

Architectural Research 2018

Sustainable Architecture use of hemp and hempcrete

Lasota Domenico
X9S2BO

Index:

- 1- Introduction
- 2- Sustainable Architecture
- 3- Eco- efficient System
- 4- Hemp
- 5- Hempcrete
- 6- Conclusions
- 7- Bibliography

1- INTRODUCTION

Nowadays we live in an era where the concept of sustainability plays an important role in everyday life. One of the main objectives is to reduce the environmental impact. One of the programs concerning sustainability is the Kyoto protocol, in force since 2005, which provides a significant reduction of emissions of some gases, responsible for the heating of planet. The target set for 2050 is to achieve an 80% reduction in these emissions. A reduction in energy consumption can be achieved by improving the efficiency of production processes, a conscious and scrupulous use of non-renewable resources, with greater exploitation of renewable resources. It is necessary to correct the productive system and the lifestyles of the societies.

The interest in sustainability starts from the United Nations Conference on the Human Environment in Stockholm in 1972, for the first time, attention is drawn to the fact that, in order to improve living conditions in a lasting way, it is necessary to safeguard the natural resources through international collaboration. The progressive global participation in the discussion on the concepts of environment and sustainability has led to the succession of a series of transversal programs, strategies and policies aimed at environmental protection. It therefore becomes opportune to identify and follow a use of renewable resources.

Among the key sectors of the world economy and energy consumption is construction, which today accounts for about 40% of total, but at the same time is the sector that offers the highest potential energy savings margin. Energy savings start before the construction, from the manufacture of raw materials and building products. For this reason, bio-architecture aims to reduce the negative impact on the environment during the entire life cycle of the building. From a thermal point of view, this result can be achieved by improving the passive performance of buildings and the using ecological materials with good insulating properties is therefore the first step towards an intelligent use of resources.

The various research and studies of construction products and materials aim to propose new alternatives to traditional ones that have very bad environmental repercussions.

Among these there is the conglomerate of hemp and lime, it is counted as a bio-composite insulation for the building industry. The term bio-composite means a material for which at least one of the main constituents derives from renewable resources. The studies conducted show that this product has a positive impact on the environment.

To be able to introduce in the market it is necessary that these materials have specific characteristics and we have specific safety requirements.

2.SUSTAINABLE ARCHITECTURE

In recent years, the concept of energy efficiency has been expanded and plays a leading role in the global economic system. In the construction sector, the potential for improvement in efficiency is large.

Among the objectives of European Union, until 2020, about climate and energy there are:

- 1-To achieve a reduction of at least 20% - 30% of CO₂
- 2-To satisfy 20% of energy needs from renewable sources
- 3-Increase energy efficiency of 20%

These objectives are to be achieved at national and European level. Investing in bio technologies will not only combat climate change, but also create new business and work opportunities and improve education.

Building Zero Energy Building is the target that the European Union has set itself for 2020. By December 31st. 2020 all new buildings must have the requirements set by European Union. For public buildings this deadline is anticipated at 31st December 2018. They will be buildings with very high energy performance. Responding to regulatory requirements is not sufficient in the architecture process.

-SUSTAINABILITY VALUATION SYSTEMS

Some of the main causes of the energy dispersions of the building heritage are:

- 1-incorrect design of environments
- 2-uncontrolled ventilation
- 3-not optimal orientation
- 4high value of the transmittance coefficient;
- 5-incorrect installation of the insulation;
- 6-use of insulating materials of poor quality
- 7-dispersions of thermal bridges;

Energy redeveloping a building means intervening on the energy flows between the building and the external environment. There are some certification systems of the building, these certifications provide for valuation of the building project. Some of the most important international certifications are:

- 1-the US LEED system (Leadership in Energy and Environmental Design)
- 2-LCA (Life Cycle Assessment),
- 3-The Water Footprint, indicator of the consumption of fresh water,
- 4-The French HQE system (Haute Qualité Environnementale)

The objective of these certification systems is to promote the construction of sustainable buildings by improving the environmental and technological culture of the designers.

-BIO BUILDING CONCEPT AND SUSTAINABLE DEVELOPMENT

The concept of ecological house was born in Germany during the 70s. The term bio building is in fact the translation of the German term "Baubiologie", it is a concept based on the relationship between environment, health and architecture. They start to build ecological houses, buildings built in respect of the environment, but still maintain maximum functionality.

-PROJECT SOLUTIONS

For the project it's necessary a collaboration between all the actors of the construction process starting from the lenders to the designers, to the clients. Studying the shape and orientation of the building it is possible to lower construction costs and limit traditional heating systems, than active and passive protection systems can be integrated with renewable energy systems.

-PASSIVE INTERVENTIONS

Passive interventions are all those interventions that can be done during the design phase of the construction, applied to the building to regulate thermal exchanges between indoor and outdoor environment without the intervention of mechanical machines like pumps, fans, boilers.

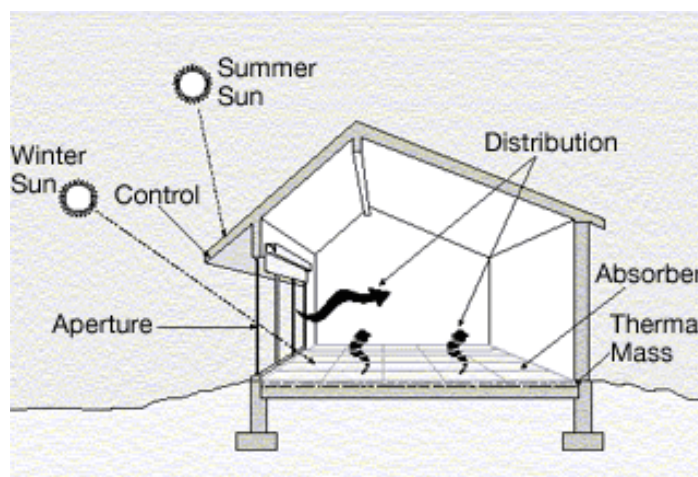
PASSIVE SOLAR SYSTEM:

Passive solar systems are classified into three main types:

- Direct gain system
- Indirect gain system
- Isolated gain system

These design solutions are in the preliminary design phase and concern:

- 1-the shape of the building: it concerns the geometry of a building: shape, size and orientation represent variables that are closely related to each other.
- 2-the choice of orientation: the choice of the orientation of the buildings depends on many factors: the local topography, the possible panoramic views, the solar radiation, the intensity and the direction of the winds.
- 3-the technological choice applied to building envelope: The term building envelope means the set of all vertical structures, opaque or transparent, horizontal structures that separate the external space from the internal one.



-ACTIVE INTERVENTION

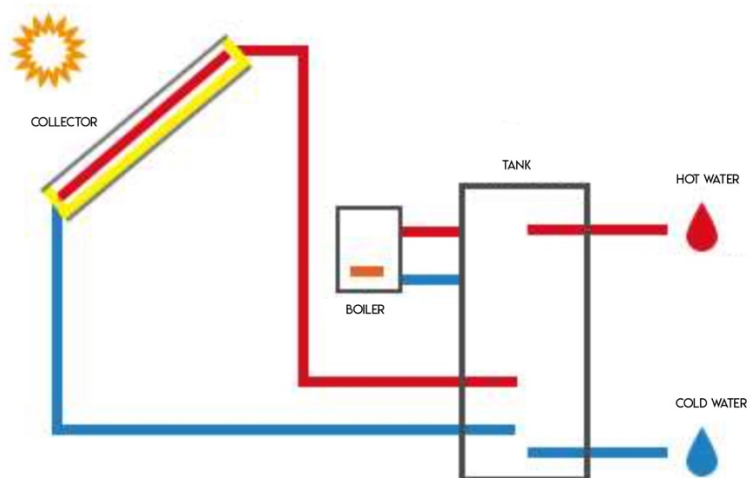
The active interventions are all those interventions that can be done during the design phase, applied to the built with the purpose of regulating the heat exchanges between internal and external environment through the use of mechanical instruments. These instruments can be classified in two categories: that of the separating construction elements and that of the technical systems.

Active systems capture, transform and use energy from renewable sources with system technology. The system technologies that are able to exploit natural resources to ensure a better thermal and energy behavior of the building are:

1. Thermal solar
2. Photovoltaic system
2. Other technologies that use renewable sources such as wind, geothermal, hydraulic

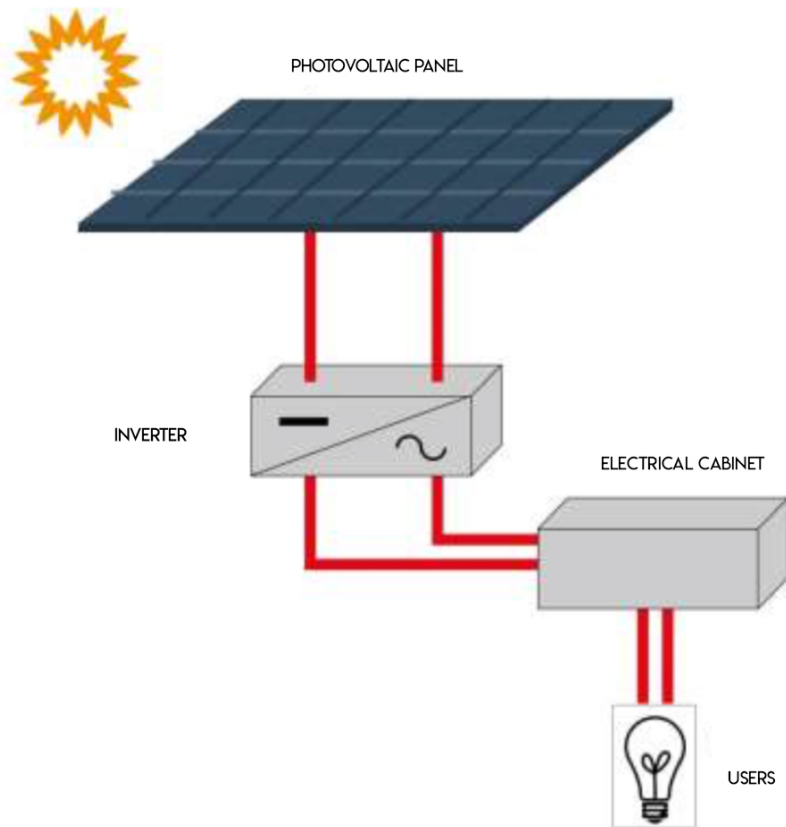
1.Solar thermal system

Solar panels are devices that capture and convert the electromagnetic energy contained in solar radiation and use it to produce thermal. The installation of the provides the availability of an external surface like the roof or facade or terrace.



2. Photovoltaic solar system

The photovoltaic solar system has the function to converting the electromagnetic energy contained in solar radiation into directly usable electric energy that can be stored in batteries.



3. ECO-EFFICIENT INSULATION SYSTEMS

The term "eco-efficient insulation" identifies a new range of products that differ from those typically used for their natural origin, these products don't derive from chemical processes, but can be animal, vegetable or mineral.

-CLASSIFICATION OF INSULATING MATERIALS

The first subdivision of insulating materials is based on their origin, can be synthetic or natural, or on their structure, which can be fibrous or cellular. Other subdivisions are based on their composition.

-PERFORMANCE

The integration of insulating materials into the system involves numerous benefits:

- 1-Control of thermal flows through the building envelope
- 2-Control of internal surface temperatures
- 3-Control of surface condensation phenomenon

The main insulating properties of these materials are:

- 1-Thermal behavior
- 2-Thermal capacity
- 3-Thermohygrometric behavior
- 4-Acoustic behavior
- 5-Hygroscopic behavior

1. Thermal behavior

The thermal conductivity is the fundamental property that characterizes the thermal performance of a homogeneous insulating material. It is a specific attribute of the material that depends exclusively on its nature.

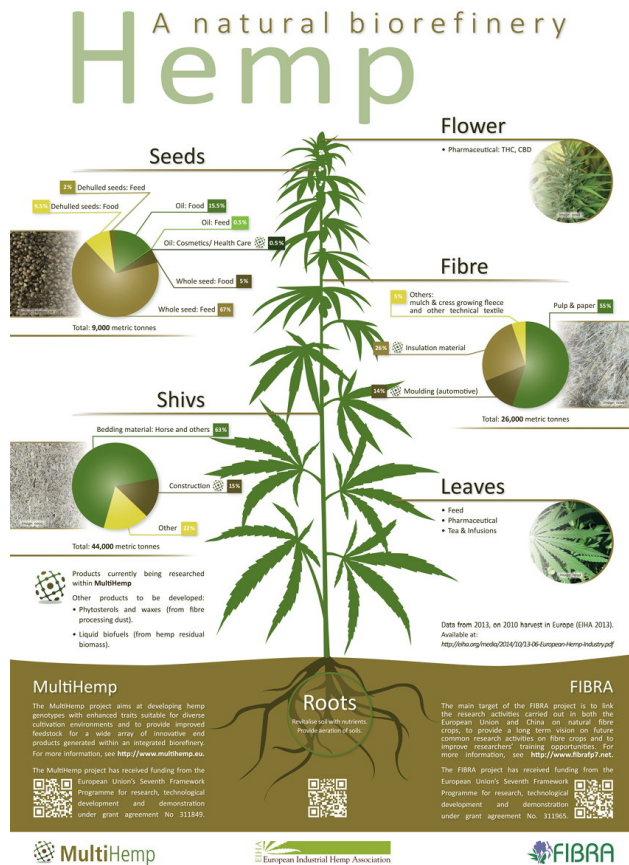
2. Thermal capacity

The thermal capacity expressed in J/K is equal to the product between its mass (kg) and the specific heat of the material of which it is composed.

5. Hygroscopic behavior

Hygroscopicity is the ability of a substance to absorb the water molecules present in the surrounding environment and is expressed in percentage.

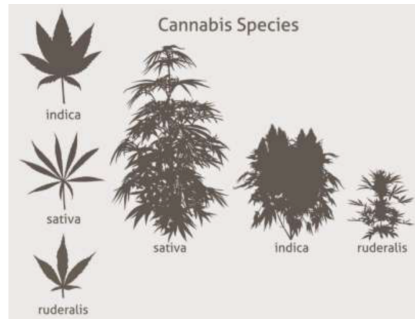
4. THE HEMP



-CHARACTERISTICS

Currently there are three different varieties of hemp:

- 1-Cannabis Sativa with important dimensions (4m)
- 2-Cannabis Indica (1.5-2 meters)
- 3-Cannabis Ruderalis (-1m)



The Cannabis, of the family of the “Cannabaceae”, is a dioecious plant, has two different types of plants: the male one, which produces pollen, and the female plant that fertilizes, produces seeds and flowers. Cannabis has a short cycle, with seeds planted in spring, flowering in mid-summer. pollination generally happen with wind, because insects like bees are not attracted by the flowers of cannabis. It is the flowers of the female that produce the largest amount of the resinous substance containing the active substance, THC. There are more than 460 chemical components of the plant among these, the delta-9-THC, present around 1-5% of the total weight, is the only one discovered to have notable psychoactive properties. Extremely strong and resistant, cannabis can develop and reproduce almost anywhere.



-HISTORY

The Cannabis Sativa is a native plant of South Asia, the spread in Europe occurred around the VII century B.C.

During the sixteenth century, hemp spread in American continent. Since 1955, the cultivation of hemp has been forbidden in America, and from here around the world, this plant is directly associated with the narcotic substance

that is obtained from some species. The rediscovery took place in Europe at the beginning of the 1990s.

-ENVIRONMENTAL BENEFITS

The hemp plantation loosens, softens and shades the ground. Falling leaves preserve the humidity of the soil.

It is also a bio-accumulator, this plant is capable to storing in the leaves any heavy metals present in the soil and contributes to the absorption of carbon.

-DERIVATIVES

The main uses of hemp are for the production of paper, but only 5% of paper is made with hemp, the production of textile fiber and hemp oil and for the known illicit products. Thanks to its absorbent properties, it is used as a vegetable granulate for the production of building materials and for thermal and acoustic insulation.



-FROM CULTIVATION TO ECO-PRODUCTS

Industrial hemp, Cannabis Sativa, is grown in China and in Europe, France has the record for European production with 65000 tonnes of straw for a cultivated area of 10000 hectares.

The vegetable fibers, thanks to their characteristics of lightness and porosity, are today often used in the packaging of insulating products. Hemp for construction purposes has been In France, in 1986, the idea of using the shives as aggregate for the packaging of a light and insulating conglomerate. Usually mixed with "natural" binders such as gypsum and lime, the shive is the aggregate of hemp concrete, considered a "bio" material for its multiple environmental benefits.

Currently, the production of construction elements based on the water-shive-binder mixture has not yet reached significant industrial dimensions, specially for the lack of normatives.

There are some products for building insulation deriving from the Cannabis fibers and the shives. Between these there are:

- 1-Hemp fiber panels
- 2-Prefabricated blocks with hemp and lime
- 3- Aggregate for insulating screeds
- 4-Conglomerate applied to filling in formworks
- 5-Conglomerate applied by spray directly to the wall
- 6-Insulating plaster

1.CANAPA FIBER PANELS

Hemp fiber panels are used more in the hollow spaces of internal coats, ventilated external coats, ventilated roofs, internal partitions, false ceilings, floor screeds.



2.PREFABRICATED BLOCKS WITH HEMP AND LIME

Bio- block is an insulating material composed of a binder of natural hydraulic lime and hemp wood. it has all the qualities required by a building material in line with sustainable development: high insulating capacity, low energy for production and ability to absorb CO₂ from the atmosphere. It doesn't have structural characteristics, but it is placed with a structure to bring a frame, it can has both the function of infill and of insulation.



4/5.CONGLOMERATE OF CANAPA AND LIME

With the mixture of lime and shive it is possible to realize the insulation of roofs, attics, insulating coats inside and outside. It is suitable for applications

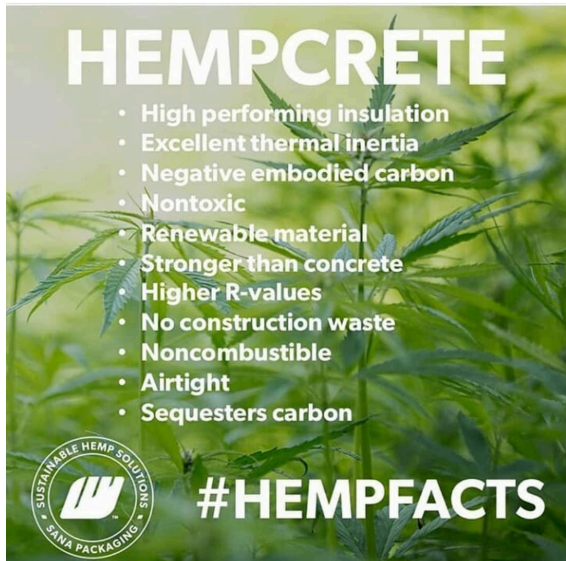
in both small and large construction sites. In addition to thermal insulation, this conglomerate is able to offer a high level of living comfort. This product is used for new buildings and for the redevelopment of buildings.



6.INSULATING PLASTER

It can be apply in traditional wall and has an optimal thermal performance in stone buildings.

5. HLC-HEMPLIMECONCRETE



-CHARACTERISTICS

The conglomerate of hemp and lime is a bio-composite material obtained by combining the woody part of the hemp stem, known as shive and a lime-based binder mixed with water. Once hardened, the mixture becomes a rigid and light material with excellent insulation and durability.

The conglomerate of lime and hemp is used in construction as an insulating material.

It is a product capable of subtract carbon from the atmosphere during the cultivation period of the plant and during the long phase of lime carbonation. Another aspect that makes this product suitable for sustainable building is the reusability of the lime-shive-water mixture, being a natural composition, even after the demolition can be used again.

-HISTORY

The use of hemp mixed with lime began to spread in the construction industry around the early 90s. France is the largest producer of hemp, it is in

fact French the association Construire en Chanvre (CenC), founded in 1998 which established the professional rules for setting up the hemp conglomerate and provides the reference procedure for obtaining the laboratory labeling. Another country that shows an active interest in this innovative material is the United Kingdom, with companies like La Lime Technology. Research on hemp and lime conglomerate is currently being conducted in UK universities.

In USA President Obama signed the 2014 Agricultural Act by removing federal restrictions on hemp culture.

- MECHANICAL AND THERMAL PROPERTIES

From the combination of shive and lime binder a construction material is obtained with mechanical, thermal and acoustic properties that differ from traditional concrete. The bio-composite has a lower density, lower thermal conductivity and better soundproofing properties, but does not have good load carrying capacity. From the combination of shives and lime we obtain a material with mechanical, thermal and acoustic properties that differ from traditional concrete. The bio-composite has a lower density, lower thermal conductivity and better soundproofing properties, but does not have good load carrying capacity.

-INFLUENCE FACTORS

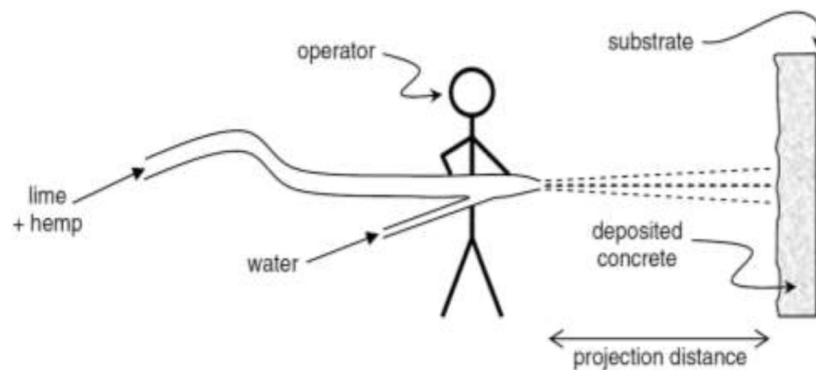
The parameters that mainly influence the properties of hemp concrete can be classified into two categories: those related to the composition, and those related to the method of implementation.

Regarding the composition of the concrete we can list the binders, which can be divided into two types, air and hydraulic. Binders are all those materials that allow the preparation of compounds having the characteristic of being able to join the building materials; the aggregates, the term aggregate indicates the material held together by a set consisting of the binder. The

important porosity of the aggregates influences the physical performance of the hemp conglomerate.

-INSTALLATION

The installation is strongly influenced by external environmental conditions. Apart from the prefabricated blocks obtained with the mixture of hemp and lime, the main methods of installation for this material are the technique of filling the formworks with compaction and the technique of projection. The projection machine originally designed to be used with the traditional mixture of concrete, has been used for other functions for many years, such as the construction of tunnels and underground constructions, covering of rock walls, repairs of concrete structures, rehabilitation of masonry structures and construction of houses and pools. The projection technique proved to be very effective for insulating materials, especially in the field of recovery construction.





6. CONCLUSION

This research is a study on sustainable architecture and on eco-efficiency systems. In addition, it explores the use of hemp and hemp conglomerate, its installation and its mechanical and thermal properties and characteristics. This work helps me to understand the benefits of the natural sources and their application to architecture and building.

7.BIBLIOGRAPHY

-boheco.org

-thefreethoughtproject.com

-passivehouse-international.org

-thehempdealer.html

-thehempbuilder.com

-ukhempcrete.com

-designingbuilding.com

-architetturaecosostenibile.it

-equilibrium-bioedilizia.it

-sharchitecture.com

-inhabitat.com

-slideshare.net

-passiv.de

