[RE] FORMING HEMP AND FLAX

HOW CAN HEMP AND FLAX BE INTEGRATED AS BIOBASED MATERIALS IN A SUSTAINABLE ARCHITECTURAL CONSTRUCTION?

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INTRODUCTION

In the Netherlands, the most pronounced concentration of the impacts of global warming and the potential rise in sea levels in the future is distinctly evident in the Groningen region and the Hunze River Valley (Feddes et al., 2021). Climate Change and its impact on us is no longer a scenario that might happen in the future but is already present. We've held this awareness as far back as 1938 when scientist Guy Callendar first linked the increasing carbon dioxide levels in the atmosphere to the occurrence of global warming, seen in phenomena such as rising sea levels (Earth Science Communications Team, 2023).

DEMAND FOR SUSTAINABLE BUILDING MATERIALS

When examining the consequences of global warming, the scientific community is aware that the creation and usage of building materials linked to fossil fuels, like concrete and steel, plays a large role in the anthropogenic global emissions. This pertains to activities involving the combustion of fossil fuels, land use, waste management, and industrial processes. (Matthews, n.d.) (United Nations, n.d.). Studies show that "the built environment is responsible for almost 40% of global energy-related carbon emissions" (Islam et al., 2021).

As a result of building with a more sustainable and reduced reliance on fossil fuels, the implementation of timber, which is a common sustainable building material, is becoming dominant in the field of architecture (Bentley, 2022). But when examining its life cycle of 25 years of growth and 40 years of utilization, coupled with the definition of sustainable harvested timber, which pertains to well managed and continually replenished forests to prevent harm to the surrounding environment, the already restricted availability of timber and its sustainability diminishes. Excessive logging and high maintenance requirements contribute to the gradual decrease in the sustainability of this building material, driving a growing demand for alternative sustainable materials (Searchinger et al., 2023).

In order to find an alternative to decrease this need it is imperative to establish a clear definition of the term "sustainable."

DEFINITION SUSTAINABILITY

In a concise definition, the term "sustainable" can be described as follows: "the ability to maintain or support a process over time" (Mollenkamp, 2023). A sustainable building material offers "specific benefits to the users in terms of low maintenance, energy efficiency, the improvement of occupant health and comfort, the increase of productivity whilst being less harmful to the environment" (Pacheco-Torgalet al., 2014).

Sustainability in materials additionally encompasses the principle of minimizing transportation distances whenever feasible. A related concept in this pursuit is that of *zero km materials*. The *zero km materials* approach promotes the utilization of products that can be obtained from nearby sources, ideally without undergoing extensive industrial processing. Throughout this concept transportation distances are reduced and aligned with the goal of achieving a more sustainable, cost-effective, and environmentally friendly built environment (Souza, 2021).

DEFINING THE SCOPE OF THE RESEARCH

To enable the investigarion of particular sustainable materials, the scope of this research is defined as follows:

This research will focus on the area of Groningen and Hunze River Valley in the Netherlands.
Regarding accessibility of sustainable building materials in and around Groningen and to provide greater detail about the focus on the location, the two biobased materials, hemp and flax, have been selected for in-depth investigation.

CONNECT TO GRONINGEN AND SELECTION OF MATERIAL

When examining Groningen's environmental landscape, it becomes evident that a substantial portion of the region's agricultural focus revolves around the cultivation of hemp. An examination of the agricultural history of the Netherlands reveals that, from approximately 1700 to 1915, the country operated within a circular economy that heavily relied on industrial crops. These crops played pivotal roles as primary resources in a wide array of industrial processes, with flax and hemp occupying essential positions in this industrial ecosystem.

Remarkably, approximately 69% of Dutch hemp cultivation takes place in the Groningen area, which provides a compelling basis for further investigation into its potential as a future building material (Selten, 2020). Furthermore, the Netherlands has a profound and longstanding connection with flax. Flax cultivation and the production of linen, a textile crafted from flax fibers, are deeply interwoven with Dutch heritage. Dutch farmers have nurtured flax crops for numerous generations, particularly in regions characterized by favorable climate and soil conditions. (Driel et al., 2022).

METHODOLOGICAL POSITIONING

The main aim of this research is to thoroughly analyze and investigate the potential utilization of hemp and flax as biobased building materials in long-lasting architectural structures. This comprehensive investigation will encompass a multifaceted approach, primarily focusing on the examination of mechanical properties, architectural form language, and the overall sustainability aspects of hemp and flax.
The methodology will involve an extensive literature review to gather in-depth knowledge about these materials, including their mechanical characteristics, ecological benefits, and any relevant advancements or best practices in their application. This theoretical foundation will be further reinforced by conducting case studies of existing buildings that have successfully incorporated hemp and flax as building materials.

Ultimately, this research will strive to answer the following pivotal question:
How can hemp and flax be integrated as biobased materials in a sustainable architectural construction?

Within this context, sustainability encompasses the proactive response to impending challenges posed by climate change and the rising sea levels in the Groningen region and the Hunze River Valley. It involves a detailed analysis of how hemp and flax as building materials.

To address these inquiries effectively, a comprehensive analysis and assessment of the historical and contemporary applications of the biobased materials hemp and flax is required. Furthermore, it is imperative to scrutinise and critique the factors that pose obstacles to the implementation of biobased materials in the area of Groningen and the Hunze River Valley. The process of scrutinizing and critiquing involves a thorough examination of hemp and flax, with the aim of understanding, evaluating, and making informed judgments. The form language, regarding its freedom of form and movement, and inherent properties are then examined, with a focus on evaluating its advantages and disadvantages. It will shed light on the barriers, flaws, errors, inconsistencies, and challenges that need to be overcome and understood to enhance the widespread use of sustainable and environmentally friendly materials in construction practices.

By comparing the biobased materials with alreadyin the building industry used materials possessing similar properties, a more comprehensive understanding of the outcomes will be achieved. The appropriate material for comparison will be selected following the evaluation of the mechanical properties of both hemp and flax. The comparative analysis is expected to yield valuable insights through a multi-faceted approach, including performance evaluation, benchmarking and environmental impact assessment.

The performance evaluation will provide a thorough assessment of biobased materials in comparison to their conventional non-biobased counterparts. By scrutinizing materials with similar characteristics, such as strength, durability, and thermal properties, this evaluation will provide essential insights into the feasibility and appropriateness of biobased materials for diverse applications within architectural construction. This comprehensive assessment is vital for a clear understanding of the potential strengths and limitations associated with the use of biobased materials in the field of architecture.
Additionally a benchmark will establish a reference point against which hemp and flax can be measured. This benchmark serves as a valuable yardstick for assessing the performance and effectiveness of biobased materials. It offers a clear perspective on whether these materials can compete with or surpass non-biobased alternatives, further informing decision-making in material selection.
Further on the Environmental Impact Assessment will help to assess the environmental impact of using biobased materials. It enables to weigh the sustainability benefits of biobased materials, such as reduced carbon footprint and renewable sourcing, against their non-biobased counterparts. This aspect is crucial in determining the eco-friendliness of these materials and aligning them with sustainable architectural practices.

DEFINITIONS

BIOBASED MATERIALS

Biobased materials are as following defined: *a "material resulting from plant or animal biomass that can be used as a raw material in construction and decoration products, fixed furniture and as a construction material in a building." (Francaise, 2012)*

HEMP

Industrial hemp, which is an annual crop, is primarily recognized for its fiber-producing capabilities. Throughout its history, these fibers have been predominantly used in the manufacturing of textiles and paper. Additionally, hemp fibers serve various purposes, such as animal bedding, insulation material, fiberboards, and medical applications. (Jeliazkov et al., 2019).
The use of hemp fibers as a raw material in construction is not a new concept, as the history of hempcrete in construction dates back at least 1500 years. Hempcrete describes a mixture of hemp shiv, a limebased-binder and water. However, the modern use of hemp in construction did not take hold until 1980 in France, where it was first used to replace deteriorating wattle and daub. Despite its long history, hemp has yet to gain independent recognition as a primary building material. (Souza, 2020).

FLAX

The flax plant is one of the most ancient plants, often known as the "textile plant." While its primary purpose is the production of linen from its fibers, flax has a range of additional uses. Its flowers can be employed to produce a blue textile dye, and its seeds, particularly linseeds, have substantial importance in the food industry
(Jhala et al., 2010). The utilization of flax in the construction industry is a relatively recent development, yet it is already the subject of investigation by various scientists and universities. Their aim is to demonstrate the substantial potential of flax as a future building material (Moore, 2023).

MECHANICAL PROPERTIES

Every material has its own strengths and weaknesses. The skilful use depends on making effective use of these properties. To maximise the potential of a material, one must utilise its strengths while being aware of its limitations. A thorough analysis of a material's properties includes an examination of their mechanical properties, such as density toughness, hardness, brittleness, plasticity, tensile strength, yield strength, young's modulus, stress and strain.

ARCHITECTURAL FORMLANGUAGE

Every material communicates a unique language through its form and inherent characteristics. The term "form" is defined as "the shape and structure of something distinct from its material" (Merriam-Webster, n.d., Form definition & meaning.). Architect Bjarke Ingels, who emphasizes that design is about "to give form to that which has not taken yet" (Ingels, 2020) underscores the evolution of a material from taking shape to being intentionally given form.
In light of this viewpoint, it becomes evident that a material should be approached and treated with a design philosophy that aligns with its own unique characteristics. These characteristics are best described as a "distinguishing trait, quality, or property" (Merriam-Webster, n.d., Characteristic definition & meaning). Characteristics refer to the distinguishing features, qualities, or properties that define and describe a particular entity, object, or phenomenon. These attributes help identify and differentiate it from others and play a significant role in understanding its nature or behavior. Characteristics can encompass a wide range of aspects, including physical, chemical, structural, or behavioral traits that provide insight into the unique qualities or attributes of the subject in question.

INTRODUCTION | BROADER RELEVANCE

FOCUS: area of groningen and hunze river valley, netherlands as study area

need of sustainable materials

acknowledgement of already existing materials

need of different sustainable materials

what is existing in regards to the definition of sustainability ?

alignment with the definition of sustainability ?

definition sustainability

definition sustainability in building materials:

- the ability to maintain or support a process over time
- low maintainence
- energy efficiency
- improvement of occupants health and comfort
- increase of productivity whilst being less harmful to the environment

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RESEARCH QUESTION

FOCUS: defining the object of investigation

hemp and flax

how can hemp and flax be implemented in a sustainable architectural construction?

definition implementation

definition sustainable architectural construction

definition hemp and flax

RESEARCH

FOCUS: hemp and flax as building materials

research of hemp and flax as building materials

sustainability of material

harvesting of material
regrowing of material

form language of material
visibility of materia

mechanical properties

stress and strain
youngs modulus
yield strength
tensile strength
plasticity
toughness, hardness, brittleness
density

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