Building Sector Case Study

Thermally comfortable and climate-friendly affordable housing in India:

The Smart GHAR III project

The Challenge

One of India's top energy policy priorities – providing affordable indoor thermal comfort in a climate-friendly and energy-efficient way – is an integral part of the Prime Minister's initiative to provide public housing to the country's urban poor. The target is to build more than 10 million affordable urban dwelling units by 2022. Rajkot, a mid-sized city in the Indian State of Gujarat, is the site of one project under this initiative. The Rajkot Municipal Corporation is the developer of the project, which comprises 11 residential towers with 1,176 dwelling units, and a total area of 57,408 square meters. The project is called Smart GHAR III for 'Green Homes at an Affordable Rate'. Meeting the policy goal of providing comfortable indoor temperatures at low cost and with minimal climate impact is a significant challenge in India's hot climate.

Design solutions for energy efficiency

The Indo–Swiss Building Energy Efficiency Project, supported by the Swiss Agency for Development and Cooperation, provided technical assistance to the builders and the developer. The process included a three-day integrated design workshop conducted at the early design phase of the project. An analysis of the initial building design revealed that indoor peak temperatures on a typical summer day could reach 38°C, and that indoor temperatures would remain above 30°C for more than 6,200 hours per year. The project developed the following design elements in response to these findings:

- Highly reflective roofs
- Lightweight concrete block walls
- Tall, partially glazed casement windows
- Innovative ventilation systems

The use of light-coloured china mosaic tiles on the roof reduces solar heat gain by reflecting rather than absorbing the sun's rays.

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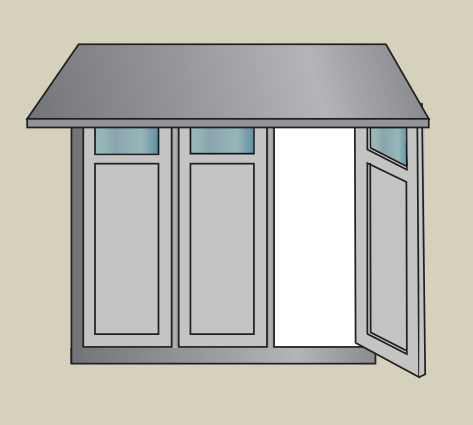
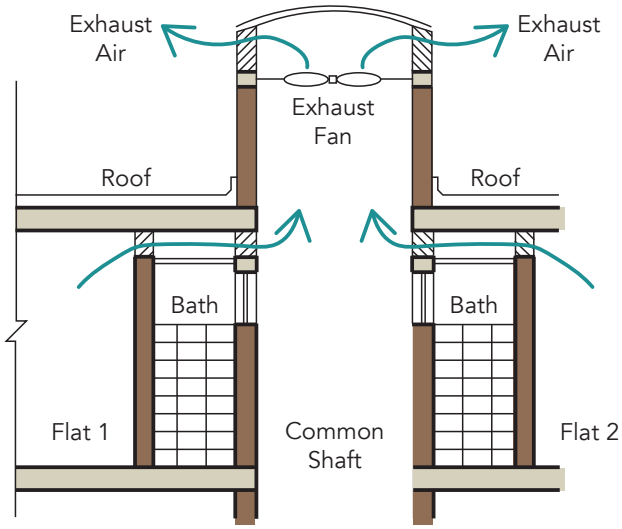
The walls on the north, south and east exposures are built with autoclaved aerated concrete (AAC) blocks that are 230 mm thick. On the western façade, cavity walls with AAC blocks on both sides of a 50 mm air space reduce the heat gain from the evening sun. The AAC blocks create a much better thermal barrier than conventional materials, and compared to clay bricks of the same dimensions, the AAC blocks reduce heat gain through the walls by as much as 60%.

Casement windows open to expose 90% of the window area, and provide better natural ventilation than typical sliding windows, which can expose less than half of the window area. Only one third of each window is glazed, and two thirds are opaque. This arrangement dramatically reduces heat gain while still providing adequate daylight.

The use of existing service shafts and fins connected to all dwelling units ensures adequate ventilation throughout the flats. A fan at the top of the shaft creates negative pressure in the shaft, and improves air circulation and increases the number of air exchanges in the living spaces.



Partially glazed casement window.



Schematic drawing of ventilation shaft.

Energy performance and climate impact

These simple, low-cost energy efficiency measures can reduce peak summer room temperatures by more than 5°C. In addition, the number of thermal discomfort hours per year will drop from an expected 6,200 under the initial design to 2,500. The improvements in thermal comfort are expected to reduce the number of air conditioning units installed by tenants, an outcome that will result in significant electricity savings and reduced CO_2 emissions.

In India, production of 1kWh of electricity results in nearly 1kg of CO_2 emissions. This 1:1 ratio is almost six times greater than the ratio of production to emissions in Switzerland. Consequently, the reduction in electricity use in the GHAR III project produces six times the corresponding reduction in CO_2 emissions that the same reduction in electricity would produce in Switzerland.

Lessons for other projects

Low-cost measures that reduce the need for the active cooling of buildings are especially useful in emerging economies and developing countries where air conditioners are often unaffordable. Conventional buildings in hot climates typically do not achieve either energy efficiency or adequate thermal comfort. The GHAR III experience, however, suggests that careful design and appropriate building materials can produce energy efficient and comfortable low-cost housing with a reduced carbon footprint.

Main partners in the Building Energy Efficiency Project

- Bureau of Energy Efficiency, Ministry of Power, Government of India
- Swiss Agency for Development and Cooperation on behalf of the Swiss Government
- Rajkot Municipal Corporation
- Effin'Art Sarl, Lausanne
- Greentech Knowledge Solutions Pvt. Ltd., New Delhi

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