

## Hemp for a Healthy and Sustainable Building in Abruzzo

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### Abstract

We present a research work concerning bio and eco-compatible materials and focused on the use of hemp in building. The work is developed both in the research and training activities, in relationship with the local market. Hemp is a biomaterial with high characteristics of eco-compatibility, but in the considered context (the Abruzzo region) these potentialities for a highly sustainable life cycle cannot be exploited because there aren't local productions. Therefore the principal purpose of our work is to promote the diffusion of a healthy architecture (through an appropriate redevelopment of the existing buildings) and a real local production able to give economic repercussion, in an agricultural-industrial-building symbiosis. This will be done by specifying the well-being performance of hemp products and individuating and overcoming the criticalities of the current practices. So we want to develop a model aiming to the human health safeguard and the economic and social sustainability (circular economy).

**Keywords:** Healthy Building; Hemp Technology; Biomaterial; Life Cycle; Local Production; Circular Economy

### Introduction

In the last decades, the discussion about the preservation of natural resources and human health has led the interest on bio-materials with the focus on renewable raw materials [1]. Among these, hemp is a bio-compatible material with high characteristics of eco-compatibility, and its sustainability (in primis environmental) is not determined just by the natural origin e the renewability but also by all the life cycle phases (from cradle to cradle) of the building process.

In our country, there are however some evident difficulties in the spread of hemp in the building field because the particular traditional condition of local building market. The Italian construction industry uses 19 million tons of cement per year (Istat – National Institute of Statistics) and cement manufacture is currently one of the most industrial source of carbon dioxide and nitrogen oxide emissions. Almost one tonne of carbon dioxide is generated in the manufacture of one tonne of Portland cement. In the considered context (the Abruzzo region) local hemp productions don't give a good to build quantity and quality harvest. Therefore the principal purpose of the presented work is to individuate the criticalities, to indicate the ways for overcoming them and promoting a real local production able to give economic repercussion, in an agricultural-

industrial-building symbiosis, developing a new model aiming to the economic and social sustainability in circular economy [2].

In our context, the hemp potentialities cannot be exploited also for several technical, cultural and commercial, knowledge and structural regulatory barriers.

In France lime-hemp construction is today common and has already been used in hundreds of new buildings. The UK has recently carried out researches, both private and academic, in order to test the claimed benefits of lime-hemp and, after a few pilot projects, the new construction material is now available on the market for those interested. On the other hand in Abruzzo, so as all over the Italian country, the lack of certification on hemp (regulatory barrier) together with an overall lack of awareness among the main stakeholders (knowledge barrier) result to be the major constraints for the diffusion of the material in the building field. Commercial issues relate to a variety of economic aspects assumed to be relevant for making lime-hemp competitive on the market as well as demanded by the final consumers.

Regulatory barriers comprise a series of issues depending on the current legislation gaps related to the structural insurance of lime-hemp constructions. In Italy, the lack of a specific structural

regulatory for several products made with natural and renewable material (such as hemp) is one of the most important question that impedes the diffusion of these materials use in the building field. This question should be urgently faced, once a good local production will be available, above all for promoting the diffusion of a sustainable architecture able to react to the seismic events.

For finding a way for overcoming these barriers, we work establishing a direct and effective connection between the scientific contest and the practical one, in this case, based on a strict collaboration with a local enterprise (EdilCanapa company of Mosciano Sant'Angelo, Teramo, Italy). Moreover we carried out an experimental planning activity, in the training context of our University for a "healthy" redevelopment of not used and abandoned buildings (either rural or urban) by using products made with biomaterials (above all hemp but also different kinds of woods, sheep wool, etc.). In this writing we report then also some results of this experimental planning activity.

**Figure 1:** The transformation of an old farmhouse in a bike-hotel with hemp products.

### Hemp sustainability and well-being features

Hemp constructive elements are among the most appropriate products to be used for a healthy architecture because they give high performance levels of well-being. Indeed hemp is the best CO<sub>2</sub> absorbing plant and the products made of it have very good characteristics for thermal and acoustical insulation and humidity reduction.

The healthy nature of hemp architecture is an important benefit for the human wellness; it is known indeed the ability of hemp to control differences in temperature and therefore to help making the building more comfortable. When the hemp is combined with lime and is exposed to the sun it warms up very little, and when the

outside temperature drops it is able to release heat to balance the difference in temperature between the inside and outside. So the overall effect of the use of hemp in buildings is a more healthy and natural environment safeguarding system, able to reduce the need of air conditioning.

The advantages offered by the use of hemp in the constructions for human health, therefore, comes also from its environmental safeguard characteristics.

On the environmental side, hemp has a photosynthetic growth (raw material supply), makes synthetic materials redundant thus reducing dependence on fossil fuels (construction phase), reduces carbon dioxide emissions thanks to its thermal properties and works capturing carbon dioxide in the structure of buildings (use phase); it is a zero waste (in local technological choices) and completely biodegradable (end of the lifecycle) material.

**Figure 2:** Well-being and the environmental safeguard strategies.

The only problematic phase of the life cycle, in our context, is the lack of the raw material production and then the semi-finished materials transportation. EdilCanapa company indeed based its production on different kinds of technologies, importing semi-finished materials from France: natural mortar, thermal plaster, thermal screed and brick. This problem could be overcome by rebuilding a regional chain with initial public investment on infrastructure.

The sustainability of the technologies using hemp products is environmental, economical and social. On the economic side, lime-hemp is sustainable if it becomes a local produced material. It directly links agriculture and industry therefore giving back the due importance to the primary sector. Local economy benefits because of the existence of a local hemp industry and the rise in local em-

ployment would be a direct consequence. Hemp is also beneficial on the social side because if the local economy flourishes, new green industry increases employment and the local communities regrow.

Farming is declining in the most developed countries (despite a timid return to the earth work, as a primary activity of excellence) thus hemp would give farmers an alternative crop and source of incomes. We refer to a new development model, that recognizes the role of the capital natural and considers the landscape as an alive entity, which is subject to the continuous actions of the communities.

### Hemp building products technical features

Hemp building products have very interesting but (in our country) also some problematic technical features. These problems concern issues related to the husbandry and processing of local hemp market, as well as the lack of some technology supply chain and its employment in the construction sector.

The pursuit of overcoming these barriers involves both the diffusion of a "hemp architecture" through the use of materials for the transformation processing and the laboratory testing as well as LCA analysis, aimed at certifying the quality of semi-finished products and products (especially in terms of safety, well-being and environmental safeguard).

In LCA process, the increased cultivation of hemp could bring many benefits to the soil such as: annual crops, no need for further irrigation, no need for chemical additives, and could heal the soil, giving it a chance for "reproducing itself" by cleansing it from heavy metals, as well as subtracting from the atmosphere of CO<sub>2</sub> through the photosynthesis process. In our region, because of the lack of appropriate hemp cultivations, we cannot have these benefits.

The local enterprise Edilcanapa, indeed, produces the following technical solution hemp-lime based, by using not local raw materials:

- **Natural Mortar:** a bio-composite material formed by the mixture of the woody core of the hemp plant (hemp wood), and a lime based binder with the addition of water;
- **Thermal Plaster:** in order to produce a workable material, the mix must contain a greater amount of lime, this system is used as well as for buildings built entirely with the bio-composite and particularly suitable if applied on traditional walls and is effective in the thermal upgrade of old stone constructions;

- **Thermal Screed:** the bio-composite can also be cast as screed; this solution is particularly suitable for floor heating which will be laid directly on it;
- **Bricks:** hemp bricks are formed by certifies hemp wood, and a lime based binder; it is a mixture of hemp, lime and water without additional additives.

Lime-hemp combines the vapour permeability of lime and the hygroscopic power of hemp, with the capacity of absorbing high quantities of water vapour. Walls and floors of a lime-hemp building can breathe thus absorbing moisture and successively releasing it through evaporation. This feature avoids the build up of dampness and associate deterioration within the materials, as well as reducing the moisture content inside the building.

For the downstream process the lime and hemp bio-composite, once arrived at end of life, can be reused, chopped and added to a small amount of lime and water, allowing producing new hemp and liming blocks. If the hemp and lime bio-composite is released into the environment, the lime crumbles and increases the pH of the soil, but hemp is no longer protected, biodegrades naturally [3].

### A healthy architecture through the building transformation

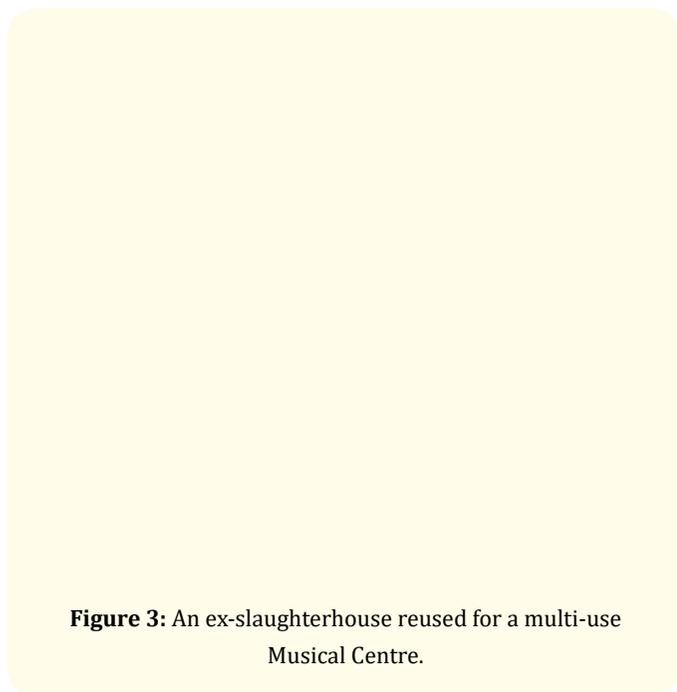
In the field of constructions, the safeguard of the environment and then also of the human health must be pursued also and above all containing the soil consumption by a responsible exploitation of the exiting buildings, of course redeveloping them [4]. Sometimes, the redevelopment goals are hindered by some policies, supported by cultural reasons that are too binding and conservative. But nowadays cultural development is very influenced by the sustainability needs. Therefore the possibilities of making the existing buildings more healthy and of reducing their impact on the environment can legitimise certain transformative action for improving the building performance. In this perspective, we propose some criteria, strategies and solutions for effective, appropriate and "convenient" buildings transformation actions.

Thanks to an experimental planning activity, we carried out some project foreseeing the transformation and the redevelopment of some buildings through the use of hemp and other natural materials products (such as timber, sheep wool, etc.) for realizing new volumes. These are new building systems to be added to or grafted in the existing constructions and characterised by high performance levels of well-being (thermal, hygrometric, acoustic and visual comfort), safety (above all for the earthquake risk), environmental safeguard, enjoy and use and management (above all for maintenance). So the addition and grafting logic is recognized as an

efficacious strategy that allows to overcoming the existing buildings performance lack.

Figures 1 and 2 show the reuse of an old farmhouse for realizing a bike-hotel. In this project, the existing building is integrated in a bigger new volume, including the masonry construction and new timber structured volumes, whose closures surfaces internally contain hemp bricks and plaster.

On the other hand, in the project of figures 3, hemp and timber elements are used in a grafting work to fill the ruin of an ex-slaughterhouse for realizing a multi-use Musical Centre.



**Figure 3:** An ex-slaughterhouse reused for a multi-use Musical Centre.

In both examples, hemp and timber elements constitute building parts, which give a reversible transformation of the existing buildings because they are dry-stone assembled and implicate a very important performance improvement (above all in well-being terms). This is a controlled transformation work in which the new added or inserted parts “respect” the pre-existences while make them excellently functioning.

## Conclusion

So with our work we do not pretend to give the solutions to the surveyed problems but at least we hope to stimulate the development of actually sustainable building policies in Italy.

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