Strategies for thermal comfort & thermal performance

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IFRC-SRU Conference on winterization
Introduction

• Increase in number of shelter programs in cold climates.
• What is good enough for emergency/recovery and how does it differ per context?
Purpose of study

• **Thermal Performance** - This is to understand how well buildings perform in Cold and Hot environments. This looks at the shape of the building, the materials it is made of, and how drafts and air flow impact on the design.

• **Thermal Comfort** - Because we all have a different sense of temperature, we want to understand what peoples’ preferences and tolerances are. This information helps us design buildings to meet peoples preferences.
Thermal comfort & thermal performance

Background definitions & factors
Thermal comfort

‘That condition of mind which expresses satisfaction with the thermal environment.’
(British Standard BS EN ISO 7730)
What is sufficient thermal comfort?

- **Too Cold** (Hypothermia)
  - Symptoms Below 35°C
- **Normal**
  - 37°C
- **Too Hot** (Hyperthermia)
  - Symptoms Above 38°C

**Provision of clothing, shelter, heating, environment, and nutrition, to allow normal activities and dignity of life.**

*Life saving measures to protect from extremes of temperature.*
Thermal comfort

Thermal comfort is **subjective** because:

- **Physiologically** there are many variables that influence individual body temperature
- **Psychologically** our individual perception and tolerance of temperature varies

The AHRAE scale is one method of measuring thermal sensation (Thermal Comfort)
Air tightness

Case studies
Kurdistan, Iraq

- Winterization of collective buildings. Providing shelter to over 10,000 individuals.
- Out-of-camp solution.
- Shelter upgrades to seal openings in unfinished buildings by providing plastic doors and windows.
- NFI fairs
Eastern Ukraine

- Freezing & snow
- Strategy to provide 1 air tight room
- Unconditional cash grants, largely used for rent.
- Provision of plastic doors and windows
- Communication focus on air tightness
Gaza

- Cold but not freezing temperatures.
- Material restrictions
- Double façade & elevated floor
- Sealing of doors and windows
- Interior ceiling
- Fire prevention measures
- Cultural habit: outside fire
- Sound isolation for double storey model
Bannu, Pakistan

- Winterized temporary shelters with extensive winterized NFI package (blankets, floor sheet)
- Cold but not freezing temperatures.
- Request for a quick temporary shelter response.
- Extensive NFI package was quicker to procure and distribute/implement than high-insulation value shelter materials (e.g. styrofoam)
Bannu, Pakistan

• A 5cm insulation layer of local ‘lokha’ and chieck mats in all walls and roof. Outside PE sheeting as waterproofing layer.

• Floor not insulated because people commonly sleep on elevated beds.

• Recommended ventilation through flaps at gable ends, not often implemented by beneficiaries causing condensation issues.

• Door not airtight, importance of wind chill prevention
Iraq & Pakistan

Thermal comfort study methodology
Thermal comfort and performance testing implementation guide

Step 1
- Introduction and agreement for the household to support

Step 2
- Building Survey

Step 3
- Positioning of Equipment

Step 4
- Agree thermal performance indicators

Step 5
- Instruction on taking temperature readings

Step 6
- Collection of Data

Step 7
- Feeding back findings
Building survey

Three parts:

- **Building Fabric**
  - The surface area (m²) of the walls, floor, and roof. (If there is a ceiling, this is used as the roof area)
  - The thickness (mm) of the walls and roof (If there is a ceiling, measure the thickness of the material and any insulation)
  - A description of the materials for the walls, floor, roof.
- **Doors and Windows**
  - Measure and record each type
  - Measure the volume of the building
  - Photographs of the building and the materials
Positioning of equipment

Positioning Thermometer (Probe)

**External** Locate the thermometer (or probe) out of direct sunlight, and in a sheltered location away from any wind.

**Internal** Locate the thermometer in a living room, 1.5m from the floor, away from any heat producing appliances, sunlight, and protected from drafts.
## Daily data collection

### Summer Average

<table>
<thead>
<tr>
<th>Date</th>
<th>Internal Temp</th>
<th>External Temp</th>
<th>Comfort Rating</th>
<th>Internal Temp</th>
<th>External Temp</th>
<th>Comfort Rating</th>
<th>Internal Temp</th>
<th>External Temp</th>
<th>Comfort Rating</th>
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<tbody>
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<td>Day 7</td>
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<td>Day 11</td>
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<td>Day 12</td>
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</tbody>
</table>
How to measure the Thermal Performance of a building - Thermal Comfort

A simplified version (below) of the ASHRAE scale is used to record basic levels of thermal comfort.

<table>
<thead>
<tr>
<th>Comfort Rating</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Too Cold</td>
</tr>
<tr>
<td>2</td>
<td>Temperature is ok for normal activities (Sitting, Sleeping, Housework)</td>
</tr>
<tr>
<td>3</td>
<td>Too Hot</td>
</tr>
</tbody>
</table>
Study outcomes
Bannu, Pakistan
- 5 participants
- February 2 – March 3, 2015

Kurdistan, Iraq
- 3 participants
- February 25 – March 26, 2015
Summary of Temperature Bannu, Pakistan

- **Morning**: Average Temperature Internal 13, Average Temperature External 11
- **Noon**: Average Temperature Internal 21, Average Temperature External 20
- **Evening**: Average Temperature Internal 15, Average Temperature External 13
Comfort level

Comfort Level Bannu, Pakistan

- Morning
- Noon
- Evening

Too Cool

Normal

- 5% Too Cool in Morning
- 0% Too Cool in Noon
- 3% Too Cool in Evening
- 95% Normal in Morning
- 100% Normal in Noon
- 96% Normal in Evening
Temperature measurements

Summary of Temperature Iraq

- **Average Temperature Internal**
- **Average Temperature External**

<table>
<thead>
<tr>
<th>Time</th>
<th>Average Temperature Internal</th>
<th>Average Temperature External</th>
</tr>
</thead>
<tbody>
<tr>
<td>Morning</td>
<td>15</td>
<td>13</td>
</tr>
<tr>
<td>Noon</td>
<td>16</td>
<td>17</td>
</tr>
<tr>
<td>Evening</td>
<td>18</td>
<td>14</td>
</tr>
</tbody>
</table>
Comfort level

Comfort Level Iraq

- Morning
- Noon
- Evening

Too Cool
- 16%
- 0%
- 10%

Normal
- 84%
- 100%
- 90%
Conclusions
&
Food for thought
Conclusions

• Small temperature differences, though inside climate is perceived comfortable.

• Thermal comfort is one thing, but it is about the performance of the whole building.
Vulnerable groups

In the elderly and sick cardiovascular loss of function reduces the capacity to maintain body temperature.

Babies and children have a higher Body Surface Area to volume ratio than adults, which makes them more susceptible to changes in temperature.
Wind chill

Wind Chill (Air Velocity) vs. air tightness

![Wind Chill Chart](chart.png)

Source: U.S. National Weather Service; Meteorological Services of Canada
**Floor insulation**

Alternative floor insulation strategies.

- Floor insulation is crucial but can be complex.
- Air tightness, elevations
- Dampness prevention
- What are ways to improve thermal performance of floors without expensive imported materials?
With limited means, aim to:

1. **Stop Drafts** – This is the most cost effective method way of improving thermal performance to keep a house warm.

2. **Improve the insulation** to the fabric of the building. Start with the roof and loft areas, then the floors and walls.

3. **Create Micro Climates** by planting trees, vegetation or building walls and screens to reduce wind chill or to provide shading in hot climates.

4. **Orientation** - The building should be orientated to capture or avoid solar gain, and look to shelter or benefit from prevailing wind and breezes.
# Sample House Improvement Checklist for Cold Climates

<table>
<thead>
<tr>
<th>Building Fabric</th>
<th>Wall Construction</th>
<th>Masonry</th>
<th>Timber</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repair of walls so that there is no air gaps. Use filler, expanding foam, mastic.</td>
<td>Repair of walls so that there is no air gaps. Use filler, expanding foam, mastic.</td>
<td>Fit fibre insulation to wall cavity on exterior wall if possible.</td>
<td></td>
</tr>
<tr>
<td>Roof Construction</td>
<td>Pitched Roof</td>
<td>Fit fibre insulation to loft area</td>
<td></td>
</tr>
<tr>
<td>Floor Construction</td>
<td>Concrete</td>
<td>Timber (Suspended)</td>
<td></td>
</tr>
<tr>
<td>Fit carpets with underlay (Use cardboard or newspaper)</td>
<td>Seal joints in floor so there is no air gaps. Lay hardboard over floorboards. Fit carpets with underlay</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Windows</td>
<td>Single glazed</td>
<td>Secondary glazed</td>
<td>Double glazed</td>
</tr>
<tr>
<td>Fit secondary glazing or new double glazed window</td>
<td>Tape joints and make sure all frames and glazing are air tight</td>
<td>Check joints for air gaps. Seal with foam and filler</td>
<td></td>
</tr>
<tr>
<td>Air Tightness (Draft exclusion)</td>
<td>Fit draft strips to doors / draft excluder to bottom of doors.</td>
<td>Block up any unused flues (NOT air vents for gas or solid fuel appliances)</td>
<td></td>
</tr>
<tr>
<td>Seal Loft Hatches</td>
<td>Fit curtains to external doors and windows</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Space Heating</td>
<td>Select the most cost efficient and reliable heat source</td>
<td>Ensure that all systems are serviced.</td>
<td></td>
</tr>
<tr>
<td>Heat Gain</td>
<td>Solar</td>
<td>Internal</td>
<td></td>
</tr>
<tr>
<td>Organise the living space so that a South / South-West room is used as a living room to maximise solar heating</td>
<td>Use heat while cooking to warm the dwelling by opening doors to allow circulation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other strategies</td>
<td>Fit layers of newspaper under mattresses to increase insulation and reduce air circulation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10% of heat loss is through your head. Wear a thermal hat inside!</td>
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</tr>
<tr>
<td>For the very old or young use is a simple room thermometer to check it is warm enough.</td>
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</tr>
<tr>
<td>Close internal doors before opening outside doors to reduce heat loss</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
FACTORS INFLUENCING HOUSEHOLDS TO ADOPT HAZARD-RESISTANT CONSTRUCTION PRACTICES IN POST-DISASTER SETTINGS

A study by Catholic Relief Services

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SEKI HIRANO
AMY HILLEBOE
KEEP WARM AND STAY COOL!