

Development and testing of a prototype straw bale house

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This paper describes the research, development, construction and initial testing of an innovative low-carbon prototype house built using novel prefabricated straw bale panels. The use of straw as insulation provides an opportunity for value-added use of a widely available low-carbon co-product of farming. The research reported in the paper seeks to enhance the understanding and develop the modern mainstream acceptance and use of straw as a construction material in housing and other applications. The paper initially summarises development and construction of the panels and the house. Tests conducted on the panels and house reported in the paper include on-going durability assessment, fire resistance testing, acoustic transmittance testing, air permeability tests and thermal surveys.

1. Introduction

Straw bale construction emerged in Nebraska in the USA in the late 1800s from the need of European colonists to provide their own shelter. The oldest existing straw bale structure, the Burke house, is just over 100 years old, and is located in Alliance, Nebraska (King, 2006). Straw bale construction was chosen by the settlers, initially as a temporary solution, because no other viable construction materials were readily available. Interest in straw as a construction material decreased in the early twentieth century as industrially produced building materials became more readily available with development of transport (King, 2006). Interest in straw bale construction re-emerged in the early 1980s in the USA and has seen a further resurgence from the early 1990s. Straw bale construction arrived in the UK in the mid-1990s (Jones, 2009). The revival of straw as a construction material has developed as builders have recognised the advantages of straw in this capacity. Straw is a natural, renewable and biodegradable material that can be readily sourced locally in many areas and involves little further processing. It has low embodied carbon and therefore its use can help significantly to reduce the environmental impact of new building infrastructure.

The modern straw bale construction techniques used initially were inspired by the Nebraska buildings, with load-bearing walls and pins driven through bales used to enhance stability. Significant developments have been made and the technique has been embraced by self-builders around the world (King, 2006). Timber frame buildings with straw bale infill have

become increasingly popular as the construction technique enables the straw walls to be built in an enclosed, dry environment.

Prefabricated straw bale building techniques take traditional materials and utilise them for modern methods of construction, taking the advantages of using straw into a controlled prefabricated process. This paper outlines the use of prefabricated straw bale construction methods to construct panels and a prototype house, built for research purposes. The panelised system focused on in this paper is ModCell (modular cellulose), first used in the University of the West of England's School of Architecture in 2002. The aim of this paper is to enhance the understanding of this technique for use in the UK. Initial results on the durability of the straw within the prototype house are reported, together with findings from investigations of the acoustic transmission performance, air permeability and thermal integrity. The sound insulation performance of individual test panels is also provided, together with their fire resistance.

2. Prefabricated straw bale construction

ModCell employs prefabrication as a method of construction using straw to provide panels for cladding and, more recently, load-bearing walls (see Figure 1). Straw bale benefits from the general advantages of prefabrication, including: improved quality; reduced construction time on site; minimisation of waste; and safer construction. However, very importantly prefabrication reduces the risk of weather delays and the straw becoming wet during