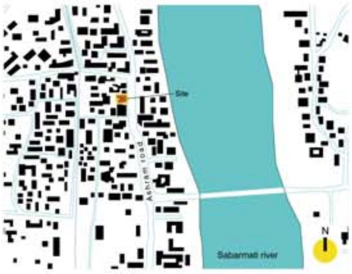
Towards sustainable architecture in hot-dry climate, India

Introduction
Traditional housing patterns in India exemplify an appropriate response to climate. Thick clay-brick walls and courtyards just big enough to trap cool night air, which subsequently seeps into the building during daytime, keeps it cool for most part of the day. Apart from providing structural stability, the thick mass of wall takes advantage of the diurnal temperature difference and delays the heat flow from exterior to the interiors till the external air temperature drops back to comfortable levels. The courtyard facilitates heat loss from the building, by creating negative pressure at the lowermost level through stack effect and inducing ventilation to release the heat accumulated during daytime.

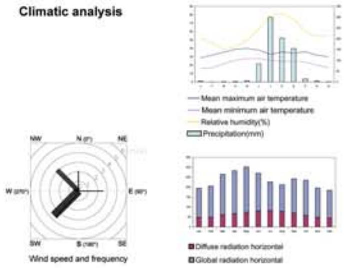
These adaptive measures are not only restricted to individual houses but also integrated in the urban structure. The narrow streets of Ahmedabad is one such example that takes into account the harsh climate and passively responds to it, to create a close-knit urban and social fabric. This research attempts at reinterpreting this attitude of yesteryears to give a comfortable living and working environment integrated with nature.

Energy in India has been a major problem and a deterrent in economic development. During peak periods, power deficit is as much as 12%. People have to compromise with unreliable and low quality power supply. In urban areas like New Delhi, residents face regular power cuts during summer months, the time when it is needed the most to maintain comfortable spaces. In such a situation, it becomes very important to come up with architectural solutions that uses materials that require less energy during manufacturing and spaces that depend less on mechanical cooling and heating appliances and more on natural elements to give comfortable spaces to work and dwell in. This research investigates the issues of energy efficient architectural solutions in the hot-dry climate of India through a design of a hotel in the city of Ahmedabad.

Site Location
Ahmedabad
Latitude: 22° 58' N
Longitude: 72°35' E
Altitude: 49 m above MSL



Climatic analysis



Project
The hotel is proposed to be situated on a 2,000 sq.m site located along the 40 metre wide Ashram road, a busy thoroughfare passing through the heart of Ahmedabad. The programme consists of twenty-eight luxurious guest rooms, a couple of meeting rooms, a conference hall, a restaurant, a coffee shop, and supporting facilities.

A three-level strategy is adopted to optimise the design solution and create comfortable spaces. Emphasis has been laid on creating energy-efficient solutions that are less dependent on power, based on traditional wisdom. In this circumstances, the first and the most important level of response is Passive mode. The second level is Mix mode measures. In certain spaces, the combined effort of passive mode and mixed mode is not sufficient to maintain comfort levels, then mechanical equipments will be required to actively condition the system. This is the third level called as the Active mode. The research so far has been focused to the level of passive mode.

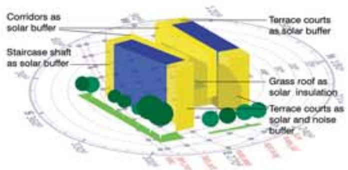
Passive strategies

1. Building form and orientation
- Longer side of the building along east-west axis.
- Shaded openings on north and south.

2. Building configuration
- Staircase shaft and outdoor spaces are placed on eastern and western sides to create buffer zones against solar radiation.
- Naturally ventilated lobby and staircase shaft.
- Natural sunlit lobby and stair shaft.
- South building block shades the northern block.

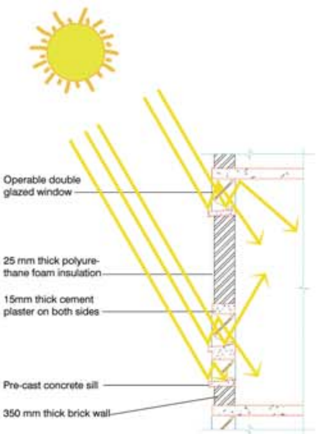
3 Solar control devices
- Limiting size of openings in the building envelope to avoid direct penetration of solar radiation.
- Guest rooms do not require high illumination levels during the day. Indirect natural lighting is provided through private green courts and common circulation passages to provide glare free light.

4 Built-form envelope
- Thick brick masonry wall with insulation and cement plaster on both sides, for low heat transmission coefficient and higher time lag to delay heat flow through the envelope.

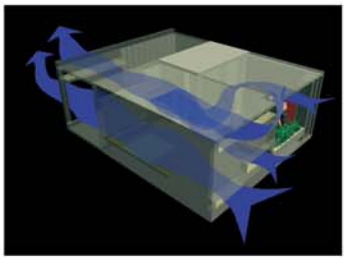


5 Wind and natural ventilation
- Short-wide slits are provided in the building envelope for specific ventilation. Effective system of natural cross ventilation would aid in physiological comfort through evaporative cooling from the human skin and help in adapting the body to higher air temperatures.
- The two building blocks have been oriented to form a V-shaped configuration to trap the prevaig wind flowing from south west. Various ventilators and brick screens let it percolate through the walls for effective air exchange.

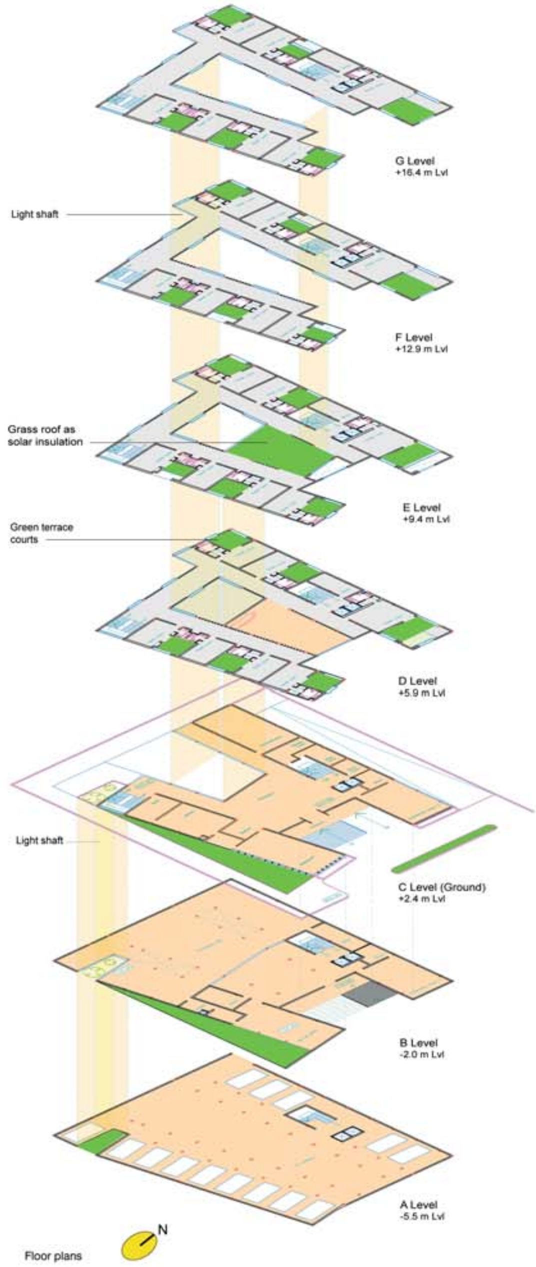
6 Vertical landscaping and planting
- A microclimate is created by reinterpreting courtyards of vernacular architecture into private green terrace courts next to each guest room. Here evaporative cooling caused due to transpiration from plants increases humidity levels and lowers the air temperature. Greens also give the much-needed respite from the highly polluted air of Ahmedabad. These greens would be irrigated by recycled gray water from showers and washing.



Detail wall section of a south/north facing wall

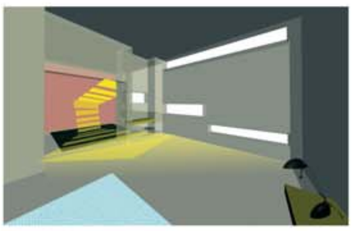


Specific cross ventilation through narrow slits in the guest rooms at the respective height of different functional planes allow maximum ventilation. Ventilator provided below the ceiling for night time cooling.

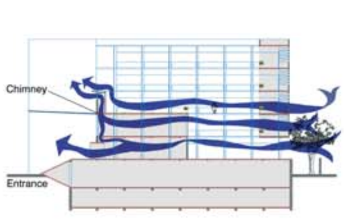


Floor plans

Conclusion
On analysis of the improvised solution, it is concluded that using proper orientation and building configuration, efficient shading devices, and low transmission coefficient glazings, insulated walls and roof, 40% savings in peak cooling load could be achieved. These simple passive measures are easy to incorporate at the conceptual level and may end up producing energy efficient solutions. The research will be pursued further into optimising the solution by using mixed mode strategies as well as active systems to make the building more energy efficient.



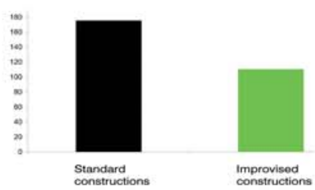
Indirect lighting in guest rooms through green terrace court



Longitudinal section highlighting wind flow through brick screens and solar chimney

Perspective view of the proposed hotel from Ashram road

Cooling load (w/m²)



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