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Public opinions on alternative lower carbon wall construction techniques for UK housing

Fiona Hamilton-MacLaren, Dennis L. Loveday, Monjur Mourshed*

School of Civil and Building Engineering, Loughborough University, Loughborough, Leicestershire LE11 3TU, United Kingdom

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A B S T R A C T

There is a widespread interest in reducing environmental impacts of all industries and processes to help achieve the targets set in the Climate Change Act of 2008. The use of alternative construction techniques to build the walls of UK housing has the potential to reduce their environmental impact in a range of ways. This includes the reduction of embodied energy as well as operational energy use, the latter through improved thermal performance. A major challenge to be overcome if alternative techniques are to be used is the acceptability to purchasers. The current acceptability of a range of construction techniques and issues that are important to purchasers were examined using a questionnaire. Although the acceptability of lower carbon alternatives is less than that of the conventional technique, findings in this research suggest that there is potential for their use in UK housing. The acceptability of alternative construction techniques varies greatly with type. Concerns expressed about the construction techniques could often be dispelled by existing research, indicating that education is key to improving acceptability of alternative construction techniques and hence opening the way to accessing their environmental benefits. The respondents identified environmental issues, finance, operating costs and risk as key areas of concern, which need to be considered during decision-making.

Introduction

Background

A target of 80% reduction in total UK carbon emissions below 1990 levels by 2050 has been set in the Climate Change Act 2008 (UK Parliament, 2008). Consequently, several policy measures have been adopted for a significant reduction in carbon emissions from UK housing (DCLG, 2008a). Measures for the new-build housing sector include frequent updates to the building regulations, focussing on the reduction of operational carbon emissions to zero by 2016 (DCLG, 2007). As the operational carbon emissions fall to zero, the emissions associated with the construction stage (i.e. the embodied carbon) increases in importance. Ravetz (2008) noted that embodied carbon of newer homes accounted for as much as 27% of the lifetime carbon emissions. Therefore, the share of embodied carbon will account for a much greater proportion of the carbon emissions associated with zero carbon homes. For any housing where all operational energy requirements are met from zero carbon sources, the embodied carbon will account for 100% of the lifetime carbon cost.

This work focuses on housing, as it accounts for 27% of the UK's carbon emissions (Boardman, 2007). By reducing these emissions through a combination of improved new-build standards, renovations and alternative methods of energy generation, a significant step would be taken towards achieving the 80% carbon reduction target. Improving energy use by retrofitting existing buildings has an important part to play; however, it is also important to find ways to construct new buildings so that they contribute to the solution from the outset, rather than requiring retrofitting in the near future. Retrofitting is the focus of a number of Government schemes such as the Green Deal (DECC, 2010) so is not considered here. Focus is given to the use of alternative wall construction techniques, which have the potential to improve environmental standards of new-build housing.

Reducing environmental impacts from construction can be achieved in a number of ways: by using low embodied energy materials such as timber (Gustavsson & Sathre, 2006; Lenzen & Treloar, 2002); by increasing the use of local materials and thereby reducing the need for transportation (Morel, Mesbah, Oggero, & Walker, 2001); and by using efficient modern methods of construction such as structural insulated panels (SIPs) and insulating concrete formwork (ICF). SIPs and ICF enable a significant

* Corresponding author. Tel.: +44 1509 228792.
E-mail addresses: F.Hamilton-Maclaren@lboro.ac.uk (F. Hamilton-MacLaren), D.L.Loveday@lboro.ac.uk (D.L. Loveday), M.M.Mourshed@lboro.ac.uk (M. Mourshed).

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reduction in waste, labour and transportation, resulting in a low embodied energy.

It is essential that while the negative environmental impact of housing construction is reduced, factors such as performance and economic viability are not compromised. Minimum levels of performance are controlled through building regulations. It is the potential impact on customer appeal, and hence the economic viability, which has been investigated in this research. Were individuals to be reluctant to purchase a house constructed using a particular technique, then it would have a reduced or no possibility of adoption by the construction industry, because of low potential for sales and hence a high risk of financial loss. By identifying construction techniques that are acceptable to purchasers, it becomes possible to take advantage of these options. This information could be used to shape government policy so that the acceptable lower impact options are encouraged and hence the negative impact of housing is reduced. Construction firms may also find this information helpful if trying to reduce the negative impacts of their projects whilst maintaining saleability and profits. The investigation also addresses factors that house purchasers consider important. These can be applied to both the construction technique and more generally across housing projects.

This research was limited to techniques used to construct walls. Consideration was only given to their use in housing, as the views collected were intended to show the opinions of house purchasers. The geographical area of study was restricted to the UK, because the research was intended to find information that could be used in the development of national policies for the reduction of environmental impacts from housing construction.

Construction techniques and their selection

The work focused on 6 construction techniques, all of which are suitable for use in house walls. This was considered sufficient to generate useful comparisons but not to be excessive to consider in detail. The selection criteria were:

- Prior use for housing in the UK;
- Availability of detailed information about the method; and
- Method suitable for use across the UK.

The construction techniques investigated were:

- Structural insulated panel (SIPs) with a brick cladding;
- Insulating concrete formwork (ICF) with a brick cladding;
- Timber frame with brick cladding;
- Thin joint block work with a brick outer skin;
- Prefabricated straw bale wall units with a lime plaster coating; and
- Brick and block.

Brick and block, the most commonly used construction technique in the UK, was included to act as a baseline for comparison. Housing data for England during 1990–2009[1] (DCLG, 2010a) and Scotland during 1997–2002 (Communities Scotland, 2006) suggest that brick and block was used for 88% and 69% of all dwellings constructed in England and Scotland respectively. The second most frequently used housing construction technique is timber frame, used for 7% and 29% of dwellings in England and Scotland respectively. Timber frame has a much higher level of use in Scotland. The remaining construction techniques were selected to cover a range of available options including modern methods of construction in the form of SIPs and ICF and one atypical method, straw bale and lime plaster. Thin joint block work was chosen because of its similarity to brick and block construction and the implied probability that its acceptability might be similar to that of brick and block. Brick cladding was selected where possible to maintain a consistent appearance between the options and to demonstrate that houses built using alternative construction techniques could look the same as those built using traditional methods. All construction techniques have been successfully used in the UK and are capable of meeting building regulations.

A number of construction techniques were considered but discarded. Rammed earth construction was considered too unusual for many purchasers and could not be used universally across the UK, because of the variations in site soil. Steel framed buildings were not included because of their similarities with timber framed buildings. Offsite *pod* construction was discarded as it was considered to not be comparable with the other methods. A range of alternative materials based on source was investigated such as local, recycled and reused materials; these were discarded because their availability varied with location.

Method

A questionnaire was designed and distributed to investigate potential house purchasers' opinion on construction techniques. Questions were included to identify factors that were important to purchasers when considering a house purchase, in particular, ones that could be affected by the use of alternative construction techniques.

Questionnaire design

Questionnaire design was based on methods discussed by Fink (2006) and Oppenheim (1992). Stages followed were: identifying the questions to be answered; generating questions; testing and altering the questions as necessary; distribution of the questionnaire; collection of responses and analysis of data. The questionnaire was aimed at answering the following questions:

- What factors are important to house purchasers when considering a house to buy?
- Are house purchasers aware of the construction techniques being examined?
- Would house purchasers buy a house built using the construction techniques being examined?
- What would increase house purchasers' interest in houses built using alternative construction techniques?

The questionnaire was anonymous, with no identifiable personal data collected in order to improve response rates and minimise ethical issues associated with data protection. The importance of a range of influencing factors was examined by using a Likert scale. Respondents were asked to score the importance of each factor on a scale from 1 (*not at all*) to 5 (*very much*).

Awareness was determined by a *yes*/*no* option for each construction technique. At this point, no additional information about each technique was provided. The acceptability of each technique was examined by providing a labelled, axonometric view (as shown in Fig. 1) and a description. Respondents were asked if they would consider purchasing a house constructed using this technique, with options of *yes*, *no* and *maybe*. This had potential for simplification, which was desirable from the points of view of succinctness of responses and probability of having the questions answered in full. Space was also provided in the form of an optional comments box, allowing respondents to expand on their choice and offer a greater depth. This allowed for comments that were relevant but not bound by specific questions, achieving an interview style

[1] Up to March 2009.