable indoor humidity level, creating a healthier living environment. The natural hygroscopic properties of hemp fibers allow hempcrete to absorb excess moisture from the air when humidity levels are high and release it when the air is dry. This capability prevents the buildup of condensation within walls, reducing the risk of mold and mildew growth, which can be harmful to both the structure and the occupants' health. Furthermore, the lime binder in hempcrete contributes to its moisture-regulating properties by facilitating breathability, allowing moisture to pass through without compromising structural integrity. This moisture management capability enhances the durability and longevity of hempcrete buildings while contributing to energy efficiency by reducing the need for mechanical ventilation systems. Overall, hempcrete's natural moisture performance attribute makes it an ideal material for sustainable construction, promoting comfort and well-being in living spaces [1] [5] [7] [32]. **Table 1** gives a brief explanation of the attributes of hempcrete, while **Table 2** summarizes the typical ranges, influencing factors, and key references associated with essential properties of hempcrete.

Table 1. Summary of hempcrete advantage in properties.

| Property | Details |
|--------------------|---|
| Sustainability | <ul style="list-style-type: none"> Plant-based, renewable, and biodegradable material Cultivated with minimal pesticide use Acts as a carbon dioxide sink (carbon-negative) Recyclable and non-toxic Supports low-carbon and energy-efficient construction methods |
| Thermal Insulation | <ul style="list-style-type: none"> Medium-density, lightweight due to high air content Trapped air in hemp shiv structure enhances insulation |
| Fire Resistance | <ul style="list-style-type: none"> Non-combustible; resists ignition and fire spread Lime binder provides fire-resistant barrier Maintains structural integrity under high heat No toxic fumes emitted during fire exposure |

Continued

| | |
|------------------------|---|
| Moisture Regulation | <ul style="list-style-type: none"> • Porous and vapor-permeable structure • Absorbs and releases moisture to maintain indoor humidity • Prevents condensation, mold, and mildew • Reduces need for mechanical ventilation (breathable wall) |
| Environmental Benefits | <ul style="list-style-type: none"> • Locally sourced; reduces transportation emissions • Suitable for affordable and sustainable housing • Supports low-carbon alternatives to traditional building materials |

Table 2. Data for hempcrete properties.

| Property | Typical Range | Influencing Factors | References |
|------------------------------|-----------------------------|--|-------------------------|
| Dry Density | 200 - 800 kg/m ³ | <ul style="list-style-type: none"> • Hemp-to-binder ratio • Compaction level • Water content | [9]-[13] |
| Thermal Conductivity | 0.06 - 0.18 W/(m·K) | <ul style="list-style-type: none"> • Density • Moisture content • Binder type | [9] [14]-[16] [33] |
| Compressive Strength | 0.2 - 1.5 MPa | <ul style="list-style-type: none"> • Density • Compaction • Binder content | [9] [10] [17]-[19] |
| Tensile Strength (Splitting) | 0.02 - 0.15 MPa | <ul style="list-style-type: none"> • Density • Curing method | [9] [10] [13] [20] [21] |
| Specific Heat Capacity | 1000 - 1590 J/(kg·K) | <ul style="list-style-type: none"> • Density • Water content • Temperature | [9] [13] [22] |
| Water Absorption | 20% to 325% by weight | <ul style="list-style-type: none"> • hemp shive treatment • Binder type • Density • Composite formula • Curing time | [17] [23]-[26] |

4. Industry Landscape

From ancient civilizations to modern construction practices, the use of industrial hemp has continued to be a valuable and environmentally friendly building material with a rich history and promising future [7]. In the modern construction, starting in the 1980s, hempcrete was developed as a method to enhance the thermal performance of medieval timber frame buildings. The use of hempcrete is

gaining popularity in the construction industry in recent decades, because of its sustainable properties [5]. Several companies in Europe and the UK have been producing hempcrete blocks commercially [5] [34] [35]. Hemp is a highly sustainable and efficient alternative to traditional wood-based construction, as one acre of hemp can produce as much cellulose fiber pulp as 4.1 acres of trees [36]. It grows rapidly, taking just a few months to harvest compared to decades for trees, making it a more renewable resource. Its strong fibers are ideal for use in pressed board, particle board, and formwork for concrete construction, providing a sustainable and versatile option for modern building materials. Additionally, hemp farming has a lower environmental impact, helps improve soil health, and reduces the need for harmful pesticides, making it a promising solution for sustainable construction. The hempcrete industry is growing rapidly, with companies emerging in various regions to meet the increasing demand for sustainable building materials. The industry's landscape is diverse, with companies playing different roles, from hemp cultivation to the manufacturing of hempcrete blocks and hemp wood building products.

1) Global Reach

Hempcrete companies are most prevalent in Europe, North America, and Australia, where hemp cultivation regulations have been more favorable. Europe, in particular, is a leading market for hempcrete, with countries like France, Belgium, and the UK hosting some of the largest hempcrete producers. North America is catching up, with the U.S. seeing significant growth after the 2018 Farm Bill legalized hemp cultivation on a federal level. The 2018 Farm Bill defines hemp as “the plant *Cannabis sativa* L. and any part of that plant, including the seeds thereof and all derivatives, extracts, cannabinoids, isomers, acids, salts, and salts of isomers, whether growing or not, with a delta-9 [THC] concentration of not more than 0.3 percent on a dry weight basis.”. Canada is also expanding its hemp industry to include hempcrete products, although its market is still in the early stages.

2) Types of Companies

a) Producers:

These companies focus on growing hemp and processing it into raw materials suitable for hempcrete production. Many producers are vertically integrated, controlling the entire process from farming to manufacturing.

b) Manufacturers:

Some companies specialize in producing hempcrete products, such as blocks, panels, or insulation, which can be used in various construction projects. These companies often work in collaboration with builders and architects to create eco-friendly structures.

c) Construction Firms:

These companies are involved in the practical application of hempcrete in building projects, either as contractors or consultants. They specialize in using hempcrete to design and construct buildings that meet high environmental standards.

3) Emerging Markets

While Europe and North America lead the way, other regions are showing potential for growth in the hempcrete industry. Countries worldwide are beginning to explore hempcrete as a sustainable option, with regulatory changes and a growing emphasis on green building practices spurring interest in the material [1] [2] [34] [37].

5. Company Profiles

Hempcrete can be a sustainable alternative to the traditional brick and concrete block home construction. As awareness about hempcrete and its adoption in home building continue to grow, several companies stand out for their contributions to the hempcrete industry. These firms are leading the charge in innovation, sustainability, and scalability from providing different types of products.

a) UK Hempcrete

UK Hempcrete (<https://www.ukhempcrete.com>), based in Derbyshire, works in the construction sector with focus on Hempcrete and other bio-based materials. The company benefits from a few decades of experience working with low- or zero-carbon products, whether for new buildings, renovations, or retrofitting projects—particularly in restoring and enhancing traditional and historic structures. One of the company's main products is hempcrete shown in **Figure 1**. Hempcrete can be applied to different structural elements including roofs, floors, and walls (**Figure 2**). **Figure 3** shows a hempcrete product from UK Hempcrete with natural fiber insulation and lime renders/plasters. The company seeks to accelerate the adoption and scaling of bio-based, low-embodied-carbon construction across both residential and commercial sectors. The company is involved in both new construction and retrofitting projects, with a focus on traditional and historic buildings, leveraging the vapor-permeable and carbon-sequestering nature of hempcrete to improve building sustainability and health. They also provide education through courses, webinars, and training to support effective use of hempcrete in modern construction.

UK Hempcrete plays a critical role in knowledge dissemination through its technical articles, webinars, on-site training, and professional courses. This educational infrastructure fosters industry capacity-building and shares application standards across the construction workforce. The company also contributes to establishing best practices by highlighting the influence of binder type, wall thickness, installation technique, and craftsmanship on final building performance. For example, the typical thermal conductivity of hempcrete is reported by the company as 0.06 to 0.07 W/(m·K). They point out that U-values for hempcrete vary depending on the thickness, the type of binder used, the exact specification, application techniques and the skill of contractors. They also state that typical u-value is 0.17 W/m²·K (0.03 BTU/(h·ft²·°F)) for a 350 mm thick hempcrete wall. Since the hempcrete blocks are designed for non-load bearing use, no information is reported by the company about compressive strength on their website.

While UK Hempcrete does not publicly disclose a specific mixture formula for their hempcrete products on their website, the company emphasizes the importance of using precise proportions of hemp, binder, and water during mixing, which is a factor critical to achieving optimal material consistency and structural performance. Through its combination of technical expertise, educational outreach, and tailored solutions for historic and contemporary architecture, UK Hempcrete contributes to the drive for broader adoption and normalization of bio-based materials in the global transition toward low-carbon, health-conscious construction.



(a) Hempcrete during mixing process

(b) Hempcrete ready to use

Figure 1. Hempcrete mixture (<https://www.ukhempcrete.com>; Used with permission).



(a) Roof



(b) Floor

(c) wall

Figure 2. Hempcrete used in construction from UK Hempcrete (<https://www.ukhempcrete.com>; Used with permission).

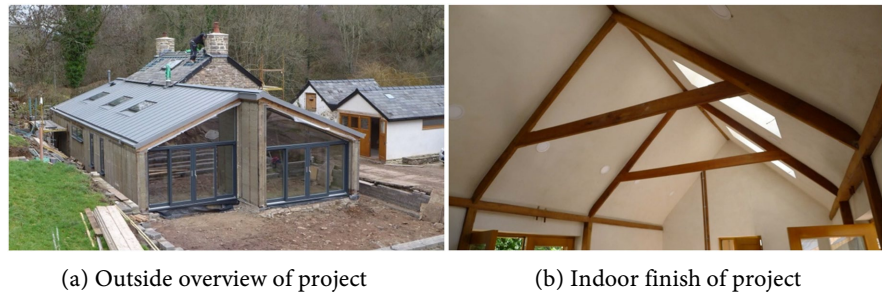


Figure 3. Hempcrete building project from UK hempcrete (<https://www.ukhempcrete.com>; Used with permission).

b) Hemp and Block (USA)

Hemp and Block (<https://hempandblock.com>) that was established in Colorado in 2018 is an American company specializing in hempcrete block made in USA. The company produces American hydraulic lime, hemp hurds, hempcrete binder, hempcrete blocks, hempcrete paver, and hempcrete garden bench. Their Hempcrete blocks range in color from off-white/beige to gray with a distinct choppy hemp texture. Their hempcrete products are lightweight (12.5 - 25 lbs./cubic foot) and strong enough to be self-supporting for building walls. These blocks provide notable insulation with R-value of 2 for every inch depth of hempcrete, depending on density. The installation method uses lime mortar (hempcrete binder + sand and/or hemp fiber) to lay blocks, which are available in sizes such as 8" × 8" × 16" (0.20 m × 0.20 m × 0.41 m) and 12" × 8" × 16" (0.30 m × 0.20 m × 0.41 m) nominal (including mortar joint), commonly used for building construction in the USA.

All raw materials are specifically sourced from within the USA to make low carbon-footprint, Made-In-USA building products. The line of hempcrete blocks manufactured by Hemp and Block are designed to meet or exceed all quality standards and expectations for use in hempcrete (hemp-lime) construction. The hempcrete blocks are strong enough to be self-supporting for building up walls but not intended to carry full structural loads, as outlined in the 2024 International Residential Code Appendix BL for Hempcrete (ICC 2024), which includes being lightweight, low-density, and non-structural [38]. Their Hempcrete blocks are promoted to be used as a high-performance and sustainable replacement for multiple conventional wall materials/components, including drywall, latex paint, fiberglass insulation, plastic wrap, OSB/plywood, and siding. The blocks can also be suitable to insulate floors and attics. The following are some feature products from Hemp and Block (**Figures 4-6**):

- Hemp and Block hempcrete provide precisely formulated hempcrete mixtures designed to meet specific construction requirements.
- For wall applications, a recommended mix ratio of 1.5 parts binder to 3 parts hemp hurd by volume produces a dense and resilient structure, suitable for high-fire-risk environments, such as industrial kitchens.
- A 1:3 binder-to-hurd ratio is suggested for standard wall construction.
- For mortar, the company advises a mix of 1 part binder to 2 parts sharp sand,

with minimal water to achieve a stiff, workable consistency.

- These formulations are optimized to enhance the mechanical and thermal performance of hempcrete, supporting durability and safety in diverse building contexts.

Hemp and Block's strategic emphasis on performance-optimized formulations and material standardization contributes to the scalability and regulatory viability of hempcrete products in the U.S. market. By aligning its product design with emerging code frameworks and offering alternatives to multiple conventional building layers within a single block, the company promotes material efficiency and supports a transition toward lower-embodied-carbon construction systems. Through these initiatives, Hemp and Block supports the domestic market for hemp-lime construction that can lead to durable, fire-safe, and thermally efficient building envelopes.

1) Hempcrete Block

The hempcrete is offered in the USA building sizes such as 8" × 8" × 16" (0.20 m × 0.20 m × 0.41 m) and 12" × 8" × 16" (0.30 m × 0.20 m × 0.41 m) nominal (including mortar joint). The blocks are cast in a quality-controlled environment and cured under strict standards (Figure 4(a)). The installation of hempcrete is simple, using lime mortar (hempcrete binder + sand and/or hemp fiber) to lay blocks (Figure 4(b)). These blocks provide notable insulation with R-value of 2 for every inch depth of hempcrete, depending on density.



(a) Hempcrete block cast and cure under strict standards and environments



(b) Block mortar made with hempcrete binder + masonry sand

Figure 4. Hempcrete block wall with lime mortar (<https://hempanblock.com>; Used with permission).

2) Hempcrete Paver

Hempcrete pavers, shown in **Figure 5**, are made from a highly dense mix of hemp and a specialized lime binder and offer a sustainable and innovative alternative to traditional paving materials. These pavers are designed for both durability and strength while providing a unique and comfortable surface for various outdoor settings.



Figure 5. Hempcrete Paver (<https://hempanblock.com>; Used with permission).

3) Hempcrete Bench

Hempcrete garden benches, illustrated in **Figure 6**, offer more than seating; they can introduce a distinctive structural element to outdoor space. The hempcrete garden bench includes a 44" × 21" × 3.5" (1.12 m × 0.53 m × 0.089 m) seat slab and two 21" × 16" × 9" (0.53 m × 0.41 m × 0.23 m) legs. The combination of the natural appeal of hemp with the durability and strength of hempcrete results in creating benches that are both functional and visually appealing. The unit texture and eco-friendly composition supports the commitment to sustainability and innovative landscaping designs. The bench is hand-finished with a beeswax-based polish made in-house, providing extra protection against environmental effects. For example, this finish causes water to bead up and run off the bench. While these details are provided on the company's website on bench's design and assembly, specific technical properties such as compressive strength are not provided.

c) HempBLOCK (USA/Australia)

HempBLOCK is an Australian manufacturer of hempcrete blocks. HempBLOCK USA (<https://hempblockusa.com/hemp-block/>) offers a range of hempcrete blocks suitable for residential, government and commercial construction projects. HempBLOCK USA provides services such as architecture design, engineering technical support, and logistic regression. The company mainly offers three types of hempcrete block, which are the following, LB 100; LB 200; LB 300 (**Figure 7**). HempBLOCK products can be used as internal and external insulation, partitions, and renovations. Besides the common environmental and construction advantages that hempcrete offers, LB 300 (**Figure 8**) comes in various



Figure 6. Hempcrete bench (<https://hempanblock.com>; Used with permission).

shapes (including LB300S, LB300C, LB300C2, LB300U) to fit into the design as beams and columns, and to use as load bearing walls for up to 2 floors structures (**Figure 8**). LB 300 blocks measure 300 mm in width, 308 mm in height, and 600 mm in length, with a weight range of 18.8 to 21 kg per block. With a wall thickness of 300 mm plus render, only 5.4 blocks are required per square meter. The blocks exhibit highly desirable thermal properties, with a thermal resistance of 4.61 m²K/W at 300 mm thickness and a thermal conductivity of 0.065 W/(m·K), and they hold a fire resistance classification of B-s1, with a fire resistance level (FRL) of 60 minutes (30 minutes with inner and outer render). HempBLOCK units are highly impact-resistant, mold- and termite-resistant, and do not emit volatile organic compounds (VOCs). They also have a dew point resistance and achieve an A+ rating for air quality. According to the company's literature (<https://hemp-blockusa.com/hemp-block/>), the blocks demonstrate excellent water buffering (2.35 g/(m²·% RH)) and vapor permeability ($\mu < 35$) with an equivalent diffusion thickness of 0.6 m. Environmentally, each square meter of wall sequesters 0.889 kg of CO₂, with a minimum wall lifespan of 100 years and 56 kg CO₂ stored per square meter. The company also provides the installation guide for HempBLOCK LB300 load bearing walls on their website along with the detailed drawings (**Figure 9**).

By addressing both structural and environmental performance, HempBLOCK USA positions its hempcrete blocks as an alternative to conventional masonry and concrete products. Through certification and provision of detailed technical documentation, the company facilitates the mainstreaming of high-performance hempcrete construction and sets new standards for scalability, resilience, and ecological responsibility in the built environment.

d) IsoHemp (Belgium)

IsoHemp (<https://www.iso hemp.com/en>) is a European manufacturer of hempcrete blocks based in Belgium. Their hemp-lime blocks, ranging from 7.5 cm

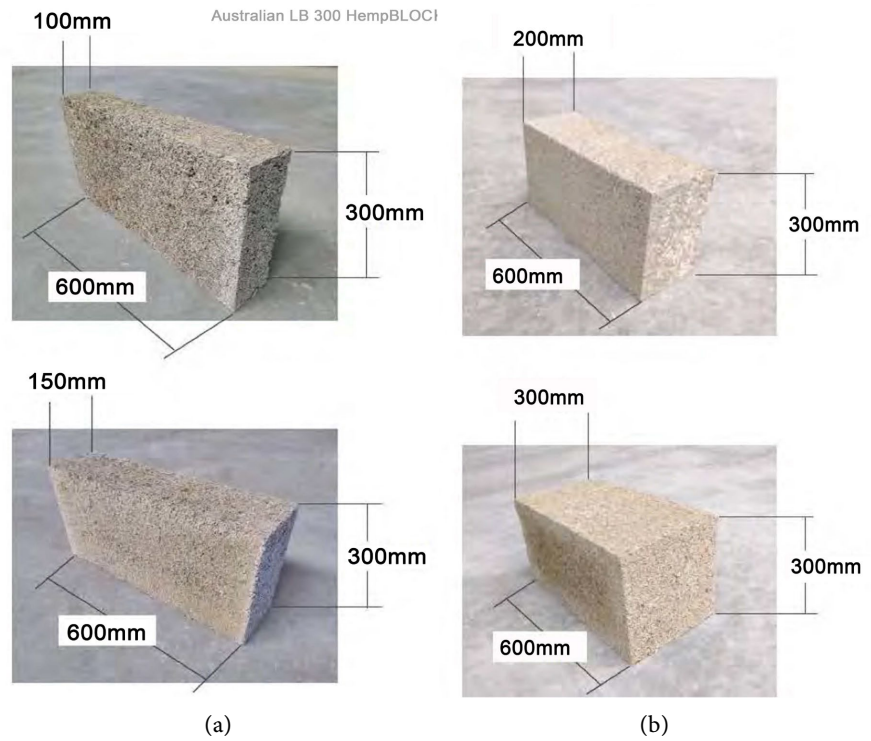


Figure 7. Different thickness of hempcrete blocks (<https://hempblockusa.com/hemp-block/>; used with permission).

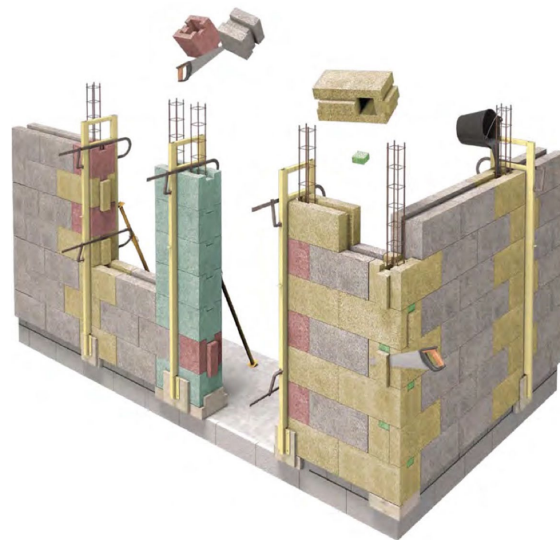


Figure 8. LB300 Load bearing wall model (<https://hemp-blockusa.com/hemp-block/>; used with permission).

to 36 cm, are used in eco-friendly building projects. Their blocks offer high thermal and acoustic insulation, as well as breathability, benefiting both energy efficiency and indoor air quality for sustainable construction. These blocks are composed of a blend of hemp fibers and a proprietary lime binder, resulting in a building material that combines the natural properties of hemp with the structural

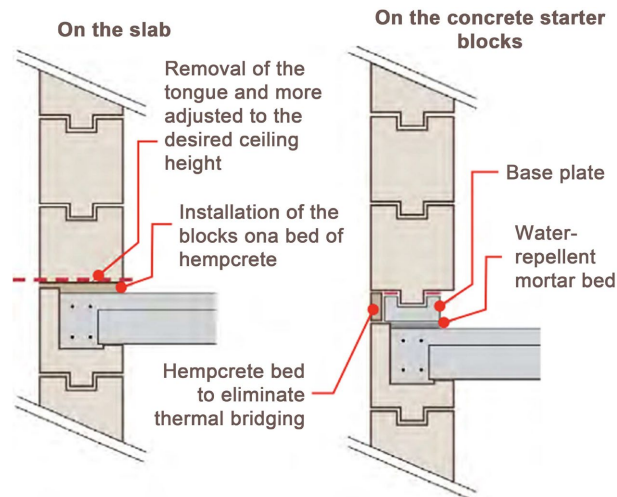


Figure 9. Details illustration for LB 300 blocks (<https://hemp-blockusa.com/hemp-block/>; used with permission).

benefits of lime. IsoHemp's hempcrete blocks offer superior thermal and acoustic insulation capabilities, while maintaining high breathability, which is crucial for regulating indoor air quality and humidity levels. This unique combination of properties makes them ideal for energy-efficient building envelopes, reducing reliance on conventional insulation methods and contributing to lower carbon footprints. Besides the normal hempcrete block, internal locking hempcrete block is also provided for enhanced construction flexibility.

IsoHemp blocks offer a thermal conductivity typically ranging from 0.06 to 0.12 W/(m·K), aiding in temperature regulation and reducing energy consumption for heating and cooling. The compressive strength of hempcrete is usually between 0.3 to 1 MPa (43.5 to 145.0 psi) [10] [39]. Their hempcrete block has a) a density of 300 - 500 kg/m³ (0.0108 - 0.0181 lb/in³), b) excellent acoustic insulation, and c) significant fire resistance, often rated at 1 - 2 hours based on thickness. Its vapor permeability supports indoor moisture regulation, reducing the potential for mold. IsoHemp's blocks promote sustainability by utilizing renewable raw materials and enabling carbon sequestration during the hemp cultivation process.

IsoHemp's contributions extend beyond product development and into market transformation. IsoHemp also contributes to the advancement of sustainable construction materials, demonstrating how natural, renewable resources can be harnessed to develop innovative solutions for the building industry. By leveraging industrial-scale manufacturing, the company supports the adoption of hempcrete across Europe and is actively pursuing international expansion. IsoHemp makes effort to demonstrate how natural, renewable resources can be industrialized into high-performing, carbon-reducing alternatives to conventional materials, while helping to accelerate the integration of hemp-lime technologies into regulatory frameworks, architectural practices, and sustainable construction standards worldwide, exploring international opportunities to promote the adoption of hempcrete technology.

e) Hempitecture

Hempitecture (<https://www.hempitecture.com/>) is a U.S.-based company focused on manufacturing sustainable building materials from hemp. They produce hemp-based insulation and prefabricated insulations, which are designed for both residential and commercial projects. HempWool is a non-toxic, natural insulation material designed for use in wood and metal framing systems, including exterior walls, floors, ceilings, and interior walls. HempWool that is offered in panel thickness of 2 in., 3.5 in., 5.5 in., and 7.5 in. HempWool provides effective thermal resistance with an approximate R-value of 3.7 per inch.

Another highly desirable HempWool property is sound insulation by absorbing noise, thus enhancing acoustic comfort indoors. Its hygroscopic nature allows it to regulate moisture by absorbing and releasing water vapor, supporting balanced indoor humidity levels. Treated with natural fire retardants, HempWool meets fire safety standards, and as a non-toxic, volatile organic compound (VOC)-free material, it promotes healthier indoor air quality. It can easily fit in any shape using friction-fit, which helps to make sure that the insulation will not slump or sag in the cavity. Hemp fiber batt is VOC-free, nontoxic, and treated with natural fire retardant.

Furthermore, Hempitecture plays a strategic role in supply chain diversification and product accessibility by serving as a distributor for IsoHemp hemp blocks in North America. This dual role—as both manufacturer and distributor—demonstrates the company's commitment to expanding the availability of hemp-based building systems across scales and typologies.

f) HempStone

Located in Massachusetts, U.S., HempStone (<https://hempstone.net>) specializes in hempcrete construction, advisory, research, education, and supply. They offer expertise in both building with hempcrete and educating others on how to incorporate it into sustainable construction projects. HempStone also provides all kinds of services regarding consultation, design schematic review, construction drawing review, and on-site constructor training. **Figure 10** shows the process of applying hempcrete spray onto wood frame by HempStone staff. **Figure 11** is the wood frame before adding hempcrete, and **Figure 12** is the wall after hempcrete spraying completed. The company is working to develop a local, abundant, and renewable supply chain for hempcrete while importing materials from Europe and Canada collaborating with domestic process throughout the U.S.

HempStone is also engaged in developing a localized and renewable hempcrete supply chain within the U.S. It collaborates with domestic processors to strengthen regional sourcing and reduce supply chain carbon footprints. This strategic focus on supply chain resilience enhances the long-term viability and accessibility of hemp-lime construction materials in North America. Through its comprehensive approach—combining technical implementation, professional training, design consultation, and supply chain advocacy—HempStone contributes to the normalization of hempcrete in architectural practice. The company's integrated model

exemplifies how service-oriented enterprises can play a catalytic role in aligning material innovation with construction industry transformation and environmental sustainability goals.



Figure 10. Spaying hempcrete on the wall (<https://hempstone.net>; used with permission).



Figure 11. Wood frame of structure before Hempcrete is applied (<https://hempstone.net>; used with permission).



Figure 12. Hempcrete wall insulation (<https://hempstone.net>; used with permission).

g) Just BioFiber (Canada)

Just BioFiber (<http://justbiofiber.ca>), a Canadian-based company, has pioneered an interlocking hempcrete block system designed for efficient assembly for both residential and commercial construction projects. Their Lego-style blocks sim-

plify the building process and enhance structural stability, allowing builders to reduce construction time significantly while maintaining the benefits of hempcrete's thermal insulation and sustainability. The blocks feature an internal structural frame that interlocks when stacked, significantly increasing compressive strength, allowing the construction of multi-story buildings. Made from bio-composite materials. These blocks are resistant to deformation from heat and exhibit excellent fire resistance, thermal insulation, and high thermal mass, making them suitable for diverse environmental conditions. Additionally, they are equipped with pre-reserved holes for wiring, facilitating efficient integration of electrical circuits. The modular system includes standard components such as blocks, channels for windows and doors, starter strips, wall caps, and adhesive materials, simplifying assembly and reducing the need for specialized tools. This innovative approach aims to provide a sustainable, efficient, and resilient solution for modern construction needs.

Just BioFiber has addressed some of the scalability challenges traditionally associated with hempcrete such as load-bearing limitation, positioning their system as a practical solution for a wider range of construction applications. The blocks are manufactured from hemp-based bio-composites and exhibit robust fire resistance, desirable thermal insulation, and thermal mass. The modular system includes standardized components such as starter strips, wall caps, window and door channels, and specialized adhesives.

The objective of Just BioFiber's product line includes a shift toward industrialized, sustainable construction practices that consider replicability, efficiency, and environmental performance. The company makes efforts to significantly lower the technical barriers for adoption while enhancing structural reliability and compliance potential. By addressing critical issues such as load-bearing capability and modular integration, Just BioFiber establishes new benchmarks for functional performance and construction adaptability in the green building industry.

h) American Lime Technology (UK/USA)

American Lime Technology (<http://www.americanlimetechnology.com>) operates in both the UK and the U.S., producing a variety of eco-friendly building products, aiming to support low-carbon, sustainable construction. The company offers a wide range of sustainable low carbon building systems for mainstream construction including lime mortars and lime renders, Tradical® Hemcrete®, External Wall Insulation systems and breathe® hemp insulation. The products range span several innovative systems, including "Tradical® Hemcrete®", "Hemclad®" pre-cast wall system, "Hembuild®" pre-cast wall system, "USHG ("USHG" stands for U.S. Heritage Group, Inc)" lime mortars, "USHG" lime plasters, "USHG" old world European limewash, and "Baumit (Baumit is a European manufacturer of building materials)" lime stucco & plasters. They have been instrumental in bringing hempcrete into mainstream construction, particularly through their collaboration with architects and builders on innovative projects. The company also focuses on education, offering training for builders interested in using hempcrete.

A “Tradical® Hemcrete®” standard system (Figure 13) comprises plaster skim, “limetec” board, Timber frame, Horizontal batten to ties “Tradical® Hemcrete®” to the timber frame, “Tradical® Hemcrete®” 275 mix, 15mm FL68 basecoat render, Mesh as required within the basecoat, and 3 mm “SEP” (“SEP” refers to a specific type of render finish used in conjunction with Tradical® Hemcrete® construction) top coat render to alternative approved render finish.

In addition to its technical innovations, it plays an active educational role through its training programs for builders and contractors. These initiatives contribute to workforce development and ensure consistent installation quality across projects. The company’s integrated product offerings, commitment to professional education, and engagement with the broader construction ecosystem have significantly accelerated the mainstreaming of hemp-lime construction. The American Lime Technology contributes to innovation and market-driven strategies that can reshape industry standards and catalyze the widespread adoption of sustainable building materials.

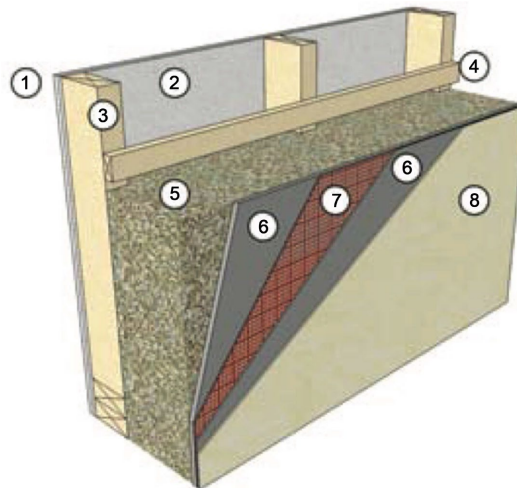


Figure 13. A Tradical Hemcrete standard system by American Lime Technology (US Heritage Group, <http://www.americanlimetechnology.com>; used with permission).

i) Tiny Hemp Houses

Tiny Hemp Houses (<http://www.tinyhemphouses.com>), based in Colorado, focuses on hempcrete construction, education, and workshops, offering hands-on experience for builders interested in using hemp-based materials in small home projects. The company also offers workshops centered around building with hempcrete—from sourcing the materials to mixing the recipe and installing it. They aim to enlighten builders, architects, urban planners, municipal authorities, property owners, and individuals about the promise of building with hemp. The company provides hands-on workshops that cover various aspects of hempcrete construction, including material sourcing, mixing techniques, and application methods. In addition to educational initiatives, Tiny Hemp Houses offers custom-

izable building solutions for both private and commercial purposes. Their projects include county cottages, guest rooms, and office places.

Tiny Hemp Houses offers customizable design and construction solutions for small-scale structures such as guest cottages, office spaces, and accessory dwelling units. Such product lines serve as practical case studies that demonstrate the viability and aesthetic potential of hemp-lime construction. By delivering tangible examples of performance and usability, Tiny Hemp Houses contributes to validating hempcrete as a legitimate alternative to traditional materials.

j) Hemp Building Company

Hemp Building Company (<https://www.hempbuildingco.com>), located in Texas, specializes in providing materials, installation, plastering, consultation, and educational workshops for both residential and commercial projects. Focused on ecological construction, the company aims to reduce the carbon footprint of building practices by offering sustainable alternatives to conventional methods.

The team at Hemp Building Company is proficient in all major hemp-lime installation techniques, including cast-in-situ, spray cast, and the use of hemp-lime blocks and panels. These methods offer flexibility in adapting to various architectural designs and structural needs. The cast-in-situ method, for example, allows for seamless application of hemp-lime around complex shapes and forms, while spray casting facilitates rapid coverage and consistent thickness. The use of hemp-lime blocks and panels, on the other hand, enables modular construction approaches, reducing overall build time.

In addition to their construction services, Hemp Building Company engages in research and development to refine hemp-lime's performance characteristics, collaborating with academic institutions and industry partners to enhance its structural integrity and long-term durability. The company contributes to the empirical validation of hempcrete's long-term durability, fire resistance, and insulation capabilities. These efforts serve to bridge the gap between experimental innovation and regulatory acceptance, thereby facilitating integration into building codes and certification systems such as LEED and Passive House. Collectively, Hemp Building Company's activities exemplify how targeted innovation, technical dissemination, and strategic partnerships can accelerate material acceptance and elevate industry standards for low-carbon construction.

k) Homeland Hempcrete

Located in Bismarck, ND, Homeland hempcrete (<https://www.homelandhempcrete.com>) influences the broader hempcrete and eco-conscious construction industry by providing a fully complete and ready to use cabin (Figure 14). The 150 ft² cabin model is built completely offsite then delivered to the destination and ready for use immediately. The innovative practice of offsite construction followed by direct-to-site delivery effectively streamlines the building process, reducing construction timelines, labor costs, and environmental footprint. The cabin has insulated floors and roof, and the walls are composed of hempcrete insulation. Beyond hempcrete, eco-conscious materials are used throughout, in-

cluding cork flooring, wood wool board walls, natural wood ceilings and finishes. The cabin is suitable for various uses, including temporary housing. This approach establishes a new industry benchmark, encouraging other builders to adopt similar prefabrication methods to enhance efficiency and sustainability standards. Additionally, Homeland Hempcrete provides multiple customizable designs.



Figure 14. All-In-One hempcrete cabin (<https://www.home-landhempcrete.com>; used with permission).

6. Challenges and Opportunities

1) Challenges

a) Regulatory Issues

Hemp cultivation and the use of hemp-based products are still subject to stringent regulations in numerous countries around the world. The varying legal frameworks and inconsistent regulations across regions create significant barriers to industry growth. In many jurisdictions, hemp cultivation is restricted or allowed only under specific conditions, limiting its potential as a mainstream material in the construction industry. For instance, in Italy, proposed legislation seeks to ban products derived from the hemp flower, threatening the nascent ‘cannabis light’ industry and potentially impacting thousands of jobs. As a result, these regulatory hurdles slow down research, commercialization, and adoption of hemp-based products, making it difficult for companies to scale their operations and for builders to use hemp materials in projects, even in regions where its benefits are well recognized.

b) Building Codes

Despite its favorable environmental and structural properties, hempcrete has not yet been fully incorporated in the building codes of many countries. Recent efforts, such as the Appendix BA Hemp-Lime (Hempcrete) Construction in the International Residential Code (IRC) for the 2024 edition (ICC 2024), have begun

to address this gap. This appendix provides guidelines on hempcrete's application as a non-load-bearing material, specifying requirements for thickness, fire resistance, and insulation properties [38]. The inclusion of hempcrete in the IRC is an essential acknowledgment of the material's unique properties and allows for greater standardization, offering architects and engineers a clear framework within which to work. However, the code currently limits hempcrete to non-structural applications, which restricts its use in multi-story or high load bearing contexts. This lack of standardization makes it challenging for builders and contractors to use hempcrete in conventional construction projects. The absence of established guidelines and specifications for hempcrete applications means that it often does not meet the requirements for safety, fire resistance, and durability as defined by existing codes. It's hard to find the complete load-bearing properties such as compressive strength of hempcrete on products description on companies' websites since hempcrete is accepted as non-load bearing material/component in the current code (for now as an appendix), which restricts its application to nonstructural uses, mainly such as insulation. Consequently, extensive testing, certification, and advocacy are needed to establish standards that will allow for broader adoption of hempcrete and encourage its inclusion in mainstream construction practices.

c) Scalability

Although hempcrete presents a sustainable and eco-friendly alternative to some traditional construction materials such as concrete and masonry blocks, scaling its production to meet the demands of the global construction sector remains a considerable challenge. The scalability issue involves enhancing the efficiency of hemp cultivation, optimizing the processing of hemp fibers, and increasing the capacity of manufacturing facilities to produce hempcrete components. Additionally, there is a need for investment in infrastructure and technology to support large-scale production, which would drive down costs and improve the supply chain. From the review of current hempcrete companies, one can conclude that they are still in their exploring states and research and development of their products. Addressing these challenges is crucial for the industry to meet the growing demand for sustainable building materials and establish hempcrete as a viable alternative to traditional masonry or concrete for certain applications.

2) Opportunities

a) Environmental Benefits

Hempcrete's ability to sequester carbon dioxide, its low energy consumption during production, and its natural insulation properties position it as an ideal material for green buildings. During its lifecycle, hempcrete can absorb up to 165 kg of CO₂ per cubic meter. This carbon-negative property supports the reduction of greenhouse gas emissions, aligning well with net-zero carbon targets sought by architects, builders, and policymakers who are thriving to achieve net-zero carbon construction. Also, because of hempcrete's thermal conductivity, typically around 0.06 - 0.12 W/(m·K), it offers effective insulation, reducing the energy needed for

heating and cooling. In addition, hempcrete allows for natural ventilation of the building, promoting healthier indoor air quality and mitigating moisture-related issues. The environmental and functional advantages of hempcrete drives its adoption as a key material in the transition from traditional building materials towards sustainable ones.

b) Government Support

Governments around the world are beginning to recognize the importance of sustainable building materials and are introducing policies and incentives to promote their use. For example, in the USA. The code officials recently included hemp-lime (hempcrete) construction in the 2024 International Residential Code (IRC) (for now as an appendix), providing standardized guidelines that support its adoption in residential buildings [38]. The integration acceptance of hempcrete into building codes provides crucial financial support impetus needed to enhance the momentum toward application of hempcrete in practice, which makes it easier for companies to invest in hempcrete production and utilization. Subsidies, tax credits, and grants for green construction projects could significantly accelerate the growth of the hempcrete industry. Such support would not only benefit the environment but also create economic opportunities and promote innovation within the construction sector, fostering a more sustainable and resilient industries.

c) Innovations in Prefabrication

Innovations in the prefabrication of hempcrete blocks and panels are transforming the construction landscape by simplifying the building process and reducing project timelines. Prefabricated hempcrete components offer a more efficient method of construction, enabling builders to assemble structures faster and with greater precision. These prefabricated systems also help to minimize material waste and labor costs, making hempcrete a more commercially viable option for large-scale projects. Continued research and development in prefabrication technology could lead to further improvements in the material's performance, ultimately enhancing its market appeal and accessibility. Furthermore, prefabricated hempcrete elements can be designed with embedded channels for electrical and plumbing systems, further simplifying the installation process and minimizing the need for on-site adjustments. These innovations also help reduce material waste by using exact measurements and standardized molds, cutting labor costs and enhancing cost predictability for large-scale projects. Continued development in this area could greatly enhance hempcrete's market appeal, making it a more accessible, eco-friendly alternative in mainstream construction.

7. Conclusions

The hempcrete industry is currently at a pivotal juncture, with numerous companies contributing to its growth through research, production, innovation, and actual hempcrete construction. These contributions span the entire supply chain, from hemp cultivation and processing to manufacturing and construction, laying

the foundation for a more sustainable building future. This review has highlighted the diverse landscape of companies contributing to hempcrete's development. Developments such as the inclusion of hempcrete in the 2024 International Residential Code support for hemp-based projects, underscores the growing recognition of hempcrete as a viable alternative to traditional building materials. Despite the challenges associated with regulation, scalability, and market adoption, the potential benefits of hempcrete—both environmental and economic—are profound. Its potential to sequester carbon, improve indoor air quality, and reduce energy consumption offers architects, builders, and policymakers a pathway toward sustainable building practices.

Despite the challenges associated with regulation, scalability, and market adoption, the potential benefits of hempcrete—both environmental and economic—are profound. Its potential to sequester carbon, improve indoor air quality, and reduce energy consumption offers architects, builders, and policymakers a solution toward sustainable building practices. Furthermore, advancements in technology such as prefabricated hempcrete panels, improved insulation properties, and the development of higher strength hempcrete through novel binders and additives present significant opportunities for enhancing its performance and adoption.

As the industry continues to evolve, it will be essential for companies to engage in dialogue and collaboration with regulators, builders, and architects to establish the necessary standards and building codes as well as practical design details that will facilitate broader acceptance of hempcrete as a construction material especially in enhancing hempcrete to load-bearing structural elements. By overcoming these barriers, the hempcrete industry has the opportunity to play a transformative role in the global shift toward sustainable buildings, helping to mitigate climate change and support the development of a resilient and sustainable economy.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

- [1] Lupu, M.L., Isopescu, D.N., Baci, I., Maxineasa, S.G., Pruna, L. and Gheorghiu, R. (2022) Hempcrete—Modern Solutions for Green Buildings. *IOP Conference Series: Materials Science and Engineering*, **1242**, Article ID: 012021. <https://doi.org/10.1088/1757-899x/1242/1/012021>
- [2] Jami, T., Karade, S.R. and Singh, L.P. (2019) A Review of the Properties of Hemp Concrete for Green Building Applications. *Journal of Cleaner Production*, **239**, Article ID: 117852. <https://doi.org/10.1016/j.jclepro.2019.117852>
- [3] Sáez-Pérez, M.P., Durán-Suárez, J.A. and Castro-Gomes, J. (2022) Improving the Behaviour of Green Concrete Geopolymers Using Different HEMP Preservation Conditions (Fresh and Wet). *Minerals*, **12**, Article No. 1530. <https://doi.org/10.3390/min12121530>
- [4] Nozahic, V., Amziane, S., Torrent, G., Saïdi, K. and De Baynast, H. (2012) Design of

- Green Concrete Made of Plant-Derived Aggregates and a Pumice-Lime Binder. *Cement and Concrete Composites*, **34**, 231-241.
<https://doi.org/10.1016/j.cemconcomp.2011.09.002>
- [5] Stanwix, W. and Sparrow, A. (2014) The Hempcrete Book: Designing and Building with Hemp-Lime.
- [6] Asokan, R., Rathanasamy, R., Paramasivam, P., Chinnasamy, M., Pal, S.K. and Palaniappan, S.K. (2023) Hemp Composite. In: Inamuddin, Altalhi, T. and Alrooqi, A., Eds., *Green Sustainable Process for Chemical and Environmental Engineering and Science*, Elsevier, 89-112. <https://doi.org/10.1016/b978-0-323-95167-8.00007-7>
- [7] Yadav, M. and Saini, A. (2022) Opportunities & Challenges of Hempcrete as a Building Material for Construction: An Overview. *Materials Today: Proceedings*, **65**, 2021-2028. <https://doi.org/10.1016/j.matpr.2022.05.576>
- [8] Abdellatef, Y. and Kavgic, M. (2020) Thermal, Microstructural and Numerical Analysis of Hempcrete-Microencapsulated Phase Change Material Composites. *Applied Thermal Engineering*, **178**, Article ID: 115520.
<https://doi.org/10.1016/j.applthermaleng.2020.115520>
- [9] Abdellatef, Y., Khan, M.A., Khan, A., Alam, M.I. and Kavgic, M. (2020) Mechanical, Thermal, and Moisture Buffering Properties of Novel Insulating Hemp-Lime Composite Building Materials. *Materials*, **13**, Article No. 5000.
<https://doi.org/10.3390/ma13215000>
- [10] Asghari, N. and Memari, A.M. (2024) State of the Art Review of Attributes and Mechanical Properties of Hempcrete. *Biomass*, **4**, 65-91.
<https://doi.org/10.3390/biomass4010004>
- [11] Kore, S.D. and Sudarsan, J.S. (2021) Hemp Concrete: A Sustainable Green Material for Conventional Concrete. *Journal of Building Material Science*, **3**, 1-7.
<https://doi.org/10.30564/jbms.v3i2.3189>
- [12] Muhit, I.B., Omairey, E.L. and Pashakolaie, V.G. (2024) A Holistic Sustainability Overview of Hemp as Building and Highway Construction Materials. *Building and Environment*, **256**, Article ID: 111470.
<https://doi.org/10.1016/j.buildenv.2024.111470>
- [13] Steyn, K., de Villiers, W. and Babafemi, A.J. (2025) A Comprehensive Review of Hempcrete as a Sustainable Building Material. *Innovative Infrastructure Solutions*, **10**, Article No. 97. <https://doi.org/10.1007/s41062-025-01906-1>
- [14] Collet, F. and Pretot, S. (2014) Thermal Conductivity of Hemp Concretes: Variation with Formulation, Density and Water Content. *Construction and Building Materials*, **65**, 612-619. <https://doi.org/10.1016/j.conbuildmat.2014.05.039>
- [15] D'Eusanio, V., Rivi, M., Malferrari, D. and Marchetti, A. (2024) Optimizing Hempcrete Properties through Thermal Treatment of Hemp Hurds for Enhanced Sustainability in Green Building. *Sustainability*, **16**, Article No. 10404.
<https://doi.org/10.3390/su162310404>
- [16] Walker, R. and Pavia, S. (2014) Moisture Transfer and Thermal Properties of Hemp-lime Concretes. *Construction and Building Materials*, **64**, 270-276.
<https://doi.org/10.1016/j.conbuildmat.2014.04.081>
- [17] Ansari, H., Tabish, M. and Zaheer, M.M. (2025) A Comprehensive Review on the Properties of Hemp Incorporated Concrete: An Approach to Low Carbon Footprint Construction. *Next Sustainability*, **5**, Article ID: 100075.
<https://doi.org/10.1016/j.nxsust.2024.100075>
- [18] Dhakal, U., Berardi, U., Gorgolewski, M. and Richman, R. (2017) Hygrothermal Per-

- formance of Hempcrete for Ontario (Canada) Buildings. *Journal of Cleaner Production*, **142**, 3655-3664. <https://doi.org/10.1016/j.jclepro.2016.10.102>
- [19] Phetcharat, S., Buntan, R., Budcha, P. and Ruekrai, R. (2024) Enhancing the Compressive Strength of Hemp Fiber Reinforced Cement and Evaluating Thermal Protection Performance. *Suranaree Journal of Science and Technology*, **31**, Article ID: 010329. <https://doi.org/10.55766/sujst-2024-05-e04266>
- [20] Mazhoud, B., Collet, F., Pretot, S. and Lanos, C. (2017) Mechanical Properties of Hemp-Clay and Hemp Stabilized Clay Composites. *Construction and Building Materials*, **155**, 1126-1137. <https://doi.org/10.1016/j.conbuildmat.2017.08.121>
- [21] Adam, L. and Isopescu, D. (2022) Physico-Mechanical Properties Investigation of Hempcrete. *Journal of Applied Life Sciences and Environment*, **55**, 75-84. <https://doi.org/10.46909/alse-551047>
- [22] Bumanis, G. and Bajare, D. (2022) PCM Modified Gypsum Hempcrete with Increased Heat Capacity for Nearly Zero Energy Buildings. *Environmental and Climate Technologies*, **26**, 524-534. <https://doi.org/10.2478/rtuct-2022-0040>
- [23] Walker, R. and Pavia, S. (2014) Moisture Transfer and Thermal Properties of Hemp-lime Concretes. *Construction and Building Materials*, **64**, 270-276. <https://doi.org/10.1016/j.conbuildmat.2014.04.081>
- [24] Jiang, Y., et al. (2020) Physico-Chemical Characterization and Development of Hemp Aggregates for Highly Insulating Construction Building Materials. In: Crini, G. and Lichtfouse, E., Eds., *Sustainable Agriculture Reviews 42: Hemp Production and Applications*, Springer, 147-170.
- [25] Zelca, Z., Kukle, S. and Kajaks, J. (2019) Water Absorption and Tensile Properties of Hemp Waste and Polyethylene Composites. *IOP Conference Series: Materials Science and Engineering*, **500**, Article ID: 012003. <https://doi.org/10.1088/1757-899x/500/1/012003>
- [26] Demir, İ. and Doğan, C. (2020) Physical and Mechanical Properties of Hempcrete. *The Open Waste Management Journal*, **13**, 26-34. <https://doi.org/10.2174/1874312902014010026>
- [27] Antonio, A.T.J., Gana, D., Adukeye, E. and Ahuchaogu, C. (2023) Unlocking the Socioeconomic Advantages of *Cannabis sativa* L. Legalization in African Countries: An In-Depth Review. *Global Journal of Agricultural Research*, **11**, 32-52. <https://doi.org/10.37745/gjar.2013/vol11n13252>
- [28] Pietruszka, B., Gołębiewski, M. and Lisowski, P. (2019) Characterization of Hemp-Lime Bio-Composite. *IOP Conference Series: Earth and Environmental Science*, **290**, Article ID: 012027. <https://doi.org/10.1088/1755-1315/290/1/012027>
- [29] Heidari, M.D., Lawrence, M., Blanchet, P. and Amor, B. (2019) Regionalised Life Cycle Assessment of Bio-Based Materials in Construction; the Case of Hemp Shiv Treated with Sol-Gel Coatings. *Materials*, **12**, Article No. 2987. <https://doi.org/10.3390/ma12182987>
- [30] Jankovic, L. and Carta, S. (2021) Biozero—Designing Nature-Inspired Net-Zero Building. *Sustainability*, **13**, Article No. 7658. <https://doi.org/10.3390/su13147658>
- [31] Yi, H., Griffin, C., Memari, A., Lanning, D. and Dooley, J.H. (2020) Hempcrete for as Residential Construction Material: State-of-the-Art and Challenges. *Proceedings of the 5th Residential Building Design and Construction Conference*, University Park, 4-6 March 2020, 10 p. <https://www.congress.gov/bill/115th-congress/senate-bill/2667>
- [32] Zuabi, W. and Memari, A.M. (2021) Review of Hempcrete as a Sustainable Building Material. *International Journal of Architecture, Engineering and Construction*, **10**, 1-

17.

- [33] Kinnane, O., Reilly, A., Grimes, J., Pavia, S. and Walker, R. (2016) Acoustic Absorption of Hemp-Lime Construction. *Construction and Building Materials*, **122**, 674-682. <https://doi.org/10.1016/j.conbuildmat.2016.06.106>
- [34] MacDougall, C. (2008) Natural Building Materials in Mainstream Construction: Lessons from the UK. *Journal of Green Building*, **3**, 1-14. <https://doi.org/10.3992/jgb.3.3.1>
- [35] Ip, K. and Miller, A. (2012) Life Cycle Greenhouse Gas Emissions of Hemp-Lime Wall Constructions in the UK. *Resources, Conservation and Recycling*, **69**, 1-9. <https://doi.org/10.1016/j.resconrec.2012.09.001>
- [36] Herer, J. (2000) The Emperor Wears No Clothes. The Authoritative Historical Record of Cannabis and the Conspiracy against Marijuana.
- [37] Bas, Y.J., Kamal, I., Muhsin, H., Najat, C. and Syamand, M. (2022) Hempcrete a Renewable Material for Green Building: Manufacturing and Properties Optimization. *AIP Conference Proceedings*, **2660**, Article ID: 020091. <https://doi.org/10.1063/5.0108734>
- [38] International Code Council (2024) International Residential Code for One- and Two-Family Dwellings: Appendix BL-Hemp Lime (Hempcrete) Construction.
- [39] Asghari, N. (2024) Study of Effective Experimental Approaches to Improve Hempcrete's Compressive Strength.