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Project: Development of insulating and heat storing biobased material for building applications

Brief description of the context and aims.

To face global warming and its consequences, governmental authorities and NGOs have adopted regulations to reduce energy consumption and consequently CO_2 emissions. It is known that construction is one of the major sectors emitting greenhouse gases (GHG). It should be noted that building engineering accounts for 40 % of the world's energy consumption, a large part of that consumption being devoted to heating [1]. In France, for example, tertiary sector which includes the residential housing is responsible for around 45 % of total energy consumption and 21 % of CO_2 emissions. Heating accounts for about 60 % of the total energy consumption in housing [2].

As part of the global energy transition, several research paths are explored to reduce the energy consumption and carbon footprint of buildings without degrading the occupants' comfort. Among the investigated solutions, heat storage represents a very promising technology which is capable to improve the energy efficiency of buildings and their technical installations (heating, air conditioning and domestic hot water). Depending on the targeted application, latent heat storage, sensible heat storage or thermochemical storage will be selected.

For housing, researchers try to improve walls thermal performances without disturbing the building envelope by using heat storage systems or adding insulation layers. To comply with thermal and environmental regulations in force in the European countries, a lot of investigations have been undertaken, at housing full scale, to reduce energy consumption and environment impact. Given that construction products are the main item determining energy consumption and GHG emissions, it is important to develop innovative materials presenting a low environmental impact combined with interesting thermal properties.

In this context, long known earth-based building techniques, ex. rammed earth, cob, light earth, etc., had a renewed interest these last years. In fact, building with earth-based materials represents a real alternative. These materials can bring many benefits, mainly renewability of the main components and a low carbon footprint. Earth and vegetal fibers are natural resources that are often widely available. Usually, these latter do not require any treatment or transformation and are enough locally abundant in the European regions allowing the reduction of emissions due to transportation. In plus, these materials have a good capacity to regulate building hygrometry, at a low economic and environmental cost. Thus, promoting a healthy indoor environment.

These materials have many advantages but their deployment on a large scale, while respecting the standards in force, remains limited. For cob and adobe, this is due to their high thermal conductivity. To overcome this issue, light-earth has been developed these last years. Indeed, compared to conventional materials or other earth-based materials, light-earth presents a weak density. This induces a low thermal conductivity. Despite its good insulating capacity, thermal mass of this material remains rather weak (inducing a low thermal buffering capacity). **Incorporation of biobased PCMs in light-earth** will surely improve this property, leading to a significant energy savings. The high efficiency of organic phase change materials (PCM) is somehow limited due to one of the demerits of leakage in the melted state and low thermal conductivity. Plant fibers could be certainly an alternative for this purpose as they contain a high porosity that allows a high loading efficiency. The synergy of such vegetal materials with biobased PCM is not only useful from environmental point of view, but also provides a solution for the biowaste [3]. Initial work in the ESITC Caen lab. has shown that heat capacity of mixtures containing 20% microencapsulated PCM is four times higher than that of a pure light-earth [4]. In plus, thermal conductivity of this mixture is being reduced by approx. 20%. Thus, its insulating capacity is proportionally increased. In addition, temperature oscillation amplitude inside the building ambience is limited, and therefore the thermal comfort is naturally ensured. Beyond the energetics gains, the combination of light-earth and biobased PCM will present a low environmental impact and will be 100% biodegradable and recyclable at the end of its life.

The aim of present project is to improve the light-earth thermal mass and consequently its thermal buffering capacity. This will result in a reduced energy consumption and thermal comfort improvement. This will be achieved by the combination of the suitable hygrometric and thermal conductivity of light earth with the PCMs appropriate heat storage capacity.

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