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Development of a cost effective probe for the long term monitoring of straw bale buildings

Jim Carfrae [a,*], Pieter De Wilde [a], John Littlewood [b], Steve Goodhew [c], Peter Walker [d]

[a] School of Architecture, Reynolds Building, University of Plymouth, Drake Circus, Plymouth PL4 8AA, UK
[b] Cardiff School of Art & Design, Department of Architectural Studies, University of Wales Institute Cardiff, UK
[c] School of Architecture, Design and the Built Environment, Nottingham Trent University, UK
[d] Department of Architecture and Civil Engineering, University of Bath, UK

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ABSTRACT

This paper reviews current methodologies for measuring the moisture content of straw bale walls in buildings. It discusses the development of an affordable and accurate moisture probe that has been designed to be easily assembled by the builder or owner of a straw bale building from items readily available in the United Kingdom (UK). The probe uses a timber block inserted into the wall, relying upon the measurable moisture variances of the timber and relating this to the surrounding straw. The probes are designed to be used in pairs of varying length, taking measurements at different depths to give an estimate of the moisture gradient through the wall. In order to properly calibrate this device, a full set of sorption and desorption isotherms were established for both Oat and Wheat straw and three different timber species. The results from an environmental chamber have been compared to readings from specimens of the new probe installed in a straw bale house in the south west of the UK. The results were found to be consistent, to within 2%, with the laboratory findings.

1. Introduction

1.1. Background

There is increasing concern and awareness of environmental issues such as climate change, depletion of fossil fuels, pollution of natural resources, and damage to eco-systems. There are many contributory factors to these changes, but as far as this paper is concerned, two statistics stand out: in 2009 27.5% of final energy consumption in the United Kingdom (UK) came from domestic dwellings [1]; and secondly, 10% of the total energy used in the UK is embodied in construction materials [2]. Current Government legislation and initiatives from within the construction industry are focused on lowering the energy used during the lifetime of new and more recently existing buildings. To minimise the carbon impact of energy efficient houses it is also necessary to consider the embodied energy and origin of construction materials and components [3]. The increased use of renewable building materials, utilising the non-food use of crops such as hemp, flax and straw, is gaining prominence [4]. However, there are concerns regarding the long term effects of moisture on the durability of these materials in a temperate maritime climate such as the UK [5].

The origins of straw bale construction date from the late nineteenth century in Nebraska, USA, following the introduction of mechanical baling machines [6,7]. Over the past 120 years straw bale building has largely remained on the fringes of the mainstream construction sector. The first straw bale building in the UK was built in 1994 and now they number a few hundred projects of varying size. Straw bale, a low cost co-product of agricultural grain production, offers many benefits but in particular excellent thermal insulation and low embodied carbon. Straw bale walls have a low thermal transmittance, typically 0.13–0.19 W/m^2 K for a standard thickness of 450–500 mm [8]. During their growth plants absorb atmospheric carbon dioxide through photosynthesis [9]. This carbon remains stored within the plant fabric until it breaks down, making straw bales carbon negative.

1.2. Objectives

As with all plant based materials, including timber, there are concerns about the long term durability of straw, especially when used in a temperate maritime climate such as found in most of the UK.

* Corresponding author. Tel.: +44 1803 862369/+44 7880 551922.
E-mail address: jim.carfrae@plymouth.ac.uk (J. Carfrae).

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