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Preliminary investigation of a vapor-open envelope tailored for subtropical climate

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ABSTRACT

Concerning global warming and resource depletion, the impact of buildings in subtropical regions is becoming even greater due to a high growth rate of urbanized areas. From the viewpoint of building physics, the main problem concerning subtropical climate is the high level of humidity in combination with high temperature. In this study, a flexible building envelope consisting of wood and clay components was developed so that the materials and the assemblies can be easily tailored to comply with local climatic conditions. The movement and accumulation of moisture in the wall was of prime concern. This has been investigated by means of testing full scale walls in a climate chamber and the corresponding one dimensional transient heat and transfer simulation. In order to achieve a consistency between calculation and measurement, the individual materials were tested for their hygric and thermal properties. Based on these findings attempts were made to calculate the behavior of an optimized wall assembly under real climatic conditions of central Japan. As a result, it was shown that the hygrothermal behavior of the envelope is predictable by means of the models and the simulation program used, and that no risk of interstitial condensation and mold growth was predicted under the real climatic conditions of Kyoto.

1. Introduction

1.1. General background

In regards to reducing CO_2 emissions worldwide, the building sector is recognized to be of great importance. For example, within European Union, the emissions caused by the production of building materials, construction processes and operation consumptions of buildings amount to up to 30% of the total CO_2 emissions [1]. Considering the impact of building sectors, developing areas must also be taken into account due to a high growth rate of urbanized areas [2]. While dealing with this issue, it is important not only to take measures for reducing CO_2 emissions, but also to consider holistic approaches, such as the triple bottom line model of sustainability that demands ecological, economic and social performances:

- Ecological sustainability: the environmental load over the complete life cycle should be as low as possible. This includes that of the production of the building materials, construction processes and the operation consumptions until the demolition/disassembly phase.
- Economic sustainability: the initial investment in higher quality or better ecological performance should pay off eventually.
- Social sustainability: providing inhabitants with a comfortable and healthy living environment. The house should be able to adapt to changes in life style.

The exact measures to be taken to reach this goal while maintaining comfort and avoiding damage caused by moisture are generally not agreed upon. The general discussion is whether to focus on passive measures such as the envelope, active measures such as heating/cooling systems and energy generation, or a change in user behavior. A central point however is that certain minimum effort has to be made in all areas in order to achieve the goals listed above. This is especially true for the building envelope since a sound concept for this part of the building will greatly affect its lifespan.

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