HEMPCRETE - POTENTIAL GREENBULDING MATERIAL

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ABSTRACT:

In the last decade, society has been looking at sustainability of construction. The pressure for improved construction methods also leads to the search for new materials. One possible material with suitable technical properties based on renewable resources ishemp fibre concrete – hempcrete. Hempcrete is a construction material made from hemp fibres, lime and water. This composite breathes, as well as having good thermal and acoustic-insulation properties. A life cycle analysis of hempcrete will be used to examine its ecological footprint, especially in reducing carbon dioxide emissions. The construction in 2014 of a New Zealand house provides data which can be used to model performance in both countries. The preliminary results suggest that hempcrete offers both environmental and construction opportunities which can help to deliver sustainable housing solutions.

KEYWORDS – Hempcrete, Green building, ecological footprint.

1. INTRODUCTION:

Environmental issues, ranging from global warming responses to life cycle analysis, are becoming more important in the design, construction and use of buildings. The mostcommon, man-made, building material is undoubtedly concrete. Every year world production is about 1 m3 of concrete per head of population. But each ton of cement produces about 900 kg CO2. Is it possible to find an eco-friendly material that would also have suitable construction properties? Like cement concrete, lime concrete is good in compression but poor in tension, so some form of reinforcing is required. Steel is widely use, but other materials may offer greater environmental benefits. It was foundthat the addition of hemp fiber resulted in a high performing construction material.

2. HISTORY:

Hemp is not a new construction material. Archaeologist have conformed theuse of hemp fiber is used by the Buddhist monks are living in the caves were actually subjected to a huge layer of hemp .times way back in 6th century AD . The caves(ELLORA CAVES) were covered withhemp constructed is unknown, with estimates ranging from

200 BC through 1000 AD. Located in the Indian state of Maharashtra

3. HEMPCRETE:

Hempcrete is bio-composite mixture of hemp shive, lime binder and water. A lightweight material, it is about one eighth the weight of concrete. Hempcrete can be used to construct walls, floors and roofs; or molded (monolithic), sprayed or precast (e.g. hemp bricks or panels).Literature review there are three different types of literature on Hempcrete: enthusiast; instruction books; and research papers. The following review explores the full range of publications. Raw materials: Industrial hempcan grow, under suitable conditions to 4 m height in 12 weeks. One Irish seller advertises that on 1 ha of land is possible togrow 8-10 tons of hemp a year [5], enough to build a small house. 60% the hemp plantsis shive which is extracted by machine.

Reduction of CO2: As with other plants, during its growth phase, it absorbs atmospheric CO2 by photosynthesis, trapping it in the shive and hence in the construction for the lifetime of the building. 1ha of hemp absorbs during its growth 4 times more CO2 than the same tree forest area. Table 1 briefly summarizes Hempcretedata:

Table 1. Hempcrete Summary Data. [6][4][5]

1 [ha] hemp field	
Hemp from 1 [ha] = 8 [t] hemp	Shiv from 1 [ha] = 4,8 [t] shiv
Hemp from 1 [ha] = 18 [t] CO_2 absorbed	Shiv from 1 [ha] = 10 [t] CO_2 absorbed
1 [m^3] hempcrete wall	
110 [kg] hemp shiv	202 [kg] CO_2 absorbed
220 [kg] lime binder	94 [kg] CO_2 emitted
Summary for a small house	108 [kg] CO_2 absorbed
Benefit of substitution of traditional brick wall by hempcrete [1m^2] wall	
A traditional brick and block wall emits in its construction	100 [kg/m^2] CO_2
A 300 [mm] Hempcrete wall absorbs in its construction	-40 [kg/m^2] CO_2
Nett benefit	140 [kg/m^2] CO_2
Typical house	
Typical house the wall area = 140 [m^2]	Equates to = 20 [t] CO_2
For a typical house the embodied carbon dioxide	50 [t] CO_2
Carbon dioxide saving	40%

4. METHOD OF HYGROTHERMALBEHAVIOR ASSESSMENT OF MULTILAYER HEMP CONCRETEWALL:

A. EXPERIMENTAL SETUP: THE BICLIMATICROOM AND THE HEMP CONCRETE WALL
B.

An experimental apparatus is developed and built at the laboratory of material science at the University de Bretagne-Suds. in order to investigate the hydrothermal behavior of a hemp concrete wall. It consists of three principal components: a specimen support frame and two climatic rooms, one to model indoor climate and thesecond to model outdoor climate (see Figure 1).

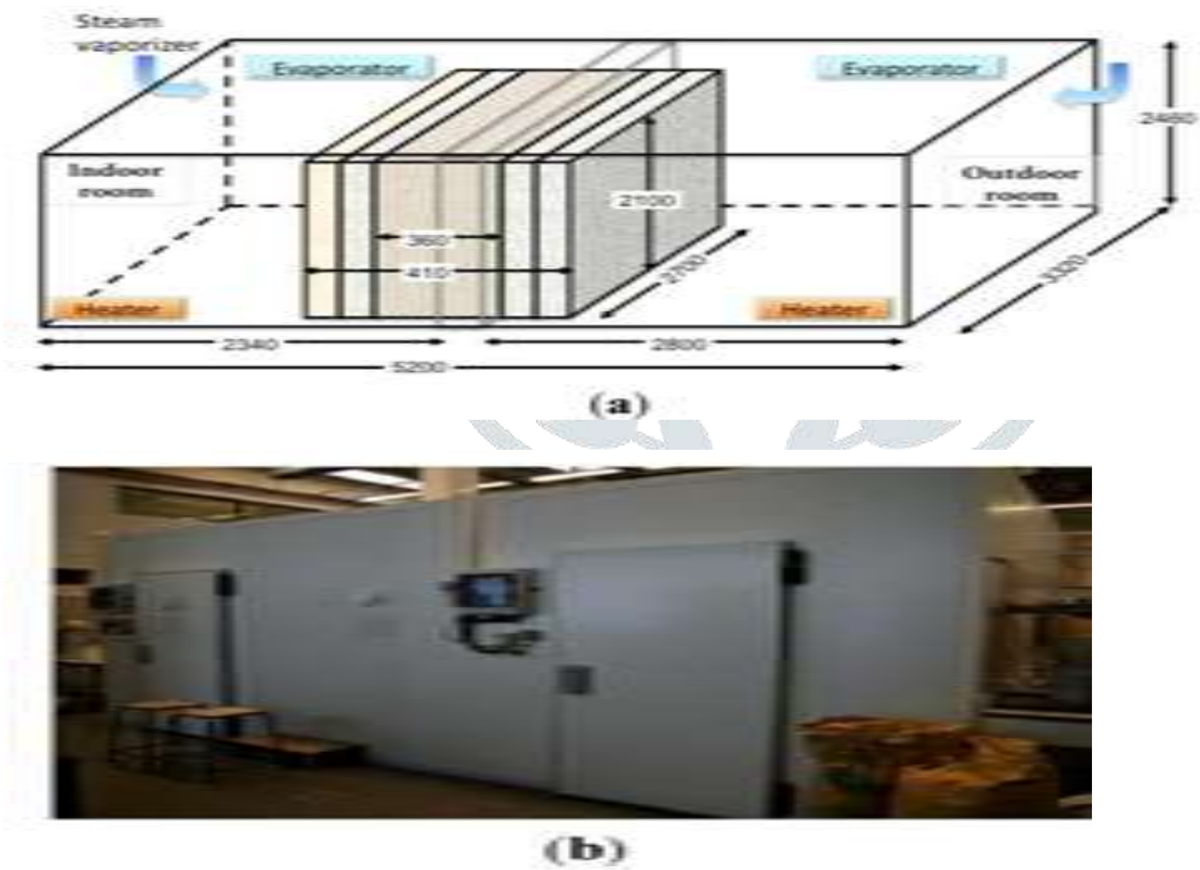

FIGURE 1. (A) SCHEMATIC OF THE TWO CLIMATIC ROOMS SEPARATED BY THE HEMP CONCRETE WALL. (B) PICTURE OF THE EXPERIMENTAL DEVICE.

Each room is insulated from the laboratory with polyurethane panels ($U \approx 0.4$ W·m−2·K−1) and equipped with heating, refrigeration (for cooling or dehumidifying) and moisture control equipment (steam vaporizer) to maintain temperature and relative humidity to the desired level (see Figure 1a). Controllers (type DR4020 from Eliwell) are used to fix the set points. Working range and accuracy of the set-up are given in Table 1.

The tested material is a hemp concrete wall with dimensions of 270 × 210 × 36 cm3 (length × height × thickness). Hemp concrete is prepared according to a wall formulation, defined as 17 wt% of hemp shives (Chanvribat®), 33 wt% of pre- formulated binder (Tradical pf 70®) and 50 wt% of water. Hemp concrete is sprayed on a support with specific concrete spraying machine]: a dry premix of lime and hemp shives is conducted by air through a hose, and pulverized water is added just before the hose outlet. This setting process has the advantage of providing a continuous homogenous mass and reducing the initial water content within the material, and thus the drying time . In order to correspond to building standards, a wood-stud frame was erected (see Figure 2). Furthermore, the wall is insulated on lateral sides to provide adiabatic boundary conditions, and thus, to ensure one-dimensional heat and moisture flow. Experiments were performed on hemp concrete for two years in order to investigate the drying stage and gain knowledge about its hygrothermal behavior in the view of developing and validating HAM model. However, in real life, hemp concrete is not used as it is, and plasters are applied on each side in order to correspond to building standards. Permeable and hygroscopic finishes have to be used inside to allow vapor dispersal from the wall, while impermeable coating must be applied outside to protect the wall from the weather load (sun, UV, rain fall, etc.). In this view, the interior and exterior coarse plasters are lime-based material and the exterior finishing plaster is a lime sand mixture, whereas the interior finishing plaster is a lime hemp mixture. Each plaster has a thickness comprised between 1 cm and 2 cm (see Figure 1 and Figure 3).

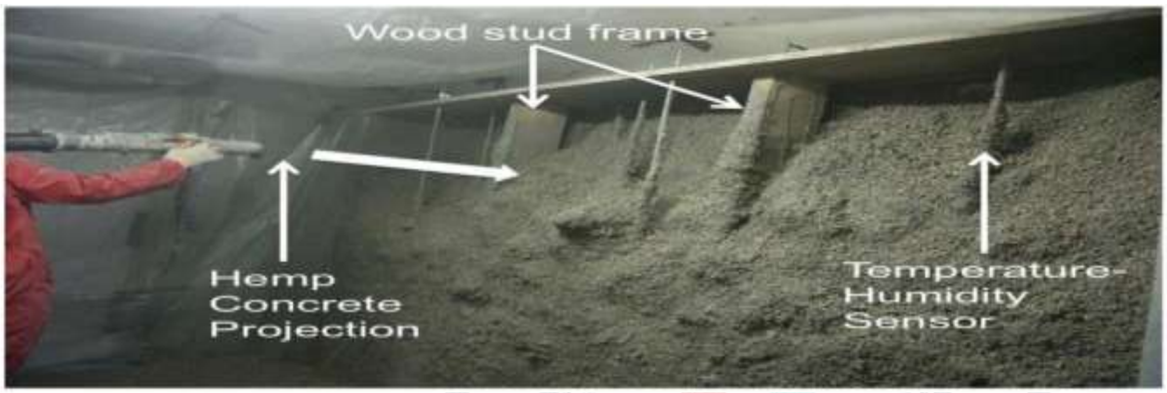

FIGURE 2. WALL PROJECTION AND VISUALIZATION OF THE WOOD-STUD FRAME AND THE SENSORS.

B. MONITORING METHODS

A monitoring of relative humidity and temperature within the wall is performed with K thermocouples and capacitive humidity sensors (type SHT 75 from Sensirion, measurement range of ϕ from 10% to 90% with an accuracy of ±2% and measurement range of θ from +5 to +45 °C with an accuracy of ±0.5 °C). The capacitivehumidity sensor has a diameter d = 6 mm and can thus be inserted inside the sample at different levels without being too much invasive (even inside the plaster). According to the recommendation of Hedenblad on humidity sensor installation (hole drilling andsealing approach), the humidity sensors areinserted within a sealed PVC-tube along theisothermal and iso-humidity lines. For the uncoated wall, humidity sensors are placed close to the indoor and outdoor rooms (resp. at x = 5 cm and x = 29 cm) and in the center of the wall. For the coated wall, additional humidity sensors are placed at the interfaces between the wall and the plasters.

Surface temperatures of the tested wall and of the room panels are measured with K thermocouples and selectively confirmed with optical pyrometers. Air temperature and relative humidity are measured in the center of each room with a thermocouple placed inside radiation shield and two capacitive humidity sensors (type HC2-S from Rotronic and type SHT 75 from Sensirion). Finally, additional sensors are selectively employed to investigate the stratification and evaluate the air velocity within the room. The positioning of all sensors is shown in Figure3.

A data logger reads all sensor signals and the measured values are then sent to a computer where they are stored. All data are recorded every 10 min during the experiment.

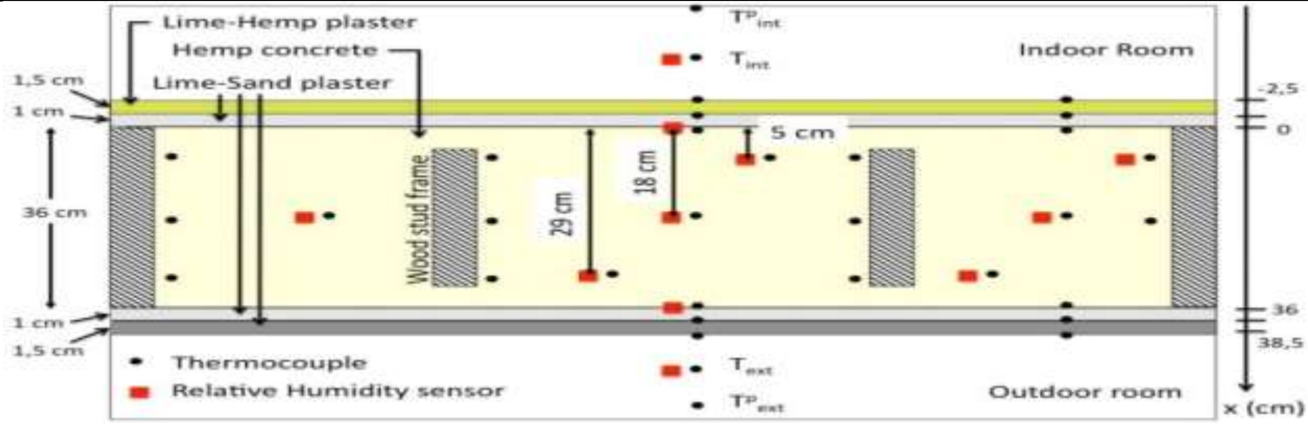

FIGURE 3. LOCALISATION OF TEMPERATURE AND RELATIVE HUMIDITY SENSORS WITHIN THE COATED HEMP CONCRETE WALL.

5. SUMMARY:

Hempcrete meets condition of eco-friendly material. It is made of renewable resources in sufficient quantity. Production is less energy-intensive. It has negative greenhouse gas emissions. It provides resistance and durability construction and healthy living condition. This material is recyclable.

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