The Ahmedabadi Pol House:
Courtyard Strategies In a Hot-Dry / Hot-Humid Climate

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THE AHMEDABADI POL HOUSE: COURTYARD STRATEGIES IN A HOT-DRY/HOT-HUMID CLIMATE

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ABSTRACT

The building stock of the dense center of Ahmedabad, India is comprised primarily of the pol house, a house type built for more than 300 years in this city. The houses are two to four stories in height with a small court open to the sky and party walls on either side. This paper discusses the thermal behavior, occupancy patterns and "operation" of a typical pol house through the seasonal cycles of hot-dry, hot-humid, and temperate-dry which characterize Ahmedabad.

1. INTRODUCTION

The city of Ahmedabad is located at 23.5° NL, inland from the Arabian Sea in the Indian state of the Gujarat (see Fig. 1). The seventh largest city in India, Ahmedabad was founded in 1411 by Ahmed Shah. The old city sits on the east bank of the Sabarmati River and was surrounded by city walls in the late 16th century (see Fig. 2). Following communal riots in 1714, and continuing through the civil disorder of the 18th century, the houses built in the city were organized in dense neighborhoods consisting of a set of dead end streets entered through a single gateway[1]. The residents of each neighborhood tended to belong to not only the same religion, but also the same caste or occupation group. The gate into the neighborhood could be closed for security and each house had capacity to store its own water and grains. These neighborhoods are called "pols" after the Sanskrit *pratoli* meaning gate or entry[2] and the houses in such neighborhoods are popularly known as "pol houses". The old city of Ahmedabad houses all religions and Hindus, Muslims and Jains all live in pol houses.

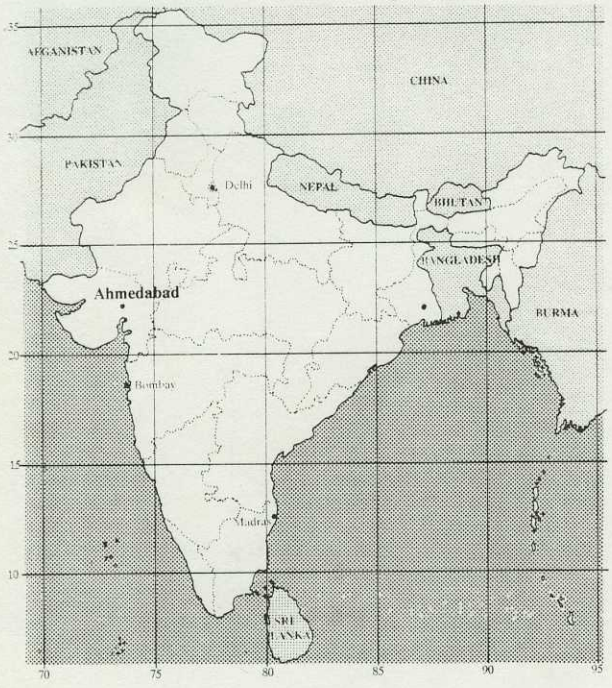

Fig. 1 Map of India.

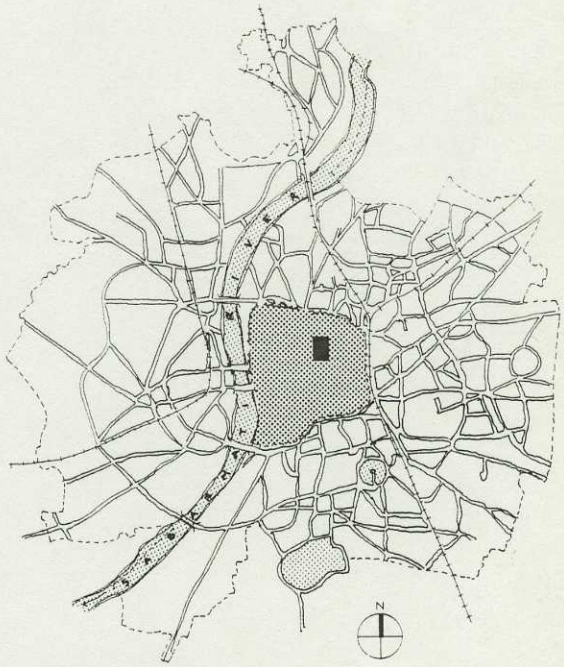

Fig. 2 Map of Ahmedabad.

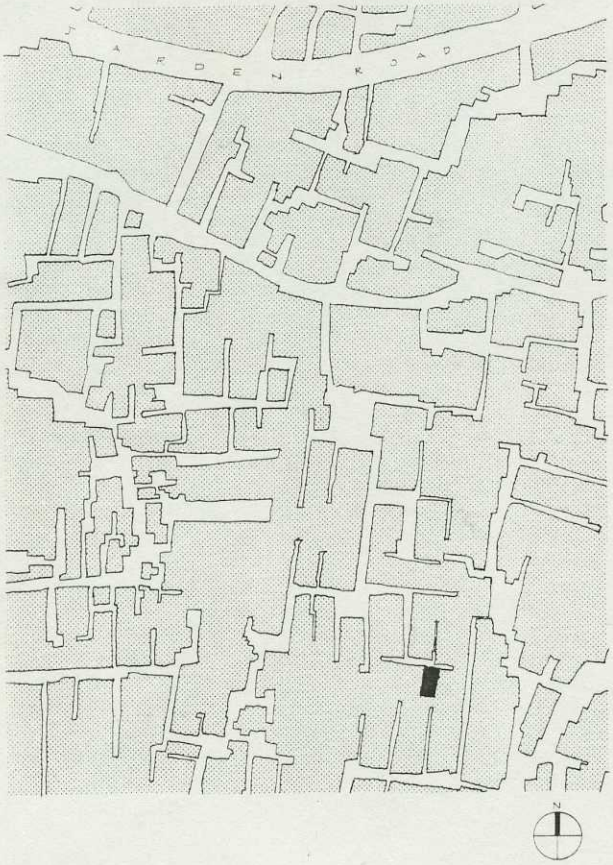

Fig. 3 Urban fabric of Ahmedabad's walled city. Surendra Patel's house in Kadwa Pol is indicated.

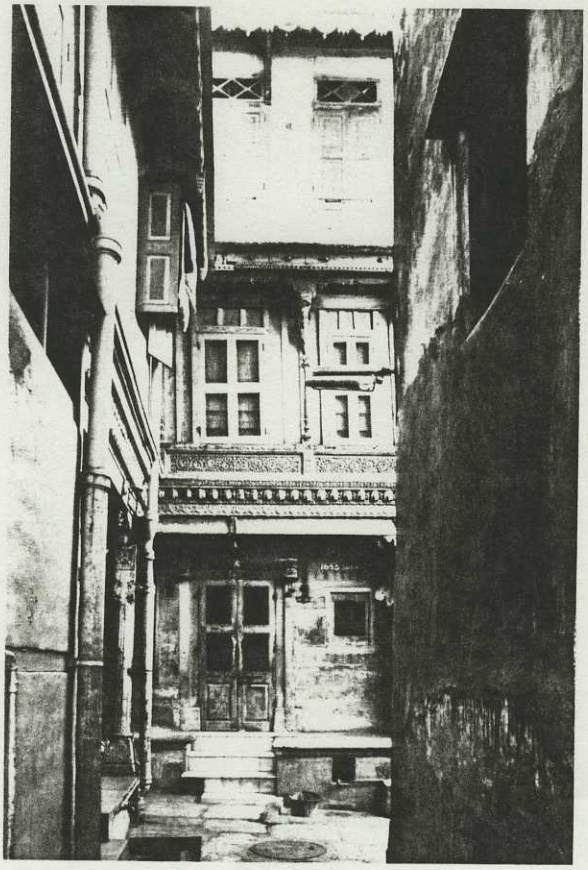

Fig. 4 Exterior of Surendra Patel's house in Kadwa Pol

2. CHARACTERISTICS OF A POL HOUSE

Pol houses typically sit with minimal frontage on the neighborhood street, which is itself quite narrow (see Fig. 3). Side walls of the house tend to be shared with the house next door and the house occupies the entire plot of land. The resulting environment in these neighborhoods is quite dense. In 1971 the population reached 225,000 people per square mile within the walled city with some areas having a greater density than Hong Kong[3].

Pol house construction is generally based on a structure of wooden posts and beams with infill walls of brick. The brick walls are not exposed to weather, but rather are plastered on the interior and exterior (see Fig. 4). The street facade is heavily treated with wooden structural and decorative elements, including carved columns, brackets, window shutters and balconies. The *oatla,* or entrance platform, is generally a plinth with a row of columns which marks the limits of the house on the street. This space is used for sitting outside and often for washing dishes and clothes if water is supplied through a tap in the street. In Hindu households the *oatla* is also an important site for religious activities.

The interior rooms tend not to be designated as "living room", "dining room" or "bedroom", but rather to be very flexible in their use (see Fig. 6). Easily movable furniture and bedding allow migration from room to room as necessary for changing family composition or to find comfort during seasonal changes. Exceptions are the *bethak* or reception space (the first room near the entrance used for visitors to the house), the kitchen, the storage rooms for drinking water and grains and the *puja* room for prayers.

In the dense urban fabric, the open spaces of the house take on increasing importance. The courtyard, known as a *chowk*, is the primary element of the house (see Figs. 5 and 6). All other rooms are built around the *chowk* and it is this space which provides the connection between inside and outside for much of the house, functioning as a light well and a ventilating shaft. In most pol houses the *chowk* is small, an opening of 60 to 100 square feet (6 to 10 square meters) moving vertically from the ground floor through the roof. "The court in a house ...[is], according to traditional Indian tenents of planning, presided over by Lord Brahma. Being open to the sky, these spaces infuse in individuals ... the consciousness of nature, as well as bringing the occupants into daily contact with the supernatural and the mythical."[4]

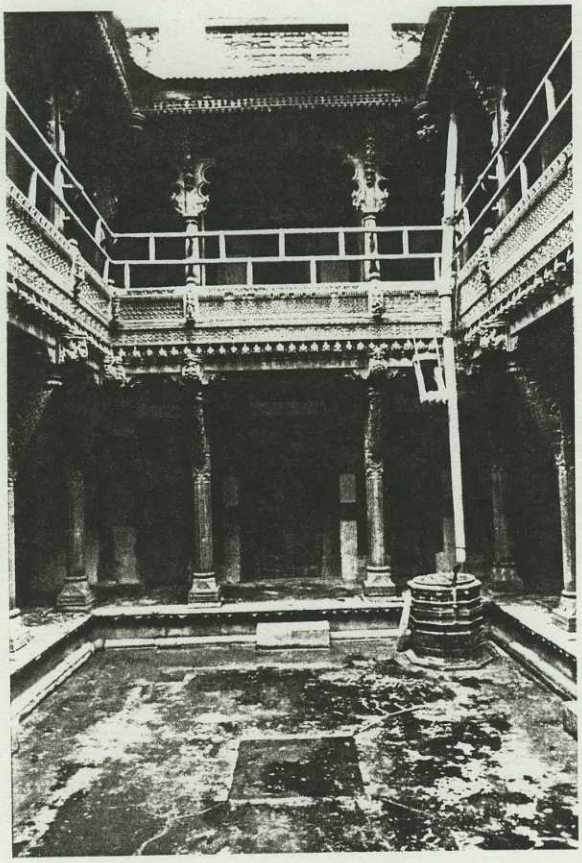

Fig. 5 The *chowk* of the Vasso Haveli showing the access to the underground water tank

A water tank is usually located beneath the floor of the *chowk*, although recently these have fallen out of use as city water has been made available. The *parasal* is the veranda space around the court, one of the most utilized spaces in the house. This space serves as a transition space, between interior and exterior as well as public and private spaces. The *parasal* is often the space in which the traditional Gujarati swing is hung and much family life takes place. The roofs of the pol houses tend to be sloping, a form which sheds the monsoon rains and provides a loft space below for storage. Most houses, however, have a flat roof or terrace at some point, which provides an area for drying clothes and sleeping outside during the hot months.

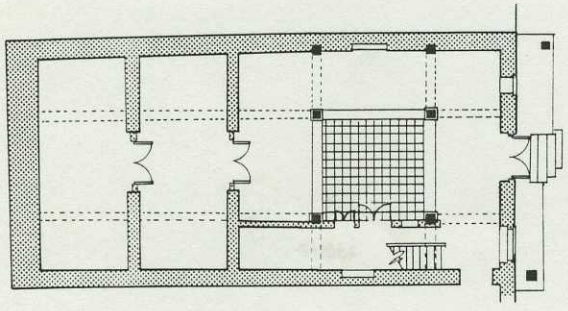

Fig. 6 Plan, typical pol house.

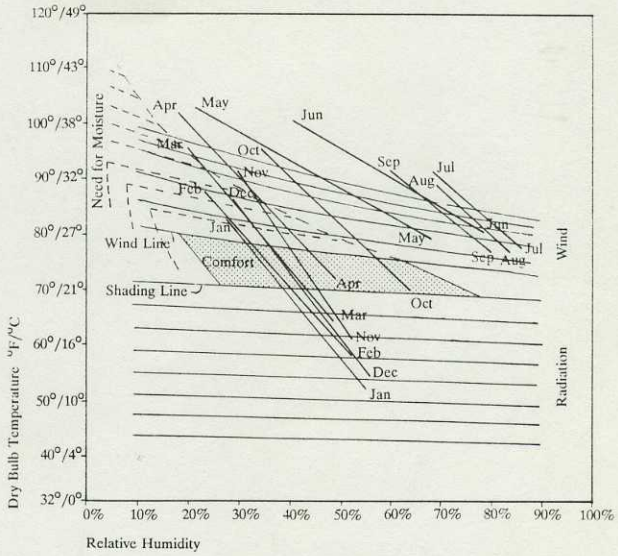

Fig. 7 Ahmedabad monthly climate data plotted on the Bioclimatic Chart.

3. THE CLIMATE OF AHMEDABAD

Ahmedabad has one of the most interesting and uncomfortable climates imaginable. Unlike North America and Western Europe, the Indian sub-continent faces a pattern of rainfall controlled by the southwest monsoon that arrives each May or June. The rains last for three months, then the dry season returns for the next nine months. Coupled with the annual cycle of solar radiation, the monsoon defines the seasons. In Ahmedabad three major seasons are generally recognized: the hot-dry "summer", the hot-humid monsoon and a temperate-dry "winter" (see Fig. 7).

The "summer" season begins in March when the temperature begins its steady climb from the 80° F (30° C) daily highs of February to the 117° F (47° C) extremes of late May. This three month hot season is

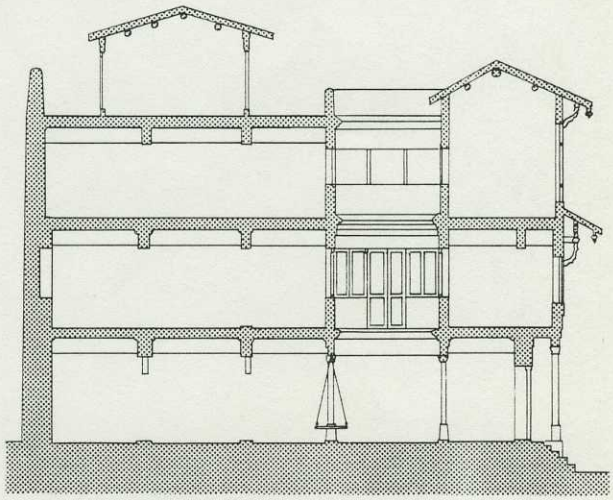

Fig. 8 Section, typical pol house.

characteristically very dry with relative humidity often below 20%, absolutely clear skies and no precipitation. This is the season when schools are on vacation, those who can afford it escape to the hills, the mountains or abroad, and everyone else simply waits out the heat, hoping for the arrival of the monsoon. Temperatures during the nights are comparatively cool in the 80's Fahrenheit (27-28° C) and the night skies are extremely clear.

The monsoon usually arrives between June 15th and 21st, although some years the rains never arrive and other years the rains arrive by June 5th. In the two weeks preceding the first rain large cumulus clouds appear and the humidity begins to rise, creating a virtual steam bath coupled with the high temperatures. The arrival of the rains is greeted with joy, as the temperatures drop to the 90's F (33° C) during the day and 75° F (24° C) at night. More importantly, the earth, the streets and the buildings release the heat stored over the relentless summer months and the environment through which people move and which they occupy cools down. The rains last for two and one-half to three months in Ahmedabad, some weeks raining just a bit every day, other weeks characterized by one or two days of torrential rains and floods. Over the season Ahmedabad receives a total of 32" (823 mm) of rain on average, although the city has received as much as 16" (415 mm) in a 24 hour period. Relative humidity stays very high (70-85%) and the skies are overcast for most of the season.

Late September and October form the post-monsoon transition to "winter" which doesn't properly start until late November when the temperatures finally cool down. October is generally spoken of as a terrible month, retaining the high humidity of the rainy season with an increase in daily temperatures. However, as November and December arrive the temperate winter season is in full swing. Once again the humidity is low and the temperatures drop to the 80's F (high 20's C) during the day and dip to the mid 50's F (12° C) at night with totally clear skies.

4. THERMAL BEHAVIOR OF THE POL HOUSE

The thermal behavior of the pol house over the seasonal cycle in Ahmedabad, is a function of the siting and massing of the house, shading, solar radiation, thermal mass and the occupancy patterns of the residents.

1. The Summer Season (mid-March to mid-June)

The behavior of densely packed courtyard houses in hot-dry climates has been described many times. In the pol houses of Ahmedabad, strategies of occupant migration, shading, earth coupling and evaporative cooling work in synthesis to create a bearable microclimate within the house. The house functions as a protective shell, keeping the outside heat at a distance and providing a microclimate of shade, cool surfaces and cooler, more humid air within the house. Inside and outside are clearly defined during these months.

The Bioclimatic chart is sufficient evidence that people need shade during the summer months as a fundamental response to daily temperatures and solar radiation. Time spent in Ahmedabad during the summer months, however, provides convincing evidence that the thermal capacity of building materials holds the primary key to thermal comfort. As the season progresses from mid-March toward the climax in June, the ability of the earth and most buildings to re-radiate heat to the night sky is not equal to the daily radiation received. The earth, the general city fabric and individual dwellings heat up over the course of the season. Shading buildings therefore becomes as important as shading people during these months.

The pol house is well sited for shading. Sharing long party walls while exposing narrow end walls is a successful strategy. The wall surfaces exposed are furthermore on narrow streets which tend to shade the house facades during much of the day, with variations obviously due to orientation. Most successful, however, is the unique pol house strategy of cloaking the exposed mass walls with wooden details. The low thermal capacity of the carved wood facings provides a shield between incident solar radiation and the thermal mass of the house.

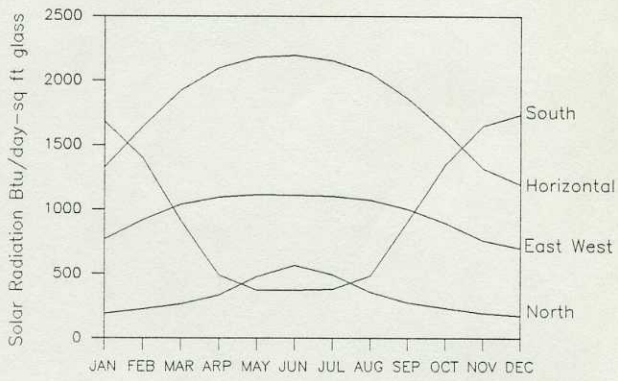

Fig. 9 Solar radiation through glass at various orientations for 24° NL (data source: ASHRAE FUNDAMENTALS 1971).

The *chowk*, however, is a less straightforward thermal amenity. One of the ironies of a courtyard house at this latitude is that shading is most easily handled on the south elevation and that horizontal openings create the largest heat gain in a building (see Fig. 9). As the season moves toward June 21st, when the sun is at 89.5° overhead, the solar radiation entering the court increases, heating up the interior mass of the pol house over the season. The tall and very narrow proportions of the *chowk* clearly minimizes the incoming solar radiation with self-shading. In many houses, the inside elevations of the *chowk* are also detailed with carved wood facings, wooden shutters, etc., keeping the wall mass shaded much as with the exterior elevation (see Fig. 10). The floor of the *chowk* is tiled and coupled either to the earth or to a water tank below. The floor

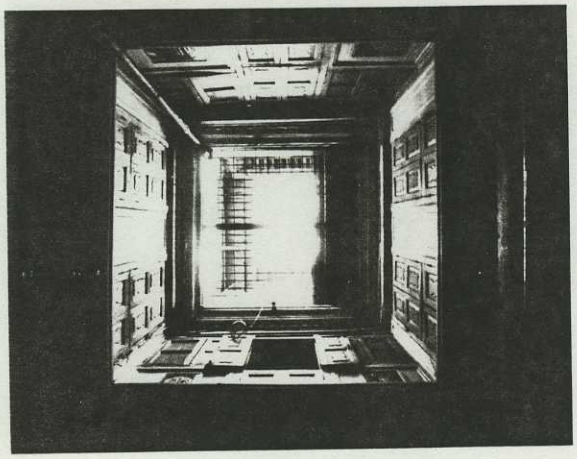

Fig. 10 View up in the *chowk* of the Surendra Patel house.

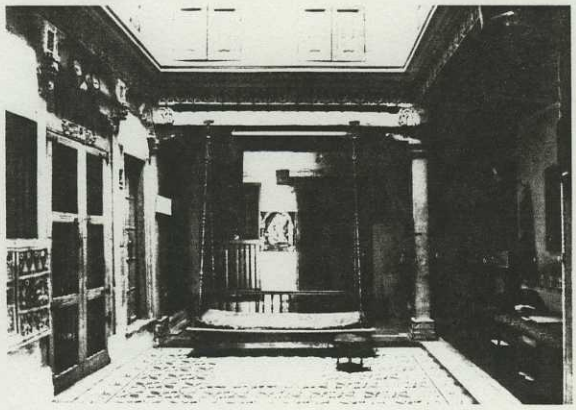

Fig. 11 Swing in the *parasal* of the Surendra Patel house.

surface gains heat through the season, but is kept from overheating by the daily practices of the household. Cleanliness in the houses of Ahmedabad is culturally dictated and in many households an obsession. The *chowk* is often the location of washing activities within the house (dishes and clothes) and is, itself, washed down several times a day to reduce dust and keep the soot of the industrial city from settling. Thus a pattern of providing evaporative cooling within the depths of the house counteracts the increasing gains from solar radiation over the summer months.

Occupant use patterns affirm the distinction between inside and outside which during the summer months seems unequivocal, in spite of the ambiguity of the *chowk* as an "outdoor" space. Window openings, which often are shuttered with wood rather than glazed, are opened during the cooler night hours and closed by 8 am to prevent the heat of the day from entering. The house is flushed with cooler air during the night and hot air is exhausted through the stack of the courtyard. The house moves from an open shell at night to a closed refuge during the hot day. The family occupies the ground floor during the day, moving around the *chowk* through the veranda space (see Fig. 11). The upper floors of the house receive more heat gain through roofs, terraces and *chowk* during the day and are too hot to be occupied. At night, however, the roof terraces are washed down, the tiles cooled off and beds are brought out. The terraces are used for evening talks, watching television and sleeping, exposing the occupants to the coolness of the night sky while the building itself cools down as much as possible before sunrise the following day. The migration patterns therefore move the occupants from the protective building interior during the day to the exposed roofs at night.

2. The Monsoon (mid-June to mid-September)

The particular problem posed by Ahmedabad is that the hot dry months turn so dramatically into hot humid and a building moves from the desert to the tropics nearly overnight. While much has been written about the courtyard house as a perfect response to the desert climate, very little can be found in the literature about the courtyard house in a tropical climate.

Residents of the pol houses, along with all residents of Ahmedabad, look forward to the coolness of the rains. The monsoon, however, is also season of floods, illness and death from water-borne disease. The ambivalence of the season is reflected in the attitudes of the occupants toward the issue of comfort in the pol houses. When the rains arrive, the heat built up in the mass of the city fabric and the individual houses is flushed out and the necessity to avoid certain areas of the house on a diurnal basis disappears. The daily patterns of occupancy and operation give way to the house as a open connector with the outdoors throughout the day. The skies remain overcast for nearly three months and the coolness of rains rather than the heat of the sun becomes the important external factor in thermal comfort.

It is during the monsoon months that the lack of exposed building skin becomes problematical. With minimal exterior openings, it is difficult to cross ventilate the pol house and much of the house becomes stagnant and damp. The *chowk* is no longer the most comfortable area of the house and, in fact, proves to be a problem since it exposed to the rains. Many pol residents cover their courtyard with plastic during the rainy season, creating a humid tent-like space that grows increasingly uncomfortable over the months. While the temperatures seem quite cool compared to the summer, daily highs are still in a range of discomfort for many people. Terraces, while outside and less damp, regularly expose occupants to mosquitoes which carry malaria. The exterior rooms on the upper floors, into which the beds were moved with the first rains of June, become the most comfortable places in the house. We found that the most common attitude to be that the season will be over eventually and was not as bad as the summer, although in many ways their houses are significantly less comfortable and less manageable thermally.

3. The Winter Season (November to February)

As the temperatures cool down in November and everyone emerges from their eight month thermal ordeal, the pol houses again begin to function on a diurnal basis. This time, however, the upper floors and terraces provide a comfortable place during hours that the sun is shining. This can be seen during the January kite-flying festival, during which the entire city takes to the roofs of their houses and flies kites for the day. The residents of Ahmedabad tend to sport sweaters and wool neck scarves when the night temperatures begin to drop below 68° F (20° C) and winter nights in the mid-50's F (12° C) are considered to be quite cold. In some ways they are, since houses have no heating systems. The orientation of the terraces and street facades becomes important, since those pol houses with south facing exposures can open the shutters and admit sun into the upper rooms. The December noon sun is 42.5°, rarely enough to penetrate farther than the top floors adjacent to the *chowk*. The chowk, however, does provide a stable environment, sheltered from the winter winds and, as in the summer, a useful connection with the outside.

5. CONCLUSIONS

The pol houses in Ahmedabad perform thermally much as one would expect from courtyard houses, with some variations due to their unique design characteristics and the dynamic climate within which they are located. The pol houses are particularly capable of responding to the hot-dry summer season, minimizing problems of thermal storage and exposure to an overhead sun while providing both an enclave and exposure as necessary for comfort of the occupants. The monsoon season poses a greater problem of general comfort for residents, one which is not well-solved, but rather "lived through". The winter conditions are not very extreme and the house performs well, but not necessarily due to any particular feature of its design. Almost every building in Ahmedabad seemed to perform passably in the gentleness of the winter conditions. Therefore, as a prototype for other houses in Ahmedabad, the pol house offers solutions for two out of the three seasons through which every building must be inhabited.

6. ACKNOWLEDGEMENTS

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7. REFERENCES

1. K.B. Jain, "Wooden Houses" in Ahmedabad ed. by George Michell and Snehal Shah, Bombay, Marg Publications, 1988, p. 157.

2. Vivek Nanda, "Urban Morphology and the Concept of Type," Diploma Thesis, School of Architecture, CEPT, Ahmedabad, April 1989, p. 168.

3. Jay Weinstein and Vijayan Kumera Pillai, "Ahmedabad: An Ecological Perspective" in Third World Planning Review, Liverpool University Press, Vol. 1 (2), Autumn 1979, p. 206.

4. Balkrishna V. Doshi, "Between Notion and Reality" in Contemporary Indian Tradition: Voices on Culture, Nature and the Challenge of Change ed. by Carla M. Borden, SMithsonian Institution Press, Washington, 1989, p. 339.