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Hygrothermal Assessment of a Prefabricated Timber-Frame Construction based in Hemp

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Abstract

In this paper, an assessment is made on a pre-fabricated timber framed hemp-based building envelope system. The hemp-lime mixture within the envelope is produced by mixing the hemp shiv with a lime formulated solution, which acts as a binder, and provides thermal insulating and moisture buffering capacity to the resulting construction.
Hemp, by its natural origin, is a fixative of CO_2 and can result in a negative carbon footprint helping to reduce the global impact of a building. In addition the hemp- lime layer absorbs and expels heat and humidity in relation to the environment and acts as a thermal storage by reducing the flow of energy through the wall. The presented system targets at the generation of an innovative building system focused on the expansion of the market for structural products, sustainable, ecological and low carbon footprint.
As part of its development its thermal insulation and moisture buffering properties have been assessed, and case studies and outcomes of full scale experimental studies are presented.

Peer-review under responsibility of the organizing committee of SBE16.

Keywords: Hemp; Thermal performance; Low embodied energy; Experimental Assessment; Certification; Prefabrication

1. Introduction

1.1. The construction market in the 21st Century

Within the last decades of the 20th century, and the beginning of the 21st century, the construction sector has evolved along with increasingly complex and demanding Building codes. A clear case for this is the Energy

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Performance of Buildings Directive (EPBD)[1] in Europe. At the same time, construction practices that incorporate materials with reduced embodied carbon footprint have steadily increased in popularity.

It is estimate that globally, about 40% of all final energy consumption is performed in buildings. In order to ensure the sustainability of the energy system in Europe, the Europe 2020[2] strategy for a sustainable energy growth was created, which is the main initiative to promote the reduction of energy consumption, by addressing several action lines such as the reduction of greenhouse gas emissions, the promotion of renewable energy and energy efficiency measures.

Also, design and commissioning codes and procedures such as the Passive House Standard[3], address building envelopes, along with building ventilation towards the optimization of the energy performance of buildings.

In the evolution in design and construction of buildings envelopes, with the introduction of sustainable materials, it has been proved that they perform similarly to standard materials, with a substantially reduced environmental and carbon footprint.

1.2. Barriers in the implementation of construction systems with sustainable materials

Prior to their introduction in the mainstream market, novel materials are commonly installed in small scale self-built constructions for demonstration purposes. However, due to the size of the construction market, the atomization of the stakeholders, risks associated with material failure, need for insurance and warranty, along with many other historical and regulatory reasons, the construction sector is a highly regulated environment. Upon the escalation of production, manufacturers need to face the certification of their products.

In the process for the introduction of novel materials in the building envelope, designers, manufacturers, installers and final users need to address the characterization and certification of the product performance. The regulatory environment provides many already available product standards which define the suitable testing and certification schemes for already established product categories (e.g. mineral wool insulation for buildings…), but new products are commonly out of the scope of these standards and lack a recognized procedure for its characterization and certification.

In order to address the lack of standardized procedures, these need to be developed, and a consensus reached on their validity within assessment committees, commonly on a case-by-case basis. The uncertainty and time requirements for these procedures to be developed are a heavy burden to the development and commercialization of novel materials.

In some cases an existing harmonized standard where the product can be placed within its scope, is available. In these cases, performance tests allow for a straightforward way to obtain the CE mark of a product. This label allows for the commercialization of the product in the EU.

When such harmonized standards are not available, alternative certification procedures need to be activated. The most common procedure requires the drafting and approval of a European Assessment Document (EAD) within the European Organization for Technical Approvals (EOTA) [4], in order to obtain a European Technical Approval (ETA).

Other alternatives are the declaration product conformity by means of National Assessment Bodies. Generally, these procedures need to be activated for each member states. In some cases, one of such approvals, if correctly targeted at a later use, may pave the way to a CE marking with the previously mentioned EAD+ETA process.

All these alternative processes, when compared with CE marking according to harmonized standard, commonly impose a relevant delay in the time to market of construction products.