Indoor Humidity Environment in Huizhou Traditional Vernacular Dwellings of China in Summer

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Abstract

A three-month field measurement of temperature and humidity was carried out in order to analyze the indoor humidity environment in a Huizhou traditional vernacular dwelling compared with that in a modern dwelling during summer. The results showed that the average relative humidity in the traditional vernacular dwelling over 83% was slightly higher than the corresponding value around 75% in the modern dwelling. The humidity fluctuation appeared stable in wing-room due to the moisture buffering effect of the internal timber wood while the humidity variation was drastic in bedroom with well air-tightness due to frequent application of air-condition. The dependency of indoor humidity on the outdoor humidity was strong resulted from a great effect of natural ventilation in the traditional vernacular dwelling with a correlation coefficient of 0.8. Although humidity was high, the thermal comfort was acceptable with the comfortable time near 60% in the traditional vernacular dwelling during summer. It is supposed to apply synthetic hygroscopic materials on the basis of the timber wood with ventilation to moderate indoor humidity in modern architectures in Huizhou area.

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Keywords: Huizhou traditional vernacular dwelling; Indoor humidity environment; Moisture buffering effect; Natural ventilation; Thermal comfort

1. Introduction

There has been a growing realization that Humidity plays a significant role in the indoor environment as the temperature does. It would deviate from the accurate assessment of the indoor thermal comfort, building energy consumption and the durability of building envelope on the overlook of the indoor humidity. On the one hand, a low
indoor humidity might induce the symptoms, such as the dryness of eyes, nasal cavity, mucous membranes and skin
[1,2]. It was reported that the indoor relative humidity should not be below 20%, which to avoid the complaints
about dryness [3]. On the other hand, when in a high humidity, it is possible to trigger off the overgrowth of the
mold and fungus as air containment, which lead to Sick House Syndrome [4]. Moreover, the moisture in the building
materials imposes a serious hygrothermal load that has an effect on the thermal performance of the building
envelope [5]. The thermal sensation of occupants in a high temperature would turn to hotter when Humidity gets
high [6]. Kalamees [7] carried out a two-year field measurement of indoor temperature and humidity in 170 detached
houses in Finland. It concluded that the ventilation system played a more important role in regulating the variation of
the indoor humidity compared with the building fabric. Zhang [8] investigated the indoor humidity conditions in
residential houses of 9 major cities of China. It analyzed that the indoor humidity not only depended on the outdoor
humidity, but also was closely associated with Heating/cooling systems, occupants activity and the thermal
insulation (or air-tightness).

The area of Huizhou belongs to the subtropical monsoon climatic region with the yearly precipitation of 1500-
2000 mm, which is characterized as hot and humid in summer as well as cold and humid in winter. Not only humid
climate, but also the unique building form has an effect on humidity related problems in Huizhou traditional
vernacular dwellings that has become increasingly serious. However, the study of Huizhou traditional vernacular
dwellings mainly focused on the indoor thermal environment. Lin [9] analyzed that Huizhou traditional vernacular
dwellings took the sunshade in consideration firstly supplemented by the natural ventilation to improve the indoor
thermal comfort in summer. Song [10] carried out a field measurement along with questionnaires. It found that the
indoor temperature was acceptable while the air humidity was high in summer. On contrary, the indoor environment
was uncomfortable due to a low temperature and a high humidity in winter [11]. Chen [12] analyzed that the indoor
thermal environment was desirable in mild seasons but comparatively cold and humid when people slept. Therefore,
it is necessary to make further efforts on the indoor humidity environment and its factors in Huizhou traditional
vernacular dwellings.

This study focus on the indoor humidity environment in Huizhou traditional vernacular dwellings based on a field
measurement in the village of Zhaji. It is aimed to clarify the characteristics of the indoor humidity environment in
order to figure out some moisture moderation designs for modern architectures.

2. Methods

2.1. Discription of dwellings

The village of Zhaji, Xuancheng located in 118.41° East longitude, 30.68° North latitude is the core area of
Huizhou area. A three-month measurement was conducted in two typical Huizhou dwellings, one of which was a
traditional vernacular dwelling (TD) and the other was a modern dwelling (MD). Table 1 shows the detailed
information of the measurement dwellings.

<table>
<thead>
<tr>
<th>Name</th>
<th>Time</th>
<th>Orientation</th>
<th>Rooms</th>
<th>Wall</th>
<th>Ground</th>
<th>Openings</th>
<th>Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional vernacular dwelling (TD)</td>
<td>Qing Dynasty</td>
<td>Facing south</td>
<td>Hall (H)</td>
<td>Clay bricks&amp; timber wood</td>
<td>Mortar</td>
<td>Patio</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Wing-room (WR)</td>
<td>Clay bricks&amp; timber wood</td>
<td>Suspended wood floor</td>
<td>Hollowed-out windows</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Living-room (LR)</td>
<td>Brick-concrete</td>
<td>Ceramic tiles</td>
<td>Glass windows</td>
<td>Air-condition</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Bedroom (BR)</td>
<td>Brick-concrete</td>
<td>Wood floor</td>
<td>Glass windows</td>
<td>Air-condition</td>
</tr>
</tbody>
</table>

| Modern dwelling (MD)      | About 5 years ago | Facing north | Living-room (LR)       | Brick-concrete         | Glass windows | Air-condition           | No            |
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