Socio-cultural and Environmental Analysis of Vernacular Residential Designs: Houses of Jammu, India

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Abstract

The Indian subcontinent has varying climatic settings, which have given rise to a wide range of designs of vernacular shelters. They are historical examples of environmentally friendly responsive building structures, produced and shaped by the Indian communities for centuries. The study of vernacular houses is pertinent in the current scenario in which residential buildings account for nearly 40 percent of energy use.

This paper discusses the validity of the design approach of the courtyard houses of Jammu city. It examines the context of energy and socio-cultural spaces for the healthy interactions in society. It presents the residential spaces and their organization for occupant's thermal and social comfort. It aims to establish the validity of vernacular settlements in the context of social, economic, cultural and thermal performance.

The research employed a field survey of vernacular typology and a comparison of internal temperature in contemporary and vernacular residential buildings with external climatic conditions.

The paper establishes that vernacular houses are better in the current challenging time also. These act as a macrocosm for families to live comfortably and perform daily activities without having to interact with the outside world. The traditional vernacular buildings outlive time and are relevant in all eras of human existence.

Keywords: Residences, vernacular architecture, traditional buildings, thermal and social comfort, energy.

Introduction

The debate on energy conservation has a lot to do with the construction sector in India. It focuses on the people in need of shelter and infrastructure requirements. Thus, a construction boom is predictable in the Indian cities. As a result, further residential energy demand is projected to rise abruptly in the near future due to the following major contributing factors:

- Urbanization
- Population growth
- High anticipation of thermal comfort

- Increase in affordability and accessibility of appliances providing thermal comfort

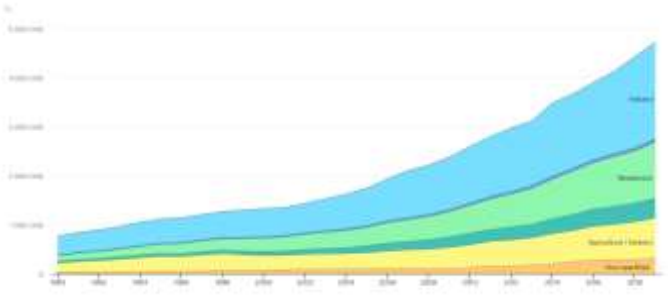

Fig. 1: Energy use by different sectors
Source: World Energy Balances, EIA, 2021

This steep increase in domestic demand as shown in Fig. 1 requires assertive energy efficiency policy and strategies. However, more efforts are required with the process formulation and in terms of designing buildings, which are resource-efficient and responsive to the environment in terms of climate responsiveness; better known as energy efficient buildings. Ever since the 1970's energy crisis, it has been accepted that non-renewable resources of energy would cease one day.

There is an overwhelming diversity of architecture of human settlements which began as adaptive choices, contextual responses and spatial requirements. Forms and design developments of traditional practices mostly reveal an energy conscious approach responsive to the context. Local solutions have evolved from local resources, methods, wisdom and cultural choices of the area. As studies and identification of ancient vernacular regions of the world reveals, they are very effective in performance in most of the aspects including energy efficiency (Zhai, 2010)

Insights provided by many scholars across the globe show that vernacular architecture is timeless (Olgyay, 2015). They can withstand disasters like earthquakes. They are also safe and economical (Ahmad, 2017; Sassu, 2011). Energy efficient architecture studies provide good inspiration from vernacular features and examples (Majumdar, 2009). Moreover, vernacular architecture connects the present with the past traditions, culture and roots of the society, as much as the built environment; Studying them can be beneficial for the future (Florea, 2020).

Significance and Appropriateness of Vernacular Architecture

Oliver (1997) provides a good definition of vernacular architecture. The definition clearly reveals that localized values, local wisdom, local methods and community participation are the key ingredients of architecture to be termed as vernacular. He also shows the sensitivity of such architecture towards culture, lifestyle, economy and principles that are pertinent to that community and location. The appropriate environments of vernacular buildings and their positive responses have garnered a lot of interest with specific reference to thermal properties, thermal comfort and energy use (Misra, 2016; Singh, 2010). They are designed in a manner that provides thermal comfort to the occupants cutting down on the requirement of modern high energy guzzling appliances (Singh, 2009; 2010). Laurie Baker writes that,

> "Vernacular architecture almost always has apt solutions to all our problems of building. All that is required is to go a step further with the research our forefathers have done; that is, to improve on what has already been accomplished"
>
> (Bhatia, 2000:237)

The relationship of natural and man-made environments specific to cultural context leads to the way of designing buildings appropriate to that location. This includes the basic

concepts of choosing the building techniques, forms, materials and spatial configurations conducive to the context: that is vernacular architecture. (Gulati, 2019; Jagatramka, 2021b; Maikol, 2020). Research indicates that there is a need as well as ways to adapt and revive the traditional practices for the sustenance of the environment of the planet earth (Dabieh, 2016; Sahu, 2020).

Need of the Study

Principles and designs of vernacular architecture have been affected adversely by the fascinations of contemporary society towards the global and current trends. A new kind of built environment today is produced using new materials. They bring about images of architecture totally devoid of the presence or transformation of the old pearls of wisdom and contextual approaches (Jagatramka et al., 2021a). Notably, there is more emphasis currently on modern luxuries and its customizations (Sharma, 2017; Sharma, 2011) despite the energy threats. However, many exemplary vernacular residences are found the world over even today, from which lessons can be learned.

The energy demands in conventional modern buildings are comparatively high. Energy in buildings accounts not only for materials i.e., embodied energy only, but a large portion of electrical energy is required for achieving thermal comfort indoors. Thus, for better indoor living and comfort conditions of such modern buildings, the environmental energy resources are unabatedly exploited. These are for meeting the construction, heating and cooling, lighting, water needs and not to exclude the share of emissions. The emissions need to be curtailed by environmentally friendly approaches. Thus, there is an inseparable link between the high energy use of modern buildings and environmental damage.

The Aims and Objectives

This paper showcases the fundamental characteristics of the traditional architecture of Jammu. These include materials, construction methods, building lay-outs and envelope features and its effectiveness toward the socio-economic and socio-cultural significance of vernacular constructions. It will evaluate the thermal comfort and energy consumption in comparison to modern buildings. It highlights some of the vernacular features and techniques present in Jammu city. It intends to reflect environmental response effectiveness of vernacular dwelling in relation to modern-day dwellings in Jammu, India. This study tries to substantive various comparative advantages of vernacular Architecture. While doing so, envelope features, spatial considerations and socio-cultural elements are taken together in the study.

The aim and objectives are as follows

1. To identify features of vernacular residences of old Jammu city for energy efficiency.
2. To determine the residential spatial setting which forms an inseparable form of socio-cultural fabric of the old settlement.
3. To establish the validity of vernacular settlements in the contexts of social, economic and cultural suitability.

Review of Literature

Many have studied energy-efficient design elements and sustainable features of vernacular architecture (Chandel, 2016; Liu, 2010; Nguyen, 2019). It is now known that the indigenous harmony of people with climate and culture is facilitated by vernacular designs because vernacular materials are derived mainly from the natural surroundings (Singh et al., 2009). Moreover, the vernacular buildings provide immense socio-cultural and socio-economic qualities (Correia, 2014; Ghaffarianhoseini, 2012; Guillaud, 2014; Wahid, 2012). Scholars have examined the original vernacular design and its spatiality, elements or transformations over a period (Jagatramka et al., 2021a; Zhai, 2010; Priya, 2012). It is argued that vernacular architecture presents a good sustainable approach and at times superior to generalized definition of sustainability (Nguyen, 2019; Salgin, 2017; Tawayha, 2019). Researchers have done extensive studies on the thermal performance of vernacular buildings in different parts of the

world (Singh, 2010). Sansaniwal (2020) through a systematic review urge more studies on the thermal performance of Indian residential buildings. Loftabadi (2019) compared the thermal performance of traditional and contemporary building taking envelope construction techniques in Cyprus. Philokyprou (2018) establishes the importance of semi-open spaces of vernacular settlements for thermal performance through a study in Cyprus (Mediterranean climate). North-eastern Vernacular buildings were found satisfactory in thermal performance except in winter months (Singh, 2010). Priya (2012) compared the thermal performance of traditional and modern houses in a warm-humid climate of the coastal Tamilnadu region. She concluded that vernacular buildings perform better in warm humid climates than contemporary buildings. It is stated in general that courtyard dwellings have better thermal performance in winters and summers (Gupta, 2017). However, some studies produced mixed results e.g. Gupta (2017) conclude that all courtyard dwellings do not indicate better thermal performance in both summers and winters in a composite climate. Tawahya (2019) supports learnings for Architects from vernacular Architecture through a qualitative study. There are not many quantitative studies on comparative analysis of thermal performance between vernacular and contemporary houses in India, particularly in composite climate. The consideration of envelope elements, construction techniques and other socio-cultural aspects of vernacular buildings for thermal comfort study taken together seems fruitful. No such study is evident for the fast-developing Jammu region, which is deviating fast from its traditional knowledge in current urban interventions.

Jammu-the study area:

Fig. 2: location of Jammu
Source: Sharma, 2016

The study context Jammu is the joint capital city for Jammu Kashmir union territory. It is popularly known as the 'City of temples' and possesses a glorified past under Rajput rulers. The city has magnificent pieces of traditional architecture. For example, traditional dwellings on both sides of typical narrow streets (bazaars) of the old city. The well-known town of Katra exists at the foothills of Mata Vaishno Devi shrine, and is a prime contributor to the economy, trade and life of Jammu. Cultural and religious tourism it brings poses environmental challenges to the Jammu city (Mathavan 2019; Sharma, 2016). The winter capital Jammu with a glorious cultural past, offers heritage wealth and values and unique places full of temples.

Jammu bears a sub hilly land profile and is located between 32°44'N and 74°55'E. The national capital Delhi is about 600 Km to the South-east and Srinagar city lies around 300 km to the North. Jammu is located at an altitude of 400 m. Typically, the developments exist as a sprawl on either side of the river Tawi flowing across the city (Sharma, 2019). The traditional part of the city exists mostly on the right bank and newer expansions of Jammu have predominantly come up on the left bank of Tawi river apart from the fewer ones on the right bank (Sharma, 2019). The old walled city has a palace complex and surrounding residential buildings of vernacular architecture. Thermal comfort has been achieved in these vernacular residences through design strategies, which ensure warmth in the winter and cooling in the summer without active use of any mechanical systems.

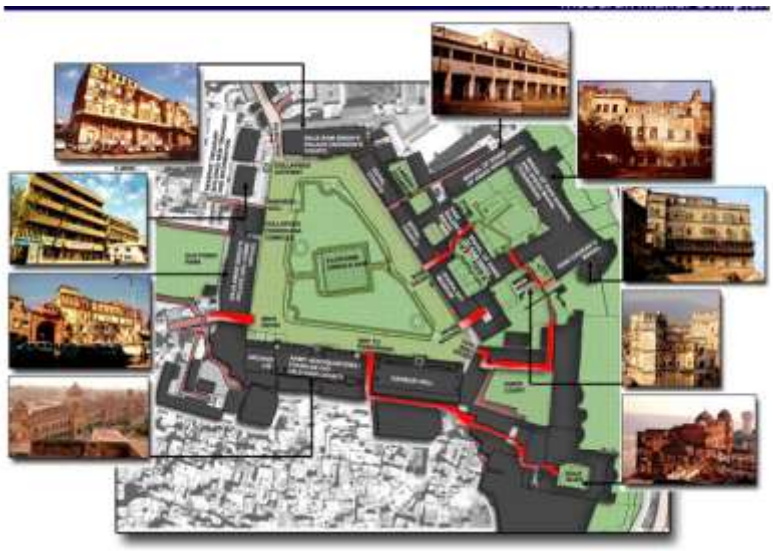

Fig. 3: Mubarak Mandi complex and the surrounding vernacular houses
Source: http://studio1860.org/Studio/Projects/Conservation/Mubarak_mandi/Mubarak_mandi.aspx

Organic Nature of the Settlement of Mubarak Mandi

The old Jammu city located on the hillock, was a walled city protected from the invaders from the mid of the 18th century. It has narrow meandering lanes typical of medieval towns. Not much remains of ramparts and gates such as the Gumat Gate on the West, the Dennis Gate on the Southwest and the Jogi Gate on the south of the city respectively. The city hosts of the Mubarak Mandi palace complex surrounded by residential houses built very close to each other with narrow lanes. These houses have typical layouts of courtyards with rooms around them in two-story buildings. The first floors typically have wooden balcony projections. They are made of *lakhori* (known as *maharaji* bricks locally) bricks - 10x15cm and 19mm thick and laid with a mixture of lime mortar, *jaggery*, black lentil and surkhi and plastered with lime mortar. The walls are 450 mm thick with some old house facades having the typical use of Tawi river pebbles for ornamental work. The first-floor balconies are made mostly of wood (good thermal insulation properties) seen projecting in the narrow lanes. The majority of the old houses have roofs supported on wooden joists. They are undeniably the vernacular architecture of Jammu.

The settlement grew around the palace complex in an organic form but with visual cohesiveness; amalgamated and intertwined into a holistic residential setting. Each house is unique and has the same spirit, although layouts are similar at the generic level with rooms around a courtyard creating a microenvironment.

The Climate and Rainfall

The climate of Jammu is referred to as composite as it is difficult to categorize it in terms of conventional classifications. It varies between the monsoon and the tropical climates. Cold weather generally prevails from December to February having an average temperature for the 03 months ranging between 13.5°C to 20.0°C. The average rainfall for the winter months is normally 150 mm. With the rise in mercury levels, summer months are seen from Mid-March till June and with temperatures above 40° C which are noticeable at the end of June. The monsoon is typically from the South-east with rains arriving in early July lasting till the fortnight of September. For the rest of the months, Jammu bears dry weather.

The year-long climatic variations of Jammu make it difficult to classify in the established climatic zones as put forth by Koenigsberger (1974). Contemporary building planning practices see the long summer season as the main issue. Earlier harsh winters were the pre-dominant factor of consideration.

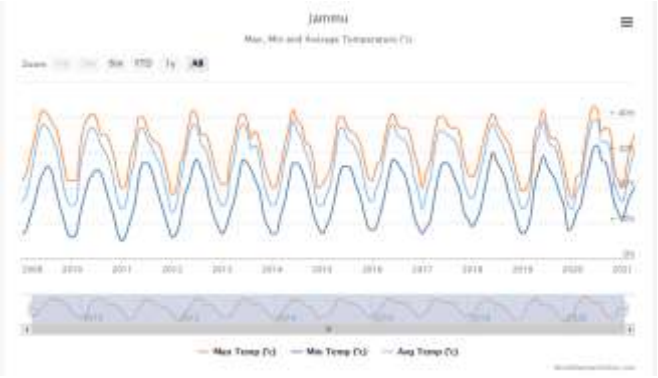

Fig. 4: Mubarak Mandi complex and surrounding vernacular houses
Source: http://www.worldweatheronline.com

The Research Methodology

The study employs a field survey of the case study. It examines thermal comfort conditions experimentally together with building materials, construction details and occupants' practices and the use of the spaces for various activities. It examines one traditional house and one modern house in Jammu city using quantitative methods of gathering data. The data is subjected to a comparative analysis of thermal performance.

This study quantitatively establishes that the traditional residential buildings of Jammu city has better thermal performance as compared to contemporary residential buildings. It thus establishes that the vernacular buildings are more energy efficient.

The research includes:

- A study of physical forms and construction systems of the vernacular buildings and contemporary houses by site visits, observations and a visual survey.
- A correlation of designed spaces with occupants' activities and practices by one-to-one structured/unstructured? interviews.
- Ascertaining thermal performance by onsite measurement of temperature using a thermal hygrometer.

Findings and Analysis

Fig. 5: Visual survey of old Jammu city - traditional dwellings
Source: author

Characteristics of Thermal Comfort Conscious Elements of Traditional Buildings of Jammu

Traditional buildings of Jammu exhibit typical localized and basic passive methods to counter varying weather challenges present. These achieve indoor thermal comfort for the 7-8 months from March to early October. Various façade articulations judiciously combat the climatic hardships in very indigenous ways. Such typical and basic indigenous methods can make design and built form an energy-conscious and environmentally enriched. Sharma et al (2019) explain that the conventional architecture of Jammu is pre-dominantly deviating from these characteristics features of traditional architecture which were advantageous in many facets of sustainability. These characteristic features of the traditional built form are as follows:

1. Building as close to each other as possible. The houses exist adjacent to narrow streets with balconies on upper floors jutting out to shade the streets. These balcony projections have intricate detailing normally in woodwork construction. MacLean (1941), while comparing the thermal insulating properties of different species of woods show that wood is a good insulating material. Thus, woodwork in façade treatment and patterns provide good insulation while shading the building parts and streets. The spaces are thus shielded from the radiation of the sun.
2. Residences have climatic responsive forms and configurations. Rooms have high ceilings with clerestory windows promoting high levels of natural ventilation and light to interiors.
3. Inserting courtyards that promote fresh air, cooling the rooms in summer seasons.
4. Having central courtyards, which serve as an excellent element for micro-climate modification. They provide coherent spaces for inhabitants to perform various essential indoor and secure activities. It is a brilliant technique to facilitate the stack effect (cross-ventilation), promote ventilation and cut the harsh tropical sun in summer. They also allow low-angle sun rays to penetrate inside to produce comfort. Thus, the courtyard is one of the key features for promoting thermal comfort and decreasing energy demands in the traditional houses of Jammu typically in the hot summer months.
5. Providing projections like *chajja* projections, roof and slab projections, eaves, and balconies act as shading elements. They prevent heat gain by building parts.
6. Using heavy roofs and thick thermal mass walls increases resistance to temperature changes. Such methods enable the increase of time lag between indoor and outdoor for the exchange of heat by delaying the release of heat stored. This makes the interiors free to counter the impacts of severe outdoor temperature conditions in summers and winters.
7. Introducing various spaces like verandahs, overhangs and arcaded corridors to act as buffer spaces to counter harmful direct climatic impacts.
8. Introducing elements like *jalies* (fenestrations) to have more ventilation induction by letting hot air accumulate on the surfaces.
9. Employing façade features deliberately for self-shading purposes. Some of such practices include façade treatment with pebbles found from the Tawi riverbed. These also include intricate cornice works.

The Socio-cultural Context of Courtyard Houses

Characteristics of the Settlement

The old city has a typical medieval town layout with narrow meandering lanes. Houses exist close to each other with projecting wooden balconies and minimum heights of twin floors. The compact layout of buildings and architectural features provide thermal comfort by cutting out the harsh sun during summers when the solar altitude angle is between 38.82° at 12.00 pm and 77.08° at 4.00 pm on a hot summer day. The lane has an East-West orientation and the

summer sun shines on the South facade from 9.30 am to 2.30 pm. The horizontal projections like the wooden balconies are suitable to shade the South-facing building.

Verandah

A sitting space at the entrance to meet and interact with guests. In other words, this is an informal meeting zone. Not all visitors enter the house but meet at this transitional space between the public zone and the private area.

Terraces

Houses share walls and terraces with low parapets, once joined form a replica of the streets at the terrace level. These terraces at varying levels connect spaces usable for community activities, household activities and play areas for children such as for flying kites. Usually, there is a system of having the neighborhood with houses of relatives and friends enabling the celebrations of family functions and festivals together. The terrace space is used by occupants for drying laundry, pickles and spices. It is here that the women get together during the winter days and enjoy the cool winter sun carrying out knitting and other creative activities. During winter season, the entire family uses this space to relax and drench in the winter sun. These become the sleeping areas for summer nights as the breezes provide comfort during the nights, blowing over the hillock on which this settlement exists.

The layout of the Houses

The old houses have rooms with covered passages surrounding the courtyards and internal covered staircases which can be accessed from the extreme end of the covered passage on the ground floor. This covered passage is a semi-open space running along the central courtyard as a place of socio-cultural interactions. On the ground floor, rooms were laid in a linear fashion around a central courtyard with a kitchen and toilets on one corner of the courtyard. Upper floors are a repetition of the same layout of linearly laid rooms with passages. Inhabiting the narrow lanes living in houses with layout and design elements, the neighborhood in old Jammu city is socially very alive. The interactive spaces in the external community spaces are the balconies and the narrow lanes with verandahs, the entrance foyers with seating for short meetings with passer-by friends having long chats with visiting guests. Lively interactions of the community have been explicitly evident and thus make a suitable case for an in-depth inquiry. The occupants of each household have 8-10 members and maintained the structure of the traditional joint family. Usually, most of the houses are two-floor structures.

The courtyard

The old houses of which very few exist today have courtyards varying from square to rectangular shapes, with three sides bounded by the house and the fourth side shaded by the wall of a neighboring house. The open-to-sky space is an activity zone for the family's daily household chores and a play area for the children. This also serves as a sit-out and a place for gathering during the family functions and festival celebrations. The enclosed courtyards served as zone for kitchen activities, washing of clothes and utensils. They were noted for their absence of any vegetation except for some plants of medicinal and religious value.

The balconies

The balconies on the first floor jut out over the street with widths varying from 600mm to 1000 mm. The narrow streets with projected balconies made a good interactive space for the neighbors to stand and chat across the streets and to interact with the movement on the streets. They would also carry out shopping for vegetables from vendors and other shops across the streets while standing on their balconies.

Environmentally sustainable materials

The vernacular buildings are constructed from materials locally available with low carbon footprints sourced from the riverbeds, nearby forests and the local brick kilns. These are

primarily locally sourced wood, locally made bricks and stone pebbles from the river Tawi chuna, and surkhi.

Economic considerations

The local craftsmen are involved in working in the construction of the houses. They are trained in the traditional ways of the building using locally available materials and methods. This practice provides employment to local craftsmen and is a source of income and livelihood for the inhabitant artisans. The narrow lanes and projecting balconies also add to the economic sustenance of vendors and shopkeepers for some of the houses are of mixed-use with private shops on the ground floor.

Comparative energy-efficient analysis

This involves an on-site study of the thermal performance of one traditional house with a modern house in Jammu city. This study is to quantify that the traditional residential built form of Jammu city has better thermal performance and provides thermal comfort to the occupants as compared to contemporary residential buildings, thus making them more energy efficient.

These included:

1. Study of the physical forms and construction systems of the vernacular buildings and contemporary houses.
2. Recording the thermal performance in the two buildings during the period of climatic extremes. The experiments were conducted on 27th January 2016 and 21st May 2016. The temperature was measured outside the buildings and in different indoor spaces every two hours for completing a one-day cycle for each building with the help of a thermal hygrometer.

Fig. 6: Typical layout of the spatial configuration of traditional residences
Source: author

Case Study 1: The traditional building

1. This is a traditional courtyard house close to the Mubarak Mandi complex in old Jammu city located on a hillock, built in the early 1900's. It is a two-storey building with a

central courtyard of dimension 8400 x 6600 mm (28'x22'), surrounded by living rooms on three sides and an entrance on the Southeast side of the corridor. Its front façade is articulated with pebble work and offsets. There is also a reduction in heat gain by providing textural shading due to ornamentation and stuccowork on the façade. The ceiling height is 3600 mm (12') with ventilators for efficient air movement. The courtyard is such that the winter high altitude sun enters the courtyard while the low altitude summer sun is kept out. The house is on the main road, which has a Southeast front orientation that acts as a channel for the free flow of wind in the narrow-shaded street. The main entrance opens into a narrow-shaded street, which induces cool air from the street into the building.

2. The courtyard shades spaces and facilitates ventilation in the interiors through the openings facing the courtyard. The projection of eaves in the courtyard provides shades from the direct solar radiation into the rooms, which open into the courtyard. When the courtyard heats up during the day, the hotter air rises and denser, cool air settles down into the courtyard and hence induces ventilation in the interior of the rooms, which open into the courtyard. The parapet of the roof has *jali* works thus facilitating free air movement over the terrace aiding in keeping the roof cool.
3. The masonry walls are 450 mm (9") thick constructed with maharaji (lakhori) bricks and finished with surkhi and lime plaster. The roof is 350 mm (14") thick made of timber joists and jack arch as a typical vernacular feature and finished in lime concrete. The massive walls and heavy roofs act as thermal mass and hence provide a time lag. The exterior and interior of the building are exposed brick. The windows and doors are white, which helps in reducing the solar radiation. The high thermal mass of the walls and the use of ventilators (known as *roshandans)* promote night ventilation.

Fig. 7: Image showing the façade of a traditional house in Jammu.
Source: author

Case study 2: The contemporary residence

This is a private house built on a plotted accommodation, in 2004 in row housing configuration and designed by an architect in the Greater Kailash area of Jammu city. It is a two-story building with a living room, a kitchen, toilets and three bedrooms on the ground floor and five bedrooms with toilets, a kitchen, and dining and living areas on the upper floor. The construction consists of 230 mm (9") thick load-bearing brick walls and 150 mm (6") thick roof. The heights of the rooms are 2850 mm (9'-6"). This building is a part of row housing and is compactly planned with a small front yard. The energy consumption of the building is not considered during the planning phase and is not a major design criterion. There are few openings, which open into the front and the rear yards, which obstruct the free movement of air and do not have provisions for cross ventilation. The roof of the first floor is 125 mm (5'') thick

R.C.C construction finished with a small brick blast and cement mortar. The roof is a major source of heat gain for the upper floor due to the absence of proper terracing. The walls heat up too because of low thermal mass and hence permit heat due to conduction. The exterior R.C.C. chajjas (projections) also conduct heat, with their sloping roof design. They retain hot air, which is entrapped under their canopy.

Fig. 8: Ground floor plan of contemporary residence at Greater Kailash Jammu
Source: author

Table 1: Data of temperature taken on 21st May 2016 (summer)
Source: author

Time	Outside temperature	Vernacular house Internal temperature	Modern house Internal temperature
7:00 AM	29°C	25°C	27°C
9:00 AM	35°C	26°C	30°C
11:00 AM	39°C	28°C	33°C
1:00 PM	42°C	30°C	36°C
3:00 PM	43°C	32°C	38°C
5:00 PM	44°C	33°C	39°C

Table 2: Data of temperature taken on 27th January 2016 (winter)
Source: author

Time	Outside temperature	Vernacular house Internal temperature	Modern house Internal temperature
7:00 AM	6°C	11°C	8°C
9:00 AM	10°C	12°C	9°C
11:00 AM	14°C	13°C	10°C
1:00 PM	19°C	15°C	12°C
3:00 PM	21°C	17°C	13°C
5:00 PM	22°C	18°C	14°C

Inference

1. The data shows that the indoor air temperature in the traditional buildings is 4-5 degree centigrade lower in summer and 4-5 degrees higher in winter as compared to the indoor temperature of the modern house.
2. The areas of buildings directly exposed to the sun were 2-3 degrees higher in the traditional buildings due to the thick walls whereas in the contemporary house, it was 7-9 degrees higher than the corresponding ambient air temperature.
3. In the traditional buildings, the indoor temperature is relatively constant with variations not more than 5-7 degrees while outdoor temperature fluctuation was in the order of 15-16 degrees.
4. The courtyard system in traditional buildings ensures ventilation even during periods when the outdoors is calm. The courtyard temperature is 2-3 degrees higher in late afternoons and 2-3 degrees lower in early mornings as compared to the indoor temperature of rooms.

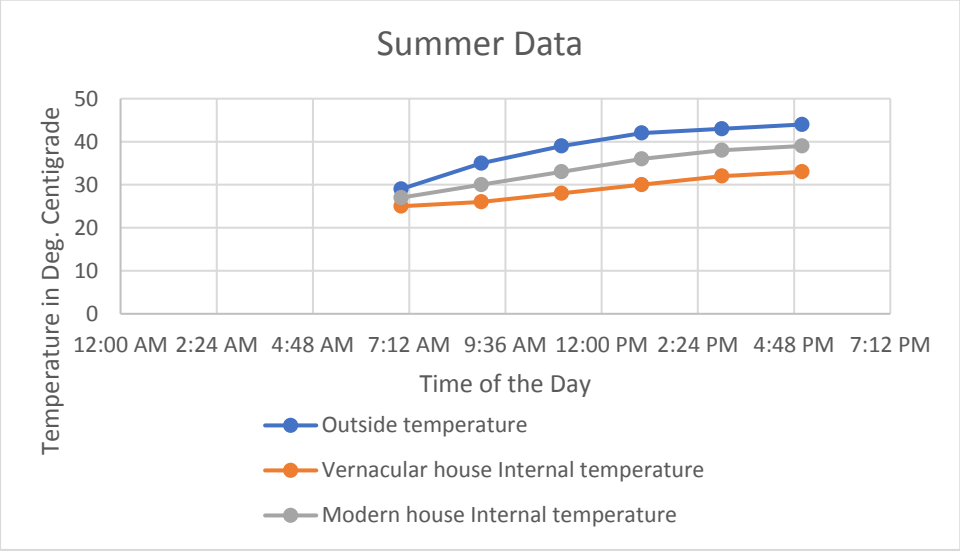

Fig. 9: comparative data from Vernacular and Modern house collected on 21st May 2016
Source: author

Summer

In summer, the mean maximum indoor temperature of rooms in various cardinal directions of a traditional house is 6-10 degrees lower than the outdoor temperature whereas in the contemporary house the mean indoor temperature is 3-5 degrees lower than the outdoor temperature. The difference of outside temperature and indoor room temperature for the traditional house is more significant in noon hours of summer conditions which cut the demand for energy considerably.

Winter

During the winter, for the traditional house there is 4-6 degrees of difference between the indoor temperature of the rooms and the mean minimum outdoor temperature whereas in the contemporary house, the indoor temperature is 4-5 degrees lower than the traditional house. The difference between the mean minimum indoor temperature and the minimum outdoor temperature at 7 a.m. is 5 degrees centigrade. The minimum temperature difference is seen between the indoor temperature of rooms of the traditional house and the higher values of the outside temperature. The maximum temperature difference is seen between the indoor room temperature of the traditional house and the lower values of the outside temperature. The reverse is seen in the case of the contemporary house which clearly depicts the better thermal performance of the traditional house in the peak winter condition. The energy demands for heating are also significantly reduced in the process.

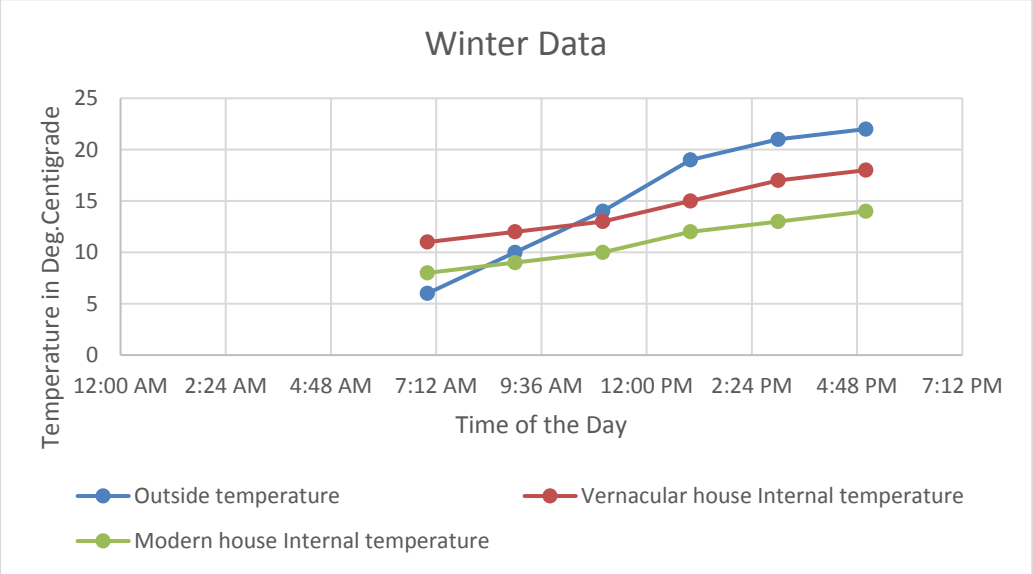

Fig. 10: comparative data from Vernacular and Modern houses collected on 27th Jan 2016
Source: author

Conclusions

The field study results clearly indicate that the vernacular building is in conformity with the climatic context and is more comfortable as compared to the contemporary residence. The spatial arrangement of the living spaces is interactive and suited for complete utilization by the occupants for social and cultural activities. This building construction involves a participatory approach of involvement of local artisans and materials with low embodied energy. Hence, the study establishes the energy-efficient and overall sustainable performance of the vernacular residences of the old Jammu city over the contemporary residences of the plotted colonies of the same city.

Thus, vernacular architecture has multi-faceted contributions from thermal comfort and energy consumption considerations, socio-cultural and socio-economic aspects in addition to heritage aspects and environmentally safe considerations. It represents a complete sustainable architecture design solution.

This study presents the advantages of the traditional building as compared to the new ones with the help of suitable case studies. Nevertheless, by customizing and adding it with judicious modern techniques, a comprehensive climate-responsive and energy-efficient modern buildings and settlements can be produced close to prescribed energy-saving standards (Watson, 1993).

The scope of future research may involve more in-depth studies of traditional houses in the Jammu city with respect to modern housing typologies and techniques that would yield more significant results. This would help in combating the climatic extremes the city is witnessing in addition to the current deviation from its roots emerging from the socio-cultural and socio-economic aspects.

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