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Smart and Healthy within the 2-degree Limit

Thermal Performance of Village Dwellings in SW China:
The impacts of the 'new vernacular'

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ABSTRACT: This paper addresses an emerging issue for village communities located particularly in SW China. Government inspired efforts to redevelop rural villages combined with aspirations of local residents have led to the replacement of the traditional, predominantly wood-construction house with a modern, mainly concrete, alternative. The new houses have modern facilities (such as for washing and cooking) but also very different thermal characteristics and are found with large windows and more restricted air flow. There is normally little involvement of professionals in appropriate ways that would allow optimisation of design for future comfort and energy efficiency. This paper describes some analytical studies of typical design options and identifies some influencing parameters. The research justifies the need for, and development of, a tool suitable for use by village committees/groups and their advisors that will provide decision-support for optimisation of comfort and energy use.
KEYWORDS: villages, dwellings, China, thermal performance, temperature

1. INTRODUCTION

Since 2005 rural areas in China have been an important focus for Government policies with much encouragement for redevelopment and improved economic prosperity. In the SW of China this has led to many villages considering an emphasis on attracting tourists to visit scenic and traditional communities and to spend money and in some well-located villages, this can lead to useful income flows.

In other places a more fundamental approach to renovation has been taken with poor buildings being classified under four levels of essential repair and remediation applied accordingly. Figure 1 shows such a dwelling being classified by a team from the Jinghong Design Institute in a village in Xishuangbanna SW China.

There is however, an opportunity to provide more sophisticated renovation and development and to consider wider sustainability remediation. This could include for example the range of issues analysed by Li and Ng [1]. Other authors have suggested that design options focused on passive solar and ventilation control were important features for future design guidance [2].

Figure 1: Dwelling being assessed for renovation (authors).

3. DESCRIPTION OF DWELLINGS

In rural villages two styles are beginning to predominate: the traditional dwelling constructed mainly from wood (for structure and walls) with roofs of tile or shingle – the 'old vernacular'; and perhaps what might be termed a 'new vernacular' style in which residents replace the old building with one made largely from concrete blocks with tile roofs and large windows. They also increase size and height by extending over more of their original plot (see figures 2 and 3).

Figure 2: Typical Traditional Style Dwelling (authors).

Figure 3: Typical New Style Dwelling. (authors)

In both styles it is the first (upper) floor which accommodates family life whilst the ground floor is used for storage or commercial activities. A third style of house was also considered – that of an earthquake resistant dwelling. The layout and use of this type was significantly different from the others two and it was discarded from the final analyses.

4. ANALYTICAL PROCEDURE

Information was collated on typical house designs from visits and from previous studies (see [3]). In addition, a pilot study of temperatures experienced in different rooms of dwellings in Jingna Town (Man Meng Xin Zhai) was carried out directed by the authors.

There is a substantial variation in construction but key characteristics can be identified. From this normalised building plans and construction features were developed which were then be extracted and used in an energy/environmental simulation model (DesignBuilder). The software was used in a parametric fashion to compute outcomes for a range of scenarios in which window area fraction was varied along with air change rate and construction details. This produced data allowing comparison in terms of internal temperatures and energy use predictions.

Large numbers of data were produced from which only a summary can be presented here.

5. SUMMARY OF RESULTS

The buildings perform quite differently due to the major variations between materials and air-tightness as well as solar heat gains through windows. These are clearly quite different in the two styles of construction however despite this, modes of use and daily life within the dwellings was observed to vary little.

A comparison of some selected aspects of the data is given in table 1. Overall the results indicated for free-running mode that the new dwelling was typically 2.2°C warmer than the traditional in the coolest month but also 1.7°C warmer in the hottest month. This outcome was also reflected in simulations for the buildings with heating and cooling systems provided: more energy was required to maintain comfort in the traditional dwellings in cool months and more needed to provide for cooling of new dwellings in summer.

6. CONCLUSIONS

It is clear that each dwelling type has positives and negatives with respect to thermal performance judged solely on the data produced. This is only part of the analysis as there are a number of other considerations. The dwelling occupants are eager to bring their properties up-to-date with modern amenities fitting their perception of a modern lifestyle though use of building is very similar to that of previous generations.

Significantly, the new buildings are constructed with little use of information or advice on how the thermal performance of the dwelling could be improved. In maximising the use of the plot area solar availability and ventilation has not often been considered.

Meanwhile for dwellings constructed by registered professionals there is recognition of the need to address earthquake resistance, this is not the case for dwelling commissioned directly by residents.

There is therefore significant potential for impacting beneficially on the process if stakeholders can be engaged and information of the right type made available in the right format. The authors propose that this could be enacted if linked to existing activities being undertaken in rural regeneration and revitalisation schemes.

Table 1: Comparison of average temperatures in January and July for traditional and new style dwellings (data show variations according to window area and ventilation rate)

window area fraction	air change rate (ach)	winter (°C)	summer (°C)
traditional dwelling			
0.3	0.25	13.0	23.1
0.3	1.0	12.9	22.9
0.3	2.0	12.8	22.8
0.5	0.25	13.2	23.2
0.5	1.0	13.1	23.1
0.5	2.0	12.9	23.0
0.7	0.25	13.4	23.4
0.7	1.0	13.2	23.3
0.7	2.0	13.1	23.2
new dwelling			
0.3	0.25	14.6	24.3
0.3	1.0	14.5	24.2
0.3	2.0	14.3	24.1
0.5	0.25	15.6	25.1
0.5	1.0	15.5	25.0
0.5	2.0	15.3	24.8
0.7	0.25	16.1	25.4
0.7	1.0	15.9	25.2
0.7	2.0	15.7	25.1

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