Structural enhancement of timber stud framing using renewable insulation materials

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ABSTRACT: Structural timber studwork framing is widely used in the construction of domestic buildings in the UK. Hemp-lime is a novel low carbon renewable construction material that is increasingly being used in the UK for insulating timber framed buildings. When combined, timber studwork framing and hemp-lime provide a highly insulating, low carbon energy efficient building system. By encasing the timber studs in hemp-lime there is potential for the hemp-lime to indirectly enhance the structural performance of the timber framing. This paper presents results from structural testing undertaken on timber studwork frames both with and without hemp-lime with compressive, in plane racking and out of plane bending loads applied. The results show that hemp-lime significantly increased the strength and stiffness of the timber studwork frames.

KEYWORDS: Studwork framing, Hemp-lime, Structural loading, Low carbon materials

1 INTRODUCTION

Minimising the energy used in construction and running of buildings is key to meeting UK Government targets of reducing greenhouse gas emissions by 2050. Therefore, construction materials and processes that minimise energy use during construction and operation of buildings are very important and relevant at this time. Structural timber studwork framing is widely used in the construction of domestic buildings in the UK and with the correct design and detailing can produce buildings compliant with government targets for reducing energy use and carbon emissions.

One material that can be used in conjunction with timber studwork framing to produce such buildings is hemp-lime. Hemp-lime is a novel low carbon renewable construction material that is increasingly being used in the UK for insulating timber framed buildings. It is cast around the timber studwork framing to form a solid insulating wall (Figure 1).

Hemp-lime is mixed from hemp shivs, a lime based binder and water to form a material that can be cast and lightly tamped into position. The lime binds together, and protects, the hemp particles to form a lightweight composite with favourable insulation and hygrothermic properties, but with only modest mechanical properties. Hemp-lime's contribution to the load-carrying capacity of walls is currently ignored. However, as it encapsulates the timber framing stud elements, it has the potential to indirectly enhance the structural performance of wall panels.

Figure 1: Typical timber studwork frame and hemp-lime construction

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2 PREVIOUS RESEARCH

There has been limited previous research on hemp-lime due to its relatively recent use within construction. Most previous research has focused on mix proportions and material properties. Evrard (2003), De Bruijn et al. (2009) and Hirst et al. (2010) all investigated the performance of different binders and densities of hemp-lime. Evrard (2003) found that increasing the density and amount of binder increased both strength and stiffness, while Hirst (2010) found that the use of a stronger binder did not increase the compressive strength of the hemp-lime. Helmich (2008) studied the effects of hemp-lime cast around lightweight steel studwork framing and found that it increased the compressive load capacity of the studs.

3 EXPERIMENTAL WORK

Six timber studwork frame and hemp-lime wall panels were constructed and allowed to dry. Three different loading conditions were tested, compressive loading of studs, in plane racking of the panels (figure 2) and out of plane bending. In addition timber studwork-only frames were subjected to the same loading conditions in order to allow a comparison.

The results from these tests have shown that the stiffness and strength of timber studwork framing can be significantly increased by encasement in hemp-lime under compressive and in plane racking loads (figure 3). Under out of plane bending loads the timber frame does not change the initial stiffness of the wall panel prior to cracking of the hemp-lime. However the post cracking strength is increased by the timber studwork framing and the walls can continue to carry significant loads.

The material properties of both the timber and hemp-lime used in the wall panel specimens were established by laboratory testing.

4 CONCLUSIONS

Hemp-lime fulfils the function that sheathing and other insulating materials play within a conventional timber studwork frame in creating a solid wall. This research has now shown that hemp-lime can enhance the structural capacity of timber studwork framing and therefore fulfil the other function of sheathing boards in resisting buckling of studs and in plane racking of wall panels. Therefore, savings in materials and costs can be realised.

Further work is required to develop theoretical models and design guidelines for the composite behaviour of timber studwork framing with hemp-lime. This will allow for the wider uptake of this type of timber framing and will lead to more efficient design and use of materials.

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