PEARL ACADEMY OF FASHION
An Environmentally Responsive Passive Habitat

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ABSTRACT: Today the urban environment of Jaipur suffers from rapid development that has inadvertently taken generic modernism and eccentric novelty. The sudden wealth and development of these cities often destroys centuries of heritage, social order and leaves behind excessive waste, a pattern that Jaipur seems to be headed towards. Jaipur houses a series of vernacular tradition, contributed by the melting pot of Rajput, Mughal and several other cultures. These ancient techniques that have been in practice for hundreds of years are now in jeopardy due to globalization. Today’s architects face the challenge of infusing new forms with the legacy of the past and with the spirit of place. The challenge to build a progressive design institute requires addressing the needs of the new generations and their social conditions, while keeping in mind tradition that can continue to inspire future design students. The paper essentially highlights the passive strategies used in Pearl Academy of Fashion in Jaipur which can trace back its roots to traditional Indian architecture. Architecture in Jaipur, is a rendition of Rajasthani classicism and Mughal architecture remnants. The design intent was to create a low-cost, environmentally sensitive campus that would set a precedent for other institutions, with elements of the historic context and the vocabulary of the region. Traditional passive cooling design strategies were executed that created unity of modern adaptations of traditional Indo-Islamic architectural elements.

Keywords: evaporative cooling, thermal sink, local materials, courtyards, jaali² (perforated screen), form optimization

INTRODUCTION

Figure 1: Completed image of Pearl Academy of Fashion

Pearl Academy of Fashion is ranked third in the top 10 fashion design institutes in India. The institute is located in a hot, dry desert type climate on the outskirts of Jaipur in the soulless Kukas industrial area, 20 kilometers from the famous walled city. The real task that challenges architects today is to infuse new forms with the legacy of the past and the spirit of place. Jaipur is a melting pot of Rajput, Mughal and several other cultures and is also the seat of a generous amount of vernacular tradition. The challenge to build a progressive design institute requires addressing the new generation, contemporary social condition and needs to be inspired by tradition, in order to be inspirational to the contemporary sensibility of the modern-day design student. Budgetary constraints on the project required the use of cost effective design solutions to keep the cost within the price points set by the client.

The architecture of the academy was proposed to be a confluence of modern adaptations of traditional Indo-Islamic architectural elements and passive cooling strategies prevalent in the hot-dry desert climate of Rajasthan. Elements such as open courtyards, water bodies, step-well or baoli¹ and jaali² were derived from their historic usages but manifested themselves through the built form and become an intrinsic part of the daily life of the students. Some of the historical references used from Indian architecture for jaali, step well, courtyard, heat sink & pavilion are Jal mahal, Hawa Mahal, Panna Mian ki Baoli in Amer Fort, Ganesh Pol in first courtyard of Amer fort, Baradhari Pavillion in Amer Fort.

| Typology: | Educational |
| Location: | 27.03° N, 75.89° E |
| Completion: | June 2008 |
| Cost: | USD 3.8 million |
| Site Area: | 12,542 sqm |

¹ Baoli: Step wells or ponds in which the water can be reached by descending a set of steps
² Jaali: the term for a perforated stone or latticed screen, usually with an ornamental pattern constructed through the use of calligraphy and geometry.
SITE AND FORM OPTIMIZATION

Due to the project location within an industrial site context and the impact of form optimization on built form, a rectangular volume was formulated that would provide with minimum exposed surface area. The entire building is raised above the ground and 4 meters were excavated to create an underbelly. The underbelly forms a natural thermal sink which is cooled by water bodies through evaporative cooling. Floating above the underbelly (figure 3) is a teaching block raised on pilotis, two stories high with footprint of 111 by 50 meters. The mass is broken into several courts creating alternative solids and voids which respond to solar geometry as shown in figure 2. The solids become studios and classrooms, whilst the voids are visual breaks that allow daylight and air through. Throughout most of the year these incisions offer shade, limiting solar ingress into the underbelly. Cool air as it warms up rises vertically through these courts creating cross ventilation. The courtyards plan is a simple form where the floor plate is no more than 9 meters wide at any point, at no point is an occupant more than 4.5 meters from a window or opening- this eliminates daytime reliance on electrical lighting, 90% of the gross space area relies on natural daylight. Green spaces and water bodies are designed as per orientation to be in shaded areas in order to lower the water evaporation and aid evaporative cooling. During the night, when the desert temperature drops, this floor slowly dissipates the heat to the surroundings, keeping the area in thermal comfort.

Learning was derived from the built heritage of Rajasthan, replete with haveli3, inward-looking blocks with rooms along corridors and in enfilade, surrounding a single or multiple courtyards. The haveli3 typology epitomizes the idea of the building as a device for environment control, where the solid-void balance is calibrated for maximum daylight penetration, minimum heat ingress and the accommodation of multiple functions. Hence, The Design response was an introverted building, given the setting which was largely industrial. A long low-lying two-floored perimeter block pushes the building envelope to the mandatory setbacks, optimizing the exposed surface area to volume ratio of the form and almost seems to float above the land.

Figure 2: Images show the shadow analysis of the building done in Ecotect to optimize building envelope and determine the fluid shape of the internal blocks to suit solar geometry

Figure 3: Perspective view showing the optimised building envelope floating over the sunken court.

MULTIFUNCTIONAL PROGRAM ZONES

The underbelly provides functional spaces that operate in a passive environment, eliminating the need for additional built volume in the form of a floor without jeopardizing the program. Steps on the perimeter of the underbelly double up as seats, making this an ad-hoc performance venue. The institute creates interactive spaces for a highly creative student body to work in multifunctional zones that blend the indoors with the outdoors seamlessly. The underbelly is thermally banked on all sides serving a large student recreation and exhibition zone. It also houses the cafeteria and spill out area thus forming the anchor for the entire project (figure 4). The ramp is multi functional as a runway during fashion shows. The spatial flexibility allows ample room for growth. An additional floor will be built in the future to accommodate students’ residences, thereby becoming a mixture of residence and workspace that will take the building even closer to the archetypal haveli. The multifunctional programming allows for the elimination of a complete storey which would otherwise use artificial techniques of cooling hence making the building extremely efficient in its energy consumption.

1 Haveli: term used for a private mansion in India and Pakistan, usually one with historical and architectural significance. The word haveli is derived from the Persian word hawli, meaning "an enclosed place".

<table>
<thead>
<tr>
<th>Gross Floor Area:</th>
<th>12,250 sqm</th>
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<tbody>
<tr>
<td>Building Height:</td>
<td>21m</td>
</tr>
<tr>
<td>Capacity:</td>
<td>600 students &amp; 100 staff</td>
</tr>
<tr>
<td>Operational Hours:</td>
<td>1100hrs/year</td>
</tr>
<tr>
<td>Programme:</td>
<td>4 classrooms, 24 studios, offices, library Auditorium (195 occupancy)</td>
</tr>
</tbody>
</table>
The Classrooms, Labs, and Offices have been designed around an internal courtyard, which is further broken down to fluid forms housing the flexible requirements of Studios.

**ELEVATIONAL STRATERGY**

*Jaali* acts as a second skin to the building, servicing the functions of 3 filters, air, light and privacy. Figure 5 shows a 1.2 m wide sliver of space between the two building skins along the outer perimeter of the teaching block cuts down solar heat gain without curtailing air flow or daylight entry. The porosity of the *jaali* panels varies with orientation of façade; the greater the solar exposure the more opaque it comes (figure 6), the variances was made with Ecotect [1].

The building is wrapped in a double skin consisting of Fritted screens set 1.2 meters away from inner walls and windows. The *jaali* moderates incoming natural light, which can be harsh much of the time. The double skin acts as a thermal buffer between the building and surrounding, thereby reducing direct heat gain through fenestrations, yet allowing for diffused daylight.

The façade is entirely composed of two detached horizontal planes formed by perforated panels, creating a ventilated buffer space to protect the outer walls and a service corridor through which the horizontal pipes, cables and ducts are supplied around the building. The wall section is inspired by the Hawa Mahal, an 18th century building with a tapered block with finely screened windows that provide shade and admit cool air. However, the primary purpose of these grilles was to allow women of the court to observe life in the street without exposing themselves to view.

**COURTYARDS / STEP WELLS**

Self-shading courts keep the solar ingress out and control the temperature of internal spaces, whilst allowing for sufficient day lighting inside studios and classrooms. The lowest floor of the building, the underbelly is able to moderate ambient temperatures with water, shade and vegetation. The underbelly is sunken 4 meters below street datum so that the cool humidified air which is heavier than warm dry air might be contained. The sinking of this space also provides privacy for inner sanctum where students gather. A matrix of water and greenery creates a microclimate via evaporative cooling and transpiration that is substantially cooler than outside.
During the night when the desert temperature drops the
underbelly floor slowly dissipates the heat to the surroundings keeping the area thermally comfortable. The time lag suits the staggered functioning of the institute. Passive environmental design helps achieve temperatures of about 27°C inside the building when outside temperatures are 42°C. The minimal aesthetic places the focus on the students who inhabit the space and the activities that bring it to life. The people-friendly intent is most evident on the lowest level, an excavated ground that steps down from all four sides of the buildings, a grotto-like space containing all the makings of desire: water, plants, food and people. Livening this multifunctional and creativity-inducing space is a gentle breeze that continually flows in all directions, generated by a temperature differential between inside and outside and the cross ventilating through Venturi effect (figure 7).

The traditional courtyards take on amorphous shapes within the regulated form of the cloister-like periphery. This curvilinear geometry is generated through a computerized shadow analysis that tracks the precise movement of the sun through the day and across the seasons. The water body works on the basic principle of evaporative cooling and was designed on the format of the “baoli” (step well). Dry winds are drawn into the underbelly due to the rise of hot air from the courtyard. These winds get cooled as they travel over the water body.

**LOCAL MATERIALS**

The pallet of materials includes stone, glass and concrete, all of which are locally sourced. Jaisalmer stone, kota stone, granite and slate are quarried from within Rajasthan. All materials used are from under 300 km distance. Aluminum, concrete come from Jaipur city limits. Concrete jaalis cast onsite by employing the local craftsmen of the region. Traditionally matkas are handmade mud vessels that are used to carry water. Hundreds of 35 cm wide matkas were placed 2.5 cm apart, the gap was filled with sand and broken bricks, and then cast over with binding layer of concrete. The sandwich of trapped air is applied to horizontal surfaces that are exposed to the sun, becoming a barrier that limits solar heat transmission. The fill and the air within the matkas provide insulation. Matka’s (earthen pots) as shown in figure 8 & 9 were inverted and placed along the terrace creating an air cavity that thermally insulates the roof. The exterior is painted orange to set off the jaalis, but the interior surfaces are white, to reduce heat absorption and create a cool backdrop for the bustle of activity and the brilliant colors of women's saris.

**ENERGY EFFICIENCY**

*Table 1: Energy performance Index calculation as per GRIHA*[^5]

<table>
<thead>
<tr>
<th>ENERGY PERFORMANCE INDEX</th>
<th>kWh/m²/year</th>
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<tbody>
<tr>
<td>Benchmark Performance AC Buildings</td>
<td>Energy E1 AC</td>
</tr>
<tr>
<td>Benchmark Performance Non-AC Buildings</td>
<td>Energy E2 Non-AC</td>
</tr>
<tr>
<td>Benchmark Performance (Both AC and non-AC)</td>
<td>Energy E1 X E2 + (E2 X A2) / AC + Non-AC (GRIHA)</td>
</tr>
</tbody>
</table>

[^5]: Matka is a Hindi- Urdu word for an earthen pot and used as a water storage cooler.
[^4]: GRIHA, an acronym for Green Rating for Integrated Habitat Assessment, is the National Rating System of India. GRIHA has been conceived by TERI and developed jointly with the Ministry of New and Renewable Energy, Government of India. It is a green building 'design evaluation system', and is suitable for all kinds of buildings in different climatic zones of the country.
According to GRIHA\(^5\) energy performance index (EPI) of an air conditioned building is 140kWh/m\(^2\)/yr (Table 1) and that of mixed mode building is 81.4140kWh/m\(^2\)/yr. Table 1 shows that GRIHA\(^5\) only takes into account the area of air conditioned and non air conditioned space. It does not consider if the air conditioning is used only during summer months and the space is free running during most part of the occupancy hours in calculating EPI. Morphogenesis created its own EPI benchmark considering that the air-conditioning is only used during 25% of the occupancy hours which comes to 53.8 kWh/m\(^2\)/yr. Figure 10 shows the comparison of the energy performance index of air conditioned, non air conditioned, mixed mode and actual energy consumption of the building. The actual energy is 24.7kWh/m\(^2\)/yr which is marginally less than EPI of the non air-conditioned space (25kWh/m\(^2\)/yr).

Passive design strategies limit the air conditioning spaces to 50% of the total area by creating an onsite microclimate that reduces cooling demand. Further, out of this 50% of air conditioned space the active air conditioning is used in less than 25% of the occupancy hours. 21.9% surface area of site is covered in plants and 3.7% surface area of site is covered in water which together work to create a micro climate on site.

100% of the gross floor area relies on natural ventilation/fans. The thermally banked underbelly maintains comfortable ambient temperatures through the year. Most areas including classrooms are without air-conditioning and run at ease only with the use of fans in this extremely hot region except for a few areas which have individual split units. November-March are months without the use of any artificial cooling/heating, March-May and September-October are months with only fan usage and air conditioning is used only in the extremely hot months of June and July, that too only in limited spaces.

Recycled water from the sewage treatment plant (STP) is used for landscape and flushing, also the bodies of water that are used for evaporation. Table 2 shows the water balance chart for Pearl Academy of Fashion. It shows that 58% of the total water requirement of the building is taken care by using recycled water from the sewage treatment plant (STP) and by only utilizing 80.5% of the recycled water. Courtyards and naturally lit corridors provide light into the building. As a result artificial lighting is eliminated during the day. The building is on a 9m grid, single bay, naturally lit and cross-ventilated. The configuration of this grid allows for day lighting, ventilation.

The roof is insulated in a traditional Indian technique of thermal insulation with earthen pots (mutkas\(^4\)). The client brief put down a requirement of a campus which was to be completed within a stipulated budget of approximately $30 per sq ft of built up area including all building services, furniture, air conditioning, power backup etc. This clearly was a very tight budget to be working with and environmental design was employed as a strategy to lower energy costs in the long run. Energy efficiency is a prime concern and the institute is 100% self sufficient in terms of captive power and water supply and promotes rain water harvesting and waste water re-cycling through the use of a sewage treatment plant.

The adverse climate makes it a challenge to control the micro climate within the project thus incorporating various passive climate control methods becomes a necessity and also reduces the dependence on mechanical environmental control measures which are resource hungry.

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**Table 1:**

<table>
<thead>
<tr>
<th>Category</th>
<th>Value</th>
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<tbody>
<tr>
<td>Total Area</td>
<td>11745</td>
</tr>
<tr>
<td>Air-conditioned Area</td>
<td>5760</td>
</tr>
<tr>
<td>Non-air-conditioned area</td>
<td>5985</td>
</tr>
<tr>
<td>% of air-conditioned operational hours</td>
<td>25%</td>
</tr>
<tr>
<td>% of free running operational hours</td>
<td>75%</td>
</tr>
</tbody>
</table>

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**Figure 11:** Graph showing the comparison of the energy consumption w.r.t the GRIHA benchmark
CONCLUSION

We are working in an environment with limited resources. Design is viewed as a process that is a resultant of different stimuli, ranging from climatic conditions, financial and market forces, globalization, local conditions, prevalent traditions and technologies, and the community. There is no other choice, but to reengage by being responsive to nature. Climate or ecological or environmentally sensitive architecture is no more an option, or a “layer” that can be applied to the design of a building; it is inherent and integral to the process of design, from concept to completion and to the full life cycle of the building. The goal when building green is to use energy and natural resources wisely and in a healthy manner. The most effective approach would be to build with local materials in a way that responds to the local climate while remaining economically viable and globally pertinent.

Architecture of the future should successfully reduce the load on the environment in its construction strategy (assembly), material resource utilization (transportation), spatial allocation (area optimization), energy consumption (passive methods) and should increasingly rely on natural environmental resources and renewable such as day lighting, ventilation, passive methods of cooling, water recycling and access to nature.

Goal was to achieve comfort conditions with utilization of minimum resources, water and wastage.

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