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# Use of Hemp in Fly Ash Brick

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***Abstract:*** ***The construction sector is one of the primary energy consuming sectors and contributes substantial atmospheric emissions. The building and construction sector is responsible for 30% of global energy use and 17% of greenhouse gas emissions. In the past decade the construction community has been looking at sustainability of construction method. The requirement for improved construction method also leads to the search for new construction materials. One feasible material with suitable technical properties based on renewable is hemp fibre concrete or also known as hempcrete..Hempcrete is a Carbon Negative, non toxic, breathable and biodegradable building material made from hemp fibre, lime, fly ash, sand and water. This bio composite material has excellent thermal and acoustic insulation properties. Using renewable plant based biomaterials such as hemp in building material removes carbon dioxide from the atmosphere, hence reducing the carbon footprint of building infrastructure.***
***Keyword: Hemp, Building Material, Lime, Fly Ash, Hempcrete, Plant-based material.***

## I. INTRODUCTION

With the futuristic global increase in carbon emissions and its implications, the need for carbon neutral or carbon negative construction methods is of utmost importance and necessity. Cellulose aggregate concrete (CAC) has not only the multi-benefits of better thermal insulation and low embodied energy and low density it can also make use of industrial wastes such as fly ash and slag. One such Cellulose aggregate concrete is called hemp concrete, which is a composite made of hemp shiv and lime based binder. Hemp is one of the world's earliest cultivated crops and has a variety of applications including construction. Hemp use dates back to the Stone Age, with hemp fibre imprints found in pottery shards in China over 10,000 years old. Hemp is the first domestically-cultivated plant, with evidence of hemp fabric dating to 6,000 years ago found in Turkey. Hemp can grow all around the globe in numerous types of soil even in small growing seasons or in dry regions and helps purify soil as well as remove weeds. Hemp can grow without pesticides. The crop also kills some weeds, purifies soil (bio regenerative), and is suitable for rotation use, due not only to its short harvest cycle (120 days). One acre of hemp produces twice as much oil as same area of peanut farm, and nearly four times as much fibre pulp as an acre of forest. Hemp has by far the strongest and longest plant fibre in the world which is immune to rot and abrasion and was in long use before DuPont patented nylon in 1937. In view of the fact of its high strength, hemp fibre can be used for bio-composite materials that could make anything from skateboard decks to fibreboard to aeronautical plane fighter bodies and construction industry. Hemp bio-composite material forms a type of concrete (hempcrete) that can be used for home infrastructure, at eighth the weight of traditional concrete. Hemp is grown for its woody core that gives a sustainable and renewable alternative to cement. Hempcrete was first used in construction to build non-structural infill walls in France during the early 1980-90s. Hempcrete is made from blending the hemp hurd with lime and water and it weighs only about an one-eighth of regular concrete weight. Industrial hemp can also be grown in a wide range of climates zone and numerous soil types; it is also an excellent substitute as a local building material. Hemp hurd is the soft, woody, highly absorbent core of a hemp stalk. They are available in various grades and are a natural by-product after the hemp stalk has been stripped of its fiber. Hemp hurd is many times talk about to as hemp wood or shives and is similar to shives in flax. A process called scutching helps isolate impurities from the raw material. Lime has been used as mortar and renders binders for thousands of years. There are mainly two key types of Lime used in mortars, firstly Non-Hydraulic Limes such as Lime Putty, and second Natural Hydraulic Limes (NHL's), which are harder and more resistant to unfavourable weather conditions. Hempcrete is a bio-composite concrete, where the small pieces of wood from the stalk of the plant are mixed with either a lime or cement binder to create a durable, eco-friendly building material. Hempcrete is lightweight and non-structural, but can instead be integrated with traditional building construction systems. Comparable to traditional concrete, it can be either cast-in-place or moulded into building components like blocks or sheets. The high silica content found naturally in the woody parts of the hemp plant means it bonds well with lime. The lime binding agent used in hempcrete is in the form of calcium hydroxide, which when hydrolysed begins absorbing carbon dioxide from the surrounding to create calcium carbonate, or limestone.

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This means hempcrete is not only durable, but actually a carbon negative material. Once cast, hempcrete requires significantly less water than traditional cement to cure, contributing to the preservation of this precious natural resource. In the case of a fire, the lime coat provides adequate fire-resistance for inhabitants to evacuate. It also lessen fire spread and risk of smoke inhalation because it burns locally and without smoking. Hempcrete does not cause any skin or respiratory complications and is also vapour permeable, creating a healthy indoor surrounding. Its lightweight structure and the air pockets created among the particles mean hempcrete is both earthquake-resistant and an efficient thermal insulator. Hemp is naturally impervious to both mold and pests, as well, and even 1500 years ago humans were making use of these specific properties. A research team led by Indian scientist M.R. Singh found that these artists had crushed the hemp plant and mixed it with lime to form a plaster. The hemp's ability to naturally fight off pests and regulate humidity means that the artwork in these caves survived the test of time while that of the Ajanta Caves built before those of Ellora and not utilizing hemp in their plaster, was eventually dismantled primarily by silverfish insects.

## II. LITERATURE REVIEW

Hana Bedlivá, Nigel Isaacs [2014] In this study it is shown that environmental issues such as global warming are of utmost importance for humankind while designing and construction of the structure. Use of plant based eco friendly renewable material having less energy intensive construction method is the need of the decade as global greenhouse gas emissions are at its peak. Hempcrete is a bio composite mixture of hemp, lime binder and water which is about one eighth the weight of concrete. Industrial variety of hemp grows up to 4 meters in height in 120 days. One hectare of land grows 8-10 ton of hemp a year. Hempcrete has shown various properties such as low construction cost, high thermal comfort, easy and fast workability, fire and pest resistant, low embodied energy and density, negative carbon footprint, damp and rot resistant while being fully recyclable.

Ruth Busbridge, Ranyl Rhydwen [2010] In this study thermal properties of hemp and clay monolithic walls has been studied. Blocks were made up of stabilised (Hemp + Lime) and unstabilised (Hemp + Clay) hemp blocks. Each block had same quantity of hemp whereas the differential density ranging from 320-730 Kg/m^3 were found subject to the quantities of clay, lime and water. Clay is a rich natural resource found anywhere on the earth. Maiden investigations shows that the basic thermal properties of hemp and clay were similar to that of their hemp and lime counterparts.

Ismail Demir1, Cuneyt Dogan [2020] In this study physical and mechanical properties iof hempcrete are studied. Density of hempcrete depends upon the mix design proportion of raw materials used. The energy efficacy of the buildings is based on the hygrothermal property of the material used in the building envelop. Hempcrete made with low volume of binder (lime) shows very low mechanical property and deformation is very high whereas the mechanical property of hempcrete made with high volume of binder (lime) shows increased strength and tends to perform better.

Mehdi Md Iftekharul Alam [2020] Hempcrete is breathable and has high alkaline properties. It is mold resistant and due to its porous structure hempcrete has a considerable hygroscopic property. Amount of ingredients imparts the overall performance of hempcrete including hygrothermal, mechanical and acoustical properties. therefore each different building design will require a independent formula for each type of construction method.

Joseph Updike [2016] This paper talks about hemp's efficiency as a sustainable agricultural commodity and the application of hempcrete as a inwall filling material. Hemp grows in around 120 days in most climatic conditions and regenerates the soil upon harvesting while sequestering a lot of CO2 than any forest of same area. Hempcret5e has a highly porous nature which results in transfer of water vapour from the surrounding environment making it a breathable concrete. This causes to regulate the indoor temperature and humidity in accordance with outer environment.

Jay H. Arehart, William S. Nelson, Wil V. Srubar III [2020] In this paper, Carbon storage and carbon sequestration potential of hemp has been discussed. Long-term biogenic carbon storage can be achieved via utilization of hemp shiv in hempcrete; additional carbon storage can be achieved via carbonation of the binder. This study advances previous carbonation modeling approaches by deriving a theoretical model based on the fundamentals of cement hydration and carbonation chemistry to quantify the total theoretical in situ CO2e sequestration potential of hempcrete binders. Hempcrete, also referred to as hemp-lime concrete or a hemplime biocomposite, is a composite construction material that has the ability to store carbon through both carbonation and photosynthesis mechanisms. Hempcrete consists of hemp shiv (i.e., hemp hurd), a byproduct of hemp fiber production, and a lime-based binder.

## III. CONCLUSION

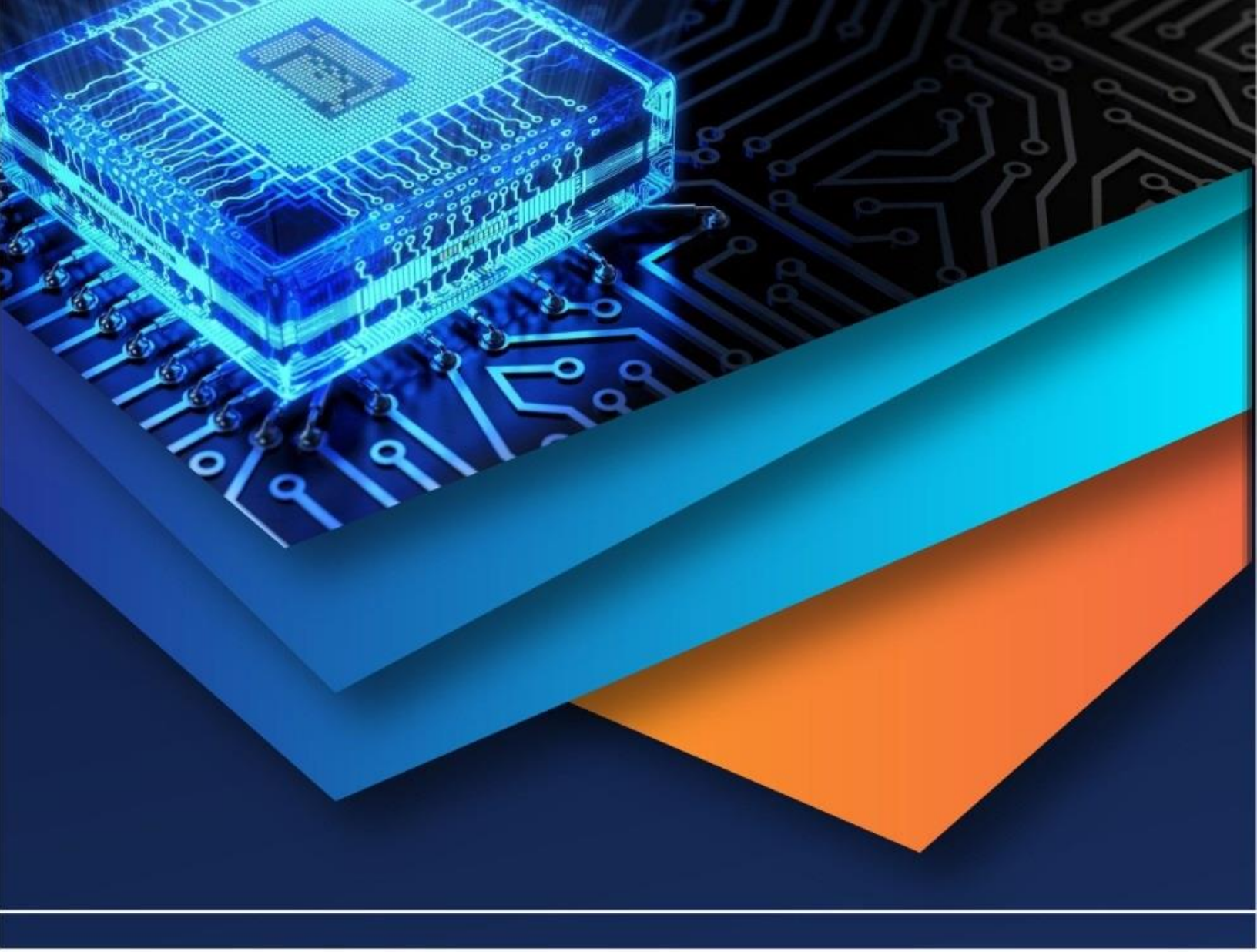
Hemp in its growth stage absorbs $CO_2$ from the atmosphere via photosynthesis and traps it into its fiber also known as Shive in the form cellulose which is used in construction, locking the $CO_2$ for the entire life cycle of the building.

Hemp Lime mixture when added with water goes in carbonation which absorbs additional $CO_2$ from the atmosphere and binds it into the structure hence proving it to be a excellent carbon storage material. Data from the compaction test shows that the Hempcrete blocks are not as strong as the cement concrete blocks. Hence cannot be used as a structural member but can be used as a non-structural member such as in partition wall with a exterior support of a timber frame. Moreover improvements can take place by redesigning the mix design and standardising the water and curing content. . It is mold resistant and due to its porous structure hempcrete has a considerable hygroscopic property. Clay is a universally abundant natural resource and is widely accessible while being fully biodegradable. Since hemp and clay are naturally occurring materials, they have the potential to reduce the environmental impact by replacing lime as a binder. Notably it is stated that clay mixture does not have required thermal properties as compared to lime binder. Hygric property of hempcrete provides excellent indoor air quality and a cozy, restful microclimate simultaneously. The mechanical properties of hempcrete are a reason for concern and should be increasingly investigated further. Hempcrete is reliable as a non-structural member and hence its thickness relies on the structural components of the building. The brief overview of this study shows that hempcrete can be used as an alternative to traditional concrete and is a environmentally friendly material.

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