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Effect of Hemp Fibre and Sustainable Construction Materials in Concrete

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Abstract: *Hemp is an agricultural crop. It is used as a new construction material in addition with lime content and cement are called as hemp concrete (HC). The main objective of the project is to utilizing hemp fibers in HC to find a mix of the different binding materials and to explore if adding silica fumes to the blend and utilizing Meta-kaolin as a binding agent which enhance the mechanical quality. The compressive strength of the different mix is tested for specimens. Cube specimens were cured for 24 hours in a carbonation chamber and tested for mechanical property and durability property. The blend didn't essentially influence mechanical quality, though to add more Meta-kaolin to the blend influenced mechanical property*

Keywords: *Cementitious Binder, Hemp fibre, , mechanical property, Durability strength, Hempcrete*

1. INTRODUCTION

HC is the term utilized in this project to depict a structure material that blended with a binder and hemp. The porosity of hemp gives a breathable structure, where dampness can be assimilated and adsorbed from its surrounding climate. This trademark empowers such protection to act as a buffer that manages against abrupt changes in temperature and humidity.

A unique consideration is paid to the utilization of hemp in the structure materials getting ready for different purposes, for example, protection sheets, mass-splashing hempcrete for the creation of lightweight composites, where it is in the part of filler. Hemp-based concrete is better suited to lighter load applications. The use of Portland cement in the binder has a significant role in providing strength to the concrete in comparison to only lime-based binders [4]. However, because of the large amount of CO_2 that is generated in the production of Portland cement and even hydrated lime, other admixtures such as meta-kaolin to reduce the carbon footprint while increasing early age strength [3].

More research is required to identify the binder components and proportions as well as other possible additives to increase the compressive strength to allow hemp lime concrete to function as a load bearing material [1].

It can be concluded that hempcrete has the properties of good thermal insulation, excellent moisture buffering, thermal mass (heat storage), low thermal diffusivity and effusively, phase change property, high dampening with longer time shifts, high comfort, low maintainability, low thermal bridging[2], biodegradable[6], good indoor air quality (ventilation) and fire resistance.

1.1. Objective of the Study

- To study the durability strength of hempcrete when mixed with different binders by carbonation test
- To study the mechanical property of hempcrete when mixed with different binders by compression test.
- To compare the results of different mix proportions.

2. MATERIAL PROPERTIES

2.1. Hemp

The hemp fibers used are of density 1.4 g per cubic centimeter.

Table1. *The composition of Hemp*

CharacteristicContent	(wt. %)
Cellulose	70-74
Hemi cellulose	17.9-20.4
Lignin	3.7-5.7
Pectin	0.9
Moisture	6.2-12
Waxes	0.8

2.2. Binding Agents

The binding agents used in this investigation were hydrated lime, meta-kaolin, cement, Alumino silicate (zeolite), flyash, silica fumes

Table2. *The chemical composition of Meta-kaolin*

Chemicals	Wt%
$SiO_2 + Al_2O_3 + Fe_2O_3$	> 97.0
SO_3	<0.50
Alkalies (as Na_2O, K_2O)	<0.50
Loss on ignition	<1.00
Moisture content	<1.00

Table3. *Density of hemp, binders and additives*

Material	Density g/cm^3
Hemp fibers (after treating with NaOH)	1.4
Hydrated lime	0.52
Meta-kaolin	1.8
Cement	3.15
Alumino silicate	1.10
Fly ash	1.5
Silica fumes	0.6

2.3. Fly Ash

Class C fly ash generally contains more than 20% lime (CaO). Unlike Class F, self-cementing Class C fly ash does not require an activator. Alkali and sulfate (SO_4) contents are generally higher in Class C fly ashes.

2.4. Experimental Program

The hemp fibers used are of density 1.4 g/cm3.The natural hemp filaments were dealt with and absorbed a NaOH at 6% by weight for 2 days. The binders utilized in this project were hydrated lime (calcium hydroxide), meta-kaolin, cement, Alumino silicate (zeolite), flyash, silica fume. Six combination of binders were prepared and named as A, B, C, D, E, F and G. All the blends on 1.5:1:1 proportion.

Add hemp fiber initially followed by the Hemp binder blend for 30 seconds, and afterward add the water and blend for 5 minutes to give a homogeneous blend. The consistency should be a firm, nearly semi-dry. The cube size of 15 × 15 × 15cm and softly packed into place. All specimens were cured for two days in an indoor atmosphere at roughly 20^{o}C and afterward demoulded from the moulds.



Table4. *Mixing proportions*

Materials	PROPORTIONS					
	A	B	C	D	E	F
Hemp	1.5	1.5	1.5	1.5	1.5	1.5
Lime	1	0.5	0.5	0.5	0.5	0.5
Meta-kaolin	-	0.5	0.25	-	0.25	0.2
Alumino – silicate	-	-	0.25	-	0.125	0.1
Silica fume	-	-	-	-	-	0.1
Flyash	-	-	-	-	-	-
Cement	-	-	-	0.5	0.125	0.1

3. RESULT AND DISCUSSIONS

The experimental work consists of results of carbonation and compression test.

3.1. Carbonation

Carbonartion: Specimen cubes of 150 x 150 x 150 mm cubes are casted and test has been conducted after 2 days from de-moulding. Carbonation test are done to determine the durability of the cubes. They were placed in a carbonation chamber that supplies 2.8 kgs of carbon dioxide for a period of 24 hours.

In the carbonation study from table 5, the composition with hemp and hydrated lime, Mix A shows the higher value of 146.5g and refers that more voids are filled after carbonation.The composition with hemp and zeolite (Alumino silicate) shows the least value of 2and is less carbonated.

Table5. *Test results for carbonation*

COMPOSITION	WEIGHT BEFORE CARBONATION (g)	WEIGHT AFTER CARBONATION (g)	DIFFERENCE IN WEIGHT (g)
A	1973.5	2120	146.5
B	2024	2123	99
C	1018	1020	2
D	1060	1073	13
E	1047	1070	23
F	1354	1400	46

3.2. Compressive Strength

The specimens are tested by compression testing machine after 28 days curing. Loads are applied gradually till the specimens fails.

From the experimental study, Compressive strength of Mix A is obtained the maximum compressive strength for both carbonated and noncarbonated specimens are 35.33N/mm2 and 16.56N/mm2. The specimens that are carbonated showed higher values than non-carbonated specimens.

Table6. *Test results for Compressive strength– Carbonated*

S.NO	WEIGHT OF CUBE (kg)		DENSITY (kg/m^3)		FAILURE LOAD (kN)		COMPRESSIVE STRENGTH (MPa)	
	Carbonated	Non Carbonated	Carbonated	Non Carbonated	Carbonated	Non Carbonated	Carbonated	Non Carbonated
A	2.120	1.973	628.15	584.59	795	375	35.33	16.56

B	2.123	2.024	629.04	599.70	440	220	19.55	9.68
C	1.020	1.018	302.22	301.62	545	235	24.22	10.38
D	1.073	1.060	317.93	314.07	245	150	10.86	6.5
E	1.070	1.047	317.04	310.22	370	170	16.43	7.36
F	1.400	1.354	414.81	401.18	650	360	28.86	15.68

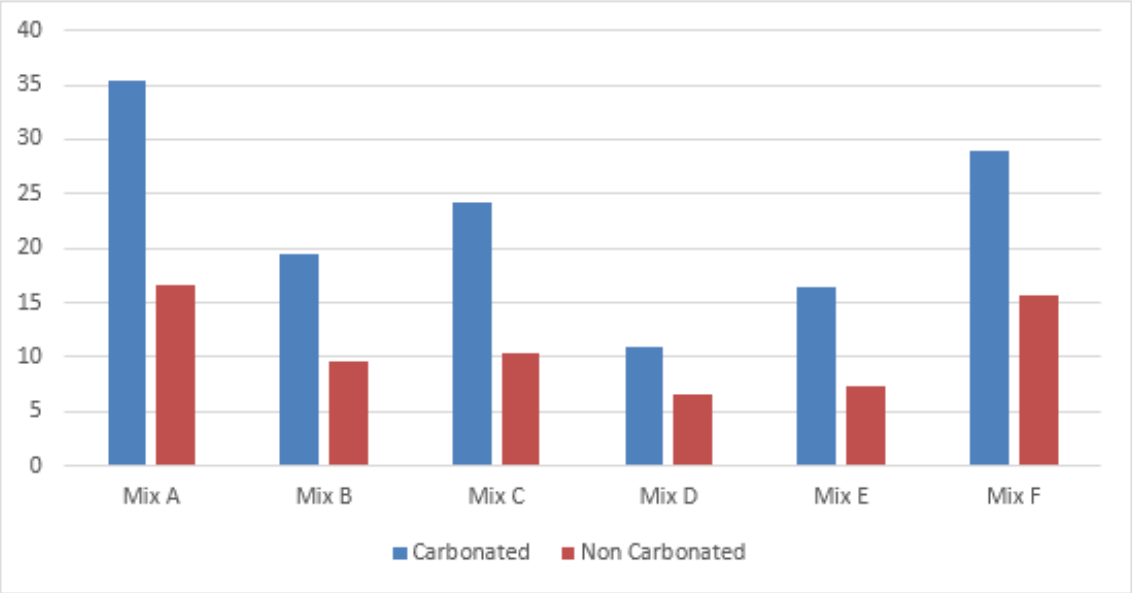

Figure1. *Graph for compression strength of different proportions- Carbonated and Non-Carbonated*

4. CONCLUSION

The objective of this project was to study about the different mixture variations of hempcrete using different binders. Throughout the various tests conducted in this project, that hempcrete is a very useful and a better alternative to bricks or concrete blocks.

The carbonation process revealed that the cubes that contained lime and/or Meta kaolin binder absorbed more CO_2 while placed in a carbonation chamber. It was checked by change in the weight of the cubes. The carbonated cubes fared better than the non-carbonated cubes, since CO_2 had filled the pores of the cubes during carbonation process making them stronger than the non-carbonated cubes. In the mechanical testing of the cubes using a compression testing machine, the cubes that had lime and/or meta kaolin binder mixture showed the maximum value followed by the cubes containing silica fumes.

The above-mentioned results indicate that the binder mixture of hemp fibre, lime and metakaolin proportions can increase the mechanical strength as well as durability strength.

REFERENCES

[1] Arnaud, L., Amziane, S., Nozahic, V., and Gourlay, E. (2013). Bio-Aggregate-Based Building Materials: Applications to Hemp Concretes. Mechanical Behavior, 153-178. ISTE Ltd, United Kingdom. Wiley. New Jersey.

[2] Arnaud, L., Samri, D., Gourlay, E., (2013). Bio-Aggregate-Based Building Materials: Applications to Hemp Concretes. HygrothermalBehavior of Hempcrete, 179-243. ISTE Ltd, United Kingdom. Wiley. New Jersey.

[3] Arizzi, A., Brummer, M., Martin-Sanchez, I., Cultrone, G., Viles, H. (2015). "The Influence of the Type of Lime on the Hygric Behaviour and Bio-Receptivity of Hemp Lime Composites Used for Rendering Applications in Sustainable New Construction and Repair Works."PLoS One, 10(5), 1-19.

[4] CHARACTERISATION OF HEMP-LIME AS A COMPOSITE BUILDING MATERIAL by Edward Alexander Joseph HIRST A thesis submitted for the degree of Doctor of Philosophy University of Bath Faculty of Engineering and Design Department of Architecture and Civil Engineering June 2013

[5] Geiger, O., (2011) "Hempcrete Blocks." Geopolymer House Blog, (Feb. 23, 2016)

[6] Gle, P., Gourdon, E., Arnaud, L. (2013). "Bio-Aggregate-Based Building Materials: Applications to Hemp Concretes." Acoustical Properties of Hemp Concretes, 242-265. ISTE Ltd, United Kingdom. Wiley.New Jerse.

[7] Houseplanninghelp.com/hph092-is-hempcrete-a-good-material-for-ecological-buildings-with-professor-tom-woolley-2

[8] Hempcrete as a sustainable material for heritage storage; applicability and transition by NielsPoelmansPromotoren: Prof. dr. ir. K. Van BalenProf.dr. ir. S. RoelsAssessoren: Prof.dr. ir. Ö. Cizer Ir. arch. A. VerseleBegeleider: Dr.ir. J. Langmans

[9] Johnson, R., (2015). "Hemp as an Agricultural Commodity."Congressional Research Service.< http://fas.org/sgp/crs/misc/RL32725.pdf> (Feb. 13th, 2016) Lanos, C., Collet, F., Lenain, G., Hustache, Y., (2013). Bio-Aggregate-Based Building Materials: Applications to Hemp Concretes. Formulation and Implementation, 118-152. ISTE Ltd, United Kingdom. Wiley. New Jersey.

[10] Omer, T., Kucukvar, M., (2012). "Eco-Efficiency of Construction Materials: Data Envelopment Analysis." Journal of Construction Engineering & Management., 138(6), 733-741.

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