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Bio-based construction materials for a sustainable future

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1 Abstract

The structural engineering community has a strong responsibility to contribute to a more efficient use of natural resources. Nowadays the construction industry is by far the most resource intense industry sector, approximately 40-50% of all primary raw materials are used, which raises the question about the architects and engineer's accountability. In this context and as a result of the Paris Climate agreement the Dutch government defined the program "*Nederland Circulair in 2050*", which states the ambition to use 50% less primary materials in 2030 and to have a full circular economy in 2050.

One possible approach to achieve these ambitious goals is the application of renewable, bio-based materials in the built environment and to replace traditional, typically cement-based, materials. Already in the past natural building materials, such as timber and bamboo have been used widely, but in recent years new materials came up and provide new opportunities to be used in the construction industry. The authors explored various alternatives, such as hemp and flax fibres, mycelium and lignin-based fibres for composite materials, which will be described with various experimental and realised case studies.

Keywords: Bio-based Composites; Innovative Materials; Circular Economy; Mycelium; Smart Systems; Sustainability; Resource-efficient Structural Design

2 Introduction

In 2015, the Paris Agreement [1] set for the first-time a challenging goal of all nations to work together and to fight against climate change and the resulting global warming. The objective is to lower the energy consumption by 30% until the year 2030 in order to reach these goals.

In this context the construction industry plays an important role and has a huge responsibility, because so far it is strongly relying on fossil-based materials (Fig. 1), which are responsible for around 40% of all energy related CO_2 emission and a substantial proportion of embodied carbon.

In the previous two decades the focus in the context of sustainability in the built environment was preliminary on the consumption and generation of (preferable) renewable energy, which was also covered in various sustainability certificates, such as LEED, BREAM or DGNB.

However, in the past years this also shifted towards the consideration of the primary material consumption as well as the embodied carbon dioxide in structures [2], [3].

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