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*Research Article*

# Using Hemp for Walls as a Sustainable Building Material

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**Abstract**

As an ancient plant from thousands of years ago, Hemp has been used as the most prominent sustainable material in buildings and other fields. Hemp has great potential to be used as a building material and can be grown in Cyprus weather with less cost than other imported building materials. Hemp's initial cost is mostly cheaper than the other insulation materials; in the long term can save almost 50% of the total energy cost. It is being used as a load-bearing construction material, the best insulator. This study proposed a detached house where Hemp can be used for walls as structure (load-bearing) and floors and roofs as plastering layers.



## 1. Introduction

Hemp or industrial Hemp is found in the northern part of the earth. It is a kind of the Cannabis sativa plant family grown for various uses in the industry. Also, it is amongst the fast-growing plants which can be easily grown. Hemp can be the raw material for numerous commercial substances, such as; biodegradable plastics, paper, insulation materials, biofuel, textiles, paint, food, and animal food [1].

Hemp had a significant role in ancient architecture as a building material, especially during Roman Empire. It was used by mixing with lime. This method of using Hemp has not continued to our recent times or is almost neglected. Recently, some endeavours can be found trying to find a way to revive using Hemp in construction; even these attempts are not at a persuasive level. This paper aims to explain the potential of Hemp as a sustainable building material and its influences on the economy, human health, acoustic benefits, etc. by using residential-detached houses for Cyprus weather.

## 2. Literature review

### 2.1. Hemp

Hemp (Cannabis sativa), a field crop native to Central Asia, has been found worldwide in tropical and temperate regions. It is a rapidly growing, resistant plant that produces a regular crop in the UK, with stalks up to 4m in height [2]. Though Hemp is a temporary crop, most nations utilize it as a rotating crop to rejuvenate farm areas since it promotes soil health [3].

Hemp is farmed for various purposes, the most common for the stem's bast (phloem) fibre. The stem comprises two parts: a fibre sheath wrapped around a woody core known as shive, hurd, or shiv, and the stem itself [4]. Because of its length, strength, endurance, and resilience to decomposition, the fibre is highly prized and widely used for ropes, paper, sails, and nets. Small and Marcus [5] note that one of the first sources of textile fiber was Hemp, which has been used in clothing for at least six thousand years [5].

Concerning construction, Merlino [6] describes two types of embodied energy: the initial form, which may be the nonrenewable energy needed for the purchase of raw materials, refinement, manufacture, delivery to site, and construction, and the recurrent form, which is the nonrenewable energy used for the upkeep, repair, restoration, refurbishing, or replacement of materials, elements, or systems throughout the structure.

One essential issue is the possibility of producing Hemp in a particular environment, as short transit routes are critical to sustainability. Hemp flourishes in various temperatures and soil types, with temperate regions between 25°-55° latitude providing the ideal conditions [6] and nutrient-rich, somewhat alkaline soils [7]. Hemp necessitates at least 600 - 700mm of rain each year. Although Hemp can resist temperatures below zero for extended periods, steep slopes and heights more than 400 m above sea level are not ideal [8].

### 2.2. Hempcrete

Hemp shivs, a byproduct of the manufacture of hemp fiber, are combined with lime to create Hempcrete, which may be used to insulate walls, floors, and roofs. According to Ahlberg, et al. [9], a vapor-permeable or "breathable" building material, such as Hempcrete, uses a combination of thermal and hygroscopic qualities to offer both great thermal efficiency and a healthy interior climate. The material is a biocomposite mostly formed of Hemp and lime and is fire- and acoustically resistant. A non-fossil, organic,

and carbon-negative crop, Hemp may also frequently be grown without pesticides, fungicides, or other chemicals.

### 2.2.1. Hempcrete as an infill in construction

A bio-composite material known as lime-hemp is created by combining hemp shiv and a lime-based binder with water. Similar to how Hemp was first used in concrete, lime-hemp uses shiv as a lightweight aggregate and lime as a binder and preservative. This composite material is robust, lightweight, and long-lasting, with excellent thermal insulation and vapour permeability.

However, its poor compressive strength is usually used as filler in a load-bearing frame, including wood or a surface coating over masonry [10]. On-site, lime-hemp is tamped or sprinkled into the formwork, which may be removed quickly because the combination holds its shape. When the wall is finished, and the shuttering is eliminated,

Depending on conditions and temperature, the hemp-lime mixture was left to dry for 4–8 weeks. Alternatively, customized pre-cast lime-hemp blocks have been designed to fit around a wood frame, giving a less weather-dependent solution during construction [4].

### 2.2.2. Hempcrete as a load-bearing material

The resultant block walls have outstanding thermal mass but are denser and have less effective thermal insulation, even if lime-hemp and sand blocks may be load-bearing [4].

The technology of producing compressed blocks from lime-hemp materials as load-bearing components has been developed. They do, however, necessitate the addition of sand, which significantly decreases their thermal performance while also increasing the material's embodied energy due to extra preparation and higher density.

## 3. Methodology

A quantitative research methodology and an inductive approach to the literature were employed in this study. The present body of research on using Hemp is the main subject of this study. A literature survey has been carried out as a result. This study compares the results of a previous study on residential houses in North Cyprus and suggests using Hemp as insulation in place of imported industrial materials.

### 3.1 Case study: Using Hemp for residential houses in Cyprus

Cyprus is the Mediterranean's warmest and driest island. It has more sunlight than any other Mediterranean resort, with an average of 340 days of sunshine each year. The rain lasts from November through March, with December and February seeing the most rainfall. The spring season is pleasant. Early May could be windy, but the temperature has begun to rise by the middle of May. The temperature may reach well over 30 degrees Celsius in July and August. Autumn lasts through November. The maximum temperature reaches about 34 degrees during August, as seen in Figure 1 [11].

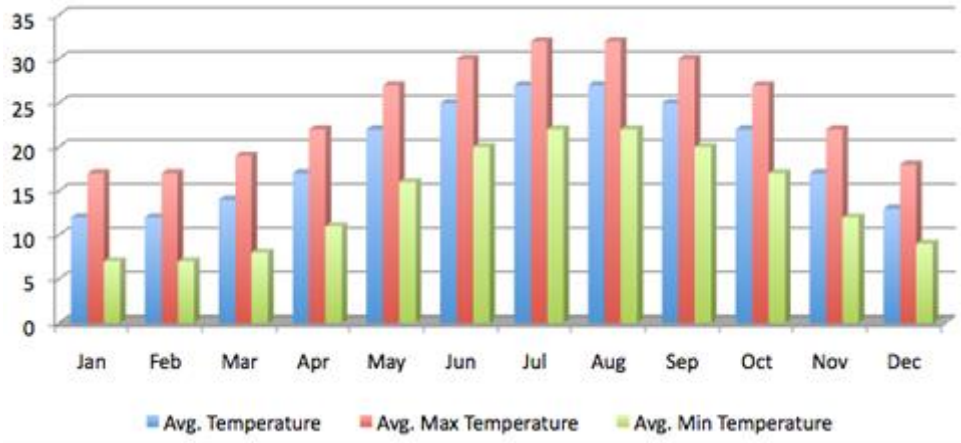


**Figure 1.** Average weather temperature in Cyprus during year

What is observed in the weather of Cyprus four months, the island needs cooling in the interior spaces, four months of heating, and four months the weather is cool, with no need for cooling or heating [12]. For this weather, using Hemp is very beneficial because of the good insulation characteristics and hygroscopic properties. In addition, Hemp may collect heat from the sun (or internal heating) and store it in the thermal mass of its walls, releasing it slowly when the structure cools.

Hempcrete keeps the house warm in the winter and cools in the summer, saving much money on energy costs. In addition, Hempcrete delivers considerable additional savings during the building's lifetime and enhances the health of the building's inhabitants [13].

For the interior walls, 'Wall Assembly 1' is proposed, which consists of a building wall with hempcrete blocks with a thickness of 30 cm and both sides plastered with hemp+lime mortar, while for the exterior walls is the same except the places where extra layer as wood or tile might be used, and the ' Wall Assembly 2' is proposed as shown in Figure 2.

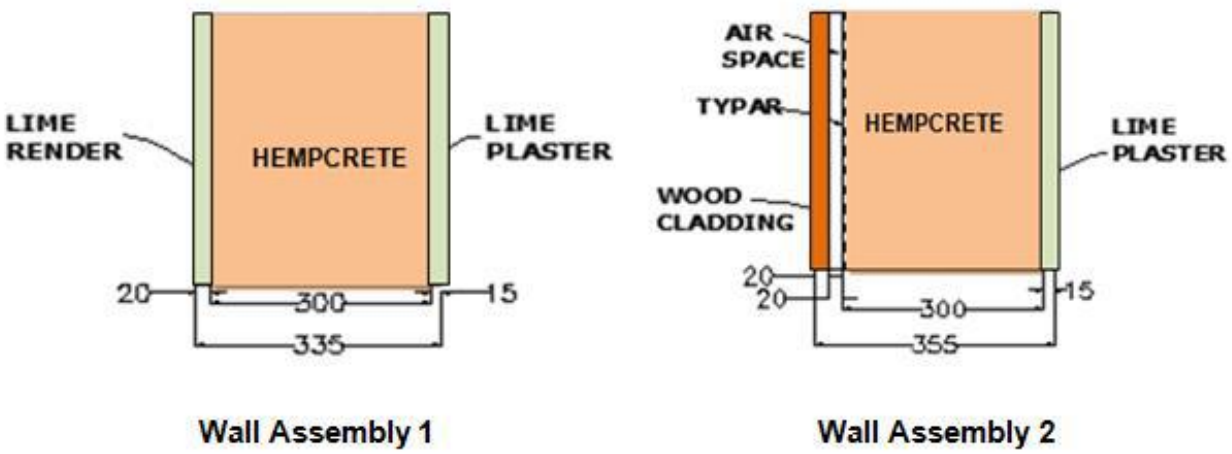


**Figure 2.** Proposed wall assemblies for the building

Furthermore, hempcrete construction methods reduce the dangers of fungus and mould growth and the respiratory tract's accompanying bacterial or viral illnesses produced by rising and falling humidity levels. The lime component contains a biocide that inhibits mould and mildew growth and a hygroscopic characteristic that minimizes condensation build-up, triggering mould and fungus growth [3].

## 4. Findings and Discussion

Because of today's worry about our planet's sustainable and nonrenewable energy supplies, energy conservation has become a top priority worldwide. Being the largest energy consumers, buildings account for roughly 40% of overall energy consumption worldwide [14]. In order to minimize the amount of energy used in buildings, construction materials should apply energy-efficient principles, such as thermal insulation of outside walls. However, prior studies in this area have mostly concentrated on the impact of insulation application on external walls with a long time lag and little decrement factor [15].

Cyprus is among the countries where Hemp can be grown, so it can be cheaper than other building materials regardless of fertilizing the agricultural lands. Making Hempcrete is an easy and affordable method.

Hemp as a building material is cheaper than other load-bearing materials. In contrast, if we need to save energy for the other materials, we should spend an extra (40-50 $ /m2 approx.) for the insulation materials. Still, the cost of Hemp has also included the insulation by itself.

**Figure 4.** Process of mixing Hemp shiv with Lime

A study in Northern Cyprus has been done on saving energy with external walls with/without thermal insulation by Emadi [16]. She could prove that 74% of the energy can be saved by using thermal insulation. So, it is also proven that Hemp is the best insulator in the same way we can save over 74% of the energy used in buildings. It means saving energy with insulation, and without insulation can be subtracted. So, we can see the difference, 74%-26%= 48%; we can save from using Hemp with less initial cost than the insulation materials imported to Cyprus. It means that almost half of the cost of electricity and energy can be saved.

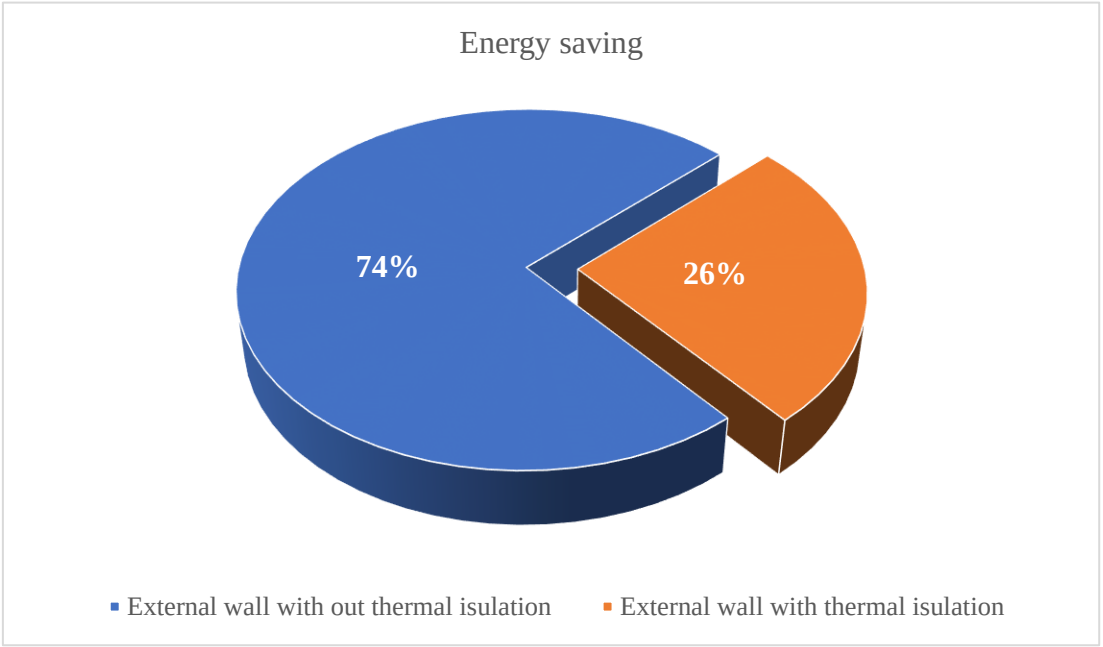


**Figure 3.** Calculation for saving energy in North of Cyprus by Emadi (2014)

Another advantage of using Hemp is providing a healthy environment that reduces health costs, as it can absorb CO2 and is anti-pesticides. Finally, it can be said that studying Hemp to be used as a sustainable building material has great advantages in Cyprus, as the initial cost is lower than other building materials. In the long-term period, it also saves half of the total expenses from energy sources.

## 5. Conclusion

Hemp is not a new material for building construction but can be supposed as one of the best materials regarding the insulation properties are healthy and life-long, as found in some ancient buildings in France, dating back to 14 centuries before. Another concern is sustainability issues; as it can be grown in Cyprus in the Mediterranean climate as shown above, which is produced in Turkey, Italy, and France, which is possible to produce it easily and change it to a building material with all its other food and benefits such as extracting food oil, engine oil, animal food, etc., it obeys sustainability principles from, economy, social and environmental aspects. Finally, workability; Producing Hemp and changing to blocks or other building materials are not complex, as they can be done with less workforce and the least time.

**Declaration of Competing Interest** The authors declare that they have no known competing of interest.

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