Etude du comportement hygrothermique et durabilité de matériaux de construction incorporant des biomasses

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Abstract
Facing growing urbanization and industrialization, the construction sector consumes vast amounts of energy and natural resources, thus contributing to pollution and the increase of carbon footprints. This situation is exacerbated by the shortage of primary energy sources and global warming. The use of eco-friendly materials, such as low-carbon binders and bio-based waste, appears as a promising solution, helping to reduce energy consumption and greenhouse gas emissions. In Europe, regulations such as RT2012 and RE2020 have been implemented to mitigate the environmental impact of the building sector. The aim of this study is to develop insulating or structural materials by combining different biomasses with low-carbon binders. Five types of biomass are used: hemp hurds, flax shives, miscanthus shives, algae fibers, and flax straw, along with two types of binders: natural prompt cement and aerial lime. The addition of biomass can alter the cohesion within the material and disrupt the hydration process, thereby affecting the physical, mechanical, thermal, water, and hygroscopic properties. This thesis presents a comparative analysis of the hygrothermal behavior of the various materials developed. After the characterization of the basic components, the materials under study are described and developed. First, the integration of algae fibers (1%, 2.5%, and 4%) and flax straw (2.5%) into cob is studied. Algae improve the thermal properties of the mixture by increasing insulation through porosity. This approach could enhance the energy efficiency of buildings and promote eco-friendly construction practices. Next, the addition of hemp hurds, flax shives, and miscanthus shives (50% of the binder mass) is studied, and their hygrothermal properties are analyzed. Finally, the durability study examines the impact of freeze/thaw cycles on the materials. A combination of miscanthus with cement and lime seems promising for maintaining good post-exposure strength. Adjustments are necessary for materials with high water absorption, such as hemp hurds and flax shives. Further research is needed to optimize formulations and manufacturing processes, particularly for cement-based mixtures and mixed cement/lime binders, to minimize mass loss and preserve compressive strength.