

Jaalis: A study on aesthetics and functional aspects in built environment

Lakshmi G Kamath¹, Srinivas Daketi²

¹ I Yr, M.Arch (Sustainable Architecture) School of Planning and Architecture, Vijayawada, India

² Assistant Professor, School of Planning and Architecture, Vijayawada, India

Abstract

Jaali as perforated screens for permitting light and ventilation in buildings have been used extensively in India. History has seen tremendous change in the way lattice screens have been conceived across the globe. The study examines and explores the design of Jaalis over time and its varying attributes according to the geography, religion and a multitude of factors to its modern interpretations and adaptations by contemporary architects through literature reviews and case studies, in the design of sustainable buildings, in India. One of the principal outcomes of the research is to help architects in designing better buildings with the traditional element of jaali.

Keywords: lattice screen, traditional architecture, geometric patterns, sustainable design.

1. Introduction

‘Jaali’ word means a net or a fine web. It is an ornamental perforated screen found in Indian, Indo-Islamic and Islamic architecture. As a shading device it is an eggcrate, a combination of horizontal and vertical shading device at a minuscule scale. It appears to be 2-dimensional, but the thickness along with the interlinked balusters forms many small devices equivalent to a large overhang or a vertical fin.

In the ancient times, structures were designed to tackle the natural conditions and provide indoor thermal comfort without relying on mechanised systems. Such a passive method is the Jaali. The first evidences of which is seen in the Mediterranean, where the windows were divided into subparts. The span of lintels was reduced with latticework and provided security. (Shah 2009)

A variation of jaalis in Egypt, Oman etc is the Mashrabiya. The term of Arabic origin means ‘a place for drinking’. In the earlier phases it was used

to cool drinking water placed in clay pots. Winds would pass over the porous surface after passing through the shaded lattice screen and bring down the temperature of water inside by evaporative cooling. Later mashrabiya were fitted with beds inside, where the occupant could relax and it suited their privacy notions. But unlike the jaali, they were typically carved out of wood. The artisans would patiently dovetail the pieces together without nails or glue to allow the wood to shrink and warp under high temperature and adjust itself. (Feeney 1974) Different names- Takhrama in Yemen, Shanashil or Roshan in Iraq and Saudi Arabia, with differences in design, materials, etc., calls them but the function remained the same as a climate control tool in the harsh deserts. (Mohamed 2015)

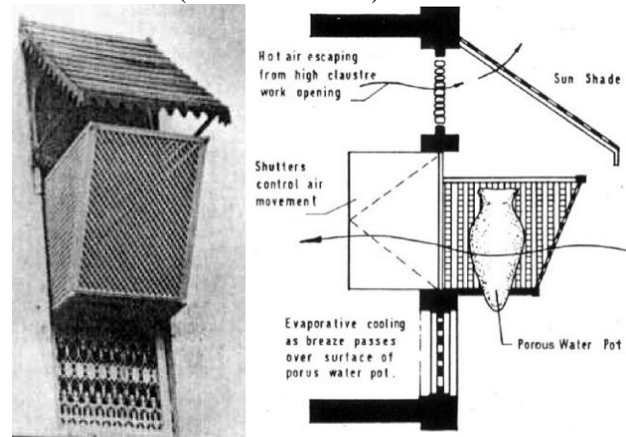


Fig.1 Mashrabiya in Muscat

Source- Rosa Schiano, 2007

In Nepal, wooden jaali windows with intricate religious carvings of mythical elements on sill lintel and jambs are seen in palaces and private residences. Multiple frames like an architrave set the jaali recessed into a bare brick wall



Fig. 2 Kathmandu square and Bhaktapur window
 Source- Author

2. Evolution in India

Tracking jaalis in the Indian architecture, it is noted that Harappan architecture had no window openings. Ajanta Chaitya openings, were carved in stone and were similar to the contemporary byzantine openings with lattice like framework. (Shah 2009) The earliest examples is at the Ladh Khan Temple, a building which had a lasting influence on the future Hindu Temple architecture. (Stierlin 2002) The stone slabs on the facade exhibit heavily eroded composition of simple square perforations and relief sculptures, lighting up the small dim interiors.

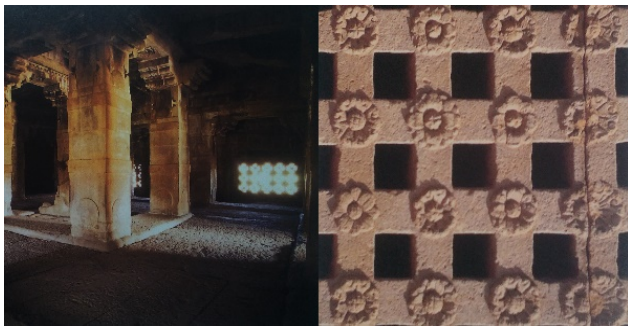


Fig.3 Jaali at Ladh Khan
 Source- Stierlin 2002

The next prominent example are the jaalis between the columns standing over a proceeding of friezes of Hoysaleshwara Temple, Halebid, built in 1120. (Stierlin 2002) The jaali is more prominent than in previous examples and is shaded with broad eaves.

With the arrival of Mughals, architecture transformed greatly. In Kashmir, local artisans, experts in wooden temple architecture carving, over generations began

innovating new decorative elements. A major contribution by the imperials was of the latticework called Pinjara, which was adopted by Himachali artisans of Rampur Bushahr. (Handa n.d)



Fig.4 Hoysaleshwara Façade
 Source- Stierlin 2002

Woodwork craft in Punjab was influenced by the Rajput style. Small human figures, foliage and animal figures were carved with delicate pinjara work. Hindu craftsmen, the Paharis carved, whereas Muslim craftsmen from Chiniot carved fine jali work in Rajput style (Culture of Punjab-Woodwork n.d)

One of the most outstanding examples of Jaali is also the logo of India's premier institute IIM-A. The rear wall jaali of Sidi Saiyyid mosque, Ahmedabad, is an example of provincial architecture influenced by local art traditions. The delicate carving reveals a feminine quality. The vision flows over the intervined branches covering the whole surface to provide structural strength and rests on to the palm.

Jaali became highly popular during Mughal rule, they were used as partitions, railings, ventilators, windows, outer walls etc. Influenced by European art they evolved to contain flowers and vegetation, evident in Red Fort of Shahjahanabad. "The Mughal response to European art was not slavish imitation but creative reinvention." (Sorensen 2009)



Fig.5 Jaali at Red Fort
Source- Author

3. Attributes

Examples of jaali in Mughal architecture are at the Humayun's tomb, where a mystical quality is lent to the space, entralling the visitor, making one imagine visiting the tomb in the then thriving empire. The magnificence of the light entering in, is symbolic of the enchantments the celestial world falling on the earth.

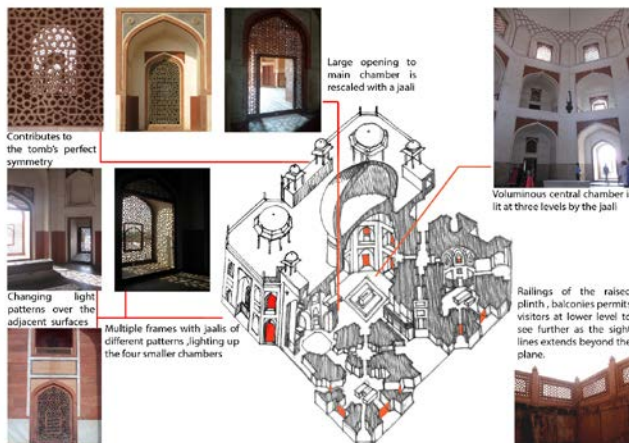


Fig.6 Use of Jaalis at Humayun's Tomb
Source- Author

3.1 Aesthetics

The jaali can be metaphorically be equated to a shady tree branch, sheltering the person bellow from the sun, creating exquisite patterns of light on the plane...a poetry of nature.

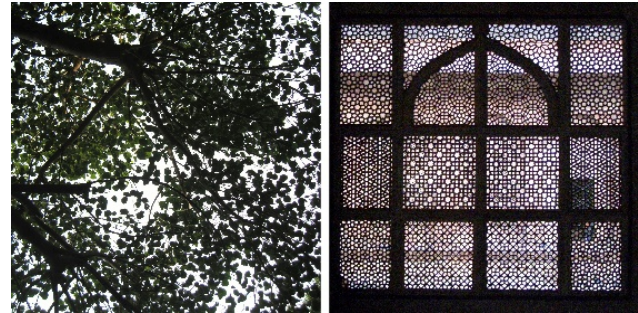


Fig.7 The sheltering effect of trees and jaali at
Fatehpur Sikri
Source- Author

A jaali being fixed serves as picture windows, framing scenery within. They can provide better aesthetics along with maintaining view and climatic comfort, better than glass.

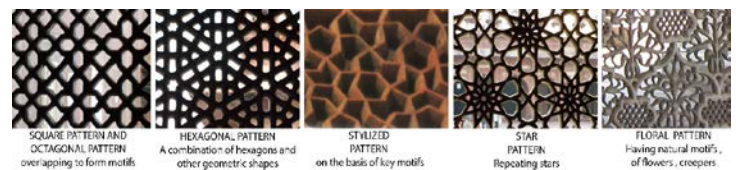


Fig. 8 Patterns of Jaali
Source- Author

Patterns- Islamic jaalis exhibit recurrence of hexagon in combination with other shapes. Hexagon represents the heaven, with 6 sides expressing 6 days of creation as per the Koran and the negative space, the 7th component is an expression of the 7th day or Sabbath, when god established his throne. The seventh component is not obvious but is integral to the composition, and allows for exchange of views. Another intention is to depict the shari'ah, which was delivered by the prophets and culmination of their cycles of philosophy on the appearance of the Natiq, who will bring in the 7th cycle of sacred history and reveal the spiritual meaning of all the previous prophetic revelations and faiths. The hexagonal shape is a mark of protection belief and faith of the followers.(Andani 2009)

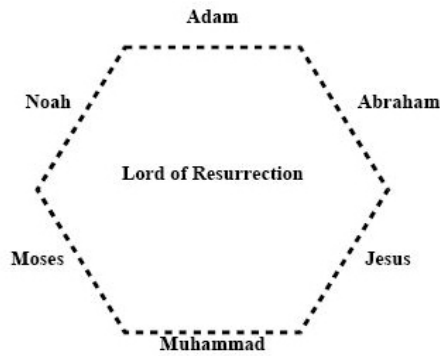


Fig. 9 Source- Andani 2009

The negative and positive spaces are created with a subtractive sculptural process. The remaining stone forms the jaali's design. Endless variants of a motif can be made which are mathematically rooted with simple tools like a compass and a ruler. The process of creating a delicate grate does not allow for possibility of making mistakes.



Fig.10 Process of making a jaali
Source- Aga Khan Trust for Culture

Repetition - Most geometric jaali patterns are made up of repetition of a module. However complex the pattern may appear to be, they can be identified to be made on a grid. The modules are composed of triangles, squares or hexagons. The continuity makes the eyes move over the composition.

Infinity - Due to replication of a module over and over, they appear to continue beyond the physical boundary of the frame. It is difficult to identify the starting and the end of the patterns. This intentional repetition is symbolic of infinite nature of God. It is so because Muslims believe that human can't imagine a stable palace for God. (Tavani 2014)



Fig.11 Traditional Jaali carving method

Source- Aga Khan Trust for Culture

Symmetry - Jaalis are typically made by mirroring of the basic unit pierced into the red sandstone, marble or other stones. The attribute of perfection is conveyed to the viewer.

Quality of Light - Light was one of the one of the first creations of god, and is an important element in the Mughal architecture. Natural light is emphasized and played with by the structure, the façade, materials, the lines and planes. Controlled light enters into the tomb space as light enters in and sun's glare is cut out. Jaalis weave a subtle play of shadow and light and provides a dynamic nature to the subtle peaceful quality of the space within as the shadow changes over the day and different seasons.

Visibility - It screens the inhabitants from the gazes of the passer-by, providing privacy due to the light difference. At the same time, a visual continuity at the ground level and clerestory is maintained between the interiors and exteriors.

JALI PATTERN	HUMAYUN'S TOMB GATEWAY	HUMAYUN'S TOMB RAILING	HUMAYUN'S TOMB CHAMBER	HUMAYUN'S TOMB CHAMBER	RED FORT
LOCATION					
MODULE					
% VOID	43	48	45	42.8	47.5
% BALUSTER	57	52	55	57.2	52.5
DEPTH	5 CM	5 CM	8 CM	5 CM	6 CM

Fig. 12 Jaali analysis
Source- Author

3.2 Climatic aspects

The small holes increase the velocity of air as it passes through them, similar to the function of a

funnel, enhancing even the mild breeze outside and allows for deeper penetration. The air also cools down while moving through the small apertures which functions like an air conditioner compressor. Thus comfort of the occupants is increased as the jaali puts both Bernoulli's and Ventury's law to effect.(Pandya 2011) In desert areas, the mesh like structure filter out the dust accompanying strong winds in the region.(Gandhi 2014) Together these attributes of the jaali make the building breathe. The cooling function is supplemented with humidification, as organic fibers of the wooden and stone jaali, absorbs, retains and releases water. The function is similar to that of evapotranspiration by plants. The wind passing through the cooled jaali holes, as at night time, gives some of the humidity which is released into the air passing through the apertures at day time when the environment is hotter.(panesar 2004) The holes are nearly the same size or smaller than thickness of the material, which implies that each void is having its height equal to its depth, mostly in the ratio of 0.8 to 1.2(Gandhi 2014) The thickness has the most significant impact on the effectiveness of jaali as a shading device.

In Rajput architecture of hot dry desert, floral motifs are incorporated at the center of a module. The fenestrations are taller and narrow, which allows for deeper penetration of light and air. Adding to the colorful painted wall and roof surfaces in the interior. Some have stained glass fitted into the apertures as seen at Junagarh Fort, Bikaner. Some jaalis have shutters that can be shut during the winters to reduce the inflow of cold air.



Fig. 13 Fenestrations at Bikaner
 Source- Author

As jaalis control the light entering in, reflecting some light back from the outer surface, they also reduce the heat associated with it. Unwanted glare is reduced with controlled illumination. The rounded balusters softens the contrast between the darkness of the

opaque balusters and glare entering in .The protruding balusters produces a silhouette that carries the eyes vertically and horizontally across the interstices.(Panesar 2004)

Padmanabhapuram palace, Thukale, exhibits wooden latticework, a consequence of availability of timber in the region, over its exterior façade with operable windows. Jaalis are found on gable roofs of attics, and allows for escape of hot air transferred down from the tiled roof. This provides good insulation, as the second roof remains cooler than the sloping roof above. In warm humid areas of Kerala, the apertures are larger, but cover smaller proportions of the wall compared to the jaalis seen in Rajasthan and other parts of the country.

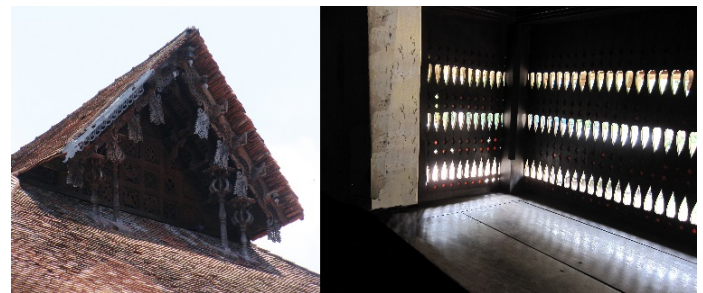


Fig. 14 Gable roof at Ammaveedu and fenestrations at Thukkale
 Source- Author

3.3 Cultural aspects

In the eastern countries, the men and women are required to be separated; this can be traced to the influence of Islam. In India, social stature, wealth were reflected in the practice of purdah, which became a part of etiquettes for women. A translation of this practice in architecture can be seen in the Hawa Mahal. (Khar 2011) Hawa mahal or "the palace of winds" is an icon of Jaipur and has its façade packed with honeycombed patterns facing the main street of the old city .It functioned like a veil for the women in the conservative social setup. Royal women could view processions and everyday life of the city from behind the screens out of the sight of strangers.

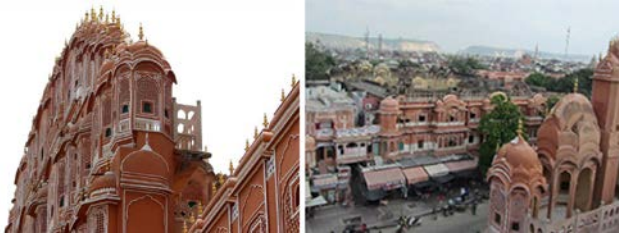


Fig.15 Hawa Mahal and the view to the streets
 Source- Author

Post- independence , in an attempt to break away from reminiscent of the British, the new architecture style blindly followed the west, with no respect for the environment ,rather than evolving the traditional vernacular, which served its purpose well socially as well as climatically. At an urban level the use of Jaalis got restricted due to proximity of houses, apprehensions on security due to occupation pattern, difficulties in pest control, as well as expenses and time consumed are issue related to utilisation of jaalis.(Srivastav & Jones 2009) Air conditioners have become a status symbol with the expanding middle class. They have replaced traditional techniques such as jaalis. But in a country which faces shortage of energy, the dependency on ACs have to be reduced.(Zagyi 2013)

In modern times, jaalis are made of materials like concrete precast blocks, mdf, light weight concrete, bricks, flyash etc.

-Jaali is a effective substitute for a window (functions)

-As an outer wall, it utilizes less mortar and bricks, leading to saving cost and faster construction; their use may be beneficial in rural context. The continued relationship between the interior and exterior can ensure the essential relationship between the streets and the buildingan essence of Indian villages.

- Safety- secure against thieves and animals

-In cities, increased use of jaalis in place of glazed windows can help bring down the problem of urban heat island effect. Jaali as a climate change solution rooted deeply in the history of our country, can allow for aspirations of India as an emerging economy.

-When used for boundary walls they can ensure natural light, ventilation, and support for tendrils of plants

-Jaalis on parapet roofs lets air move over the heated roof surface and carries away the heat and increases the speed of heat loss during the night.

Taking the present cases of jaali use ,many architects have re- interpreted the element of Jaali with different materials. Laurie Baker used Jaali of bricks to create dynamic facades that brought in air by the effect of stack. Unlike traditional jaalis , brick jaalis did not require skilled labour for construction. The patterns and dimensions were constrained by the brick sizes. An example of recent buildings is Sanjay Puri's, office building in Jaipur. The building is enveloped on all sides by a concrete jaali supported on a steel framework, to perform its functions. Projections varying from 0.9m -1.5 m create an insulation space at every level where plants are grown. The external heat is cut out as air is subjected to venturi effect. A sculptural quality to the façade has been lent by the jaali which is reminiscent of the past and establishes its connection to the present.(Jayakar 2013)

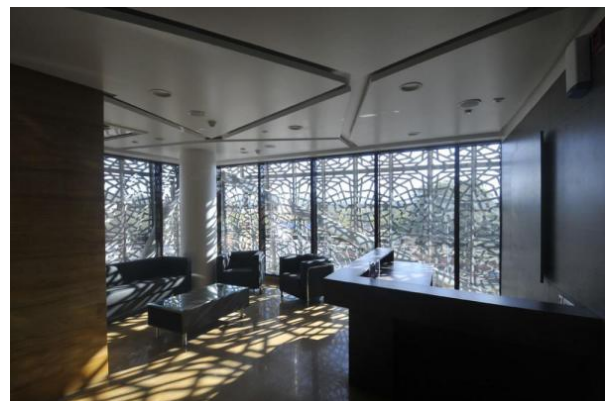


Fig. 16 Screens Jaipur
 Source - Roof and Facade Asia: Sustainable and Traditional Design , 2009

Pearl academy of Fashion, designed by Morphogenesis in 2008 is a union of traditional and modern, derived from traditional elements of the dry desert climate of Rajasthan. The built form was designed to become an core part of students life with the jaali double skin 4 ft away serving the primary purpose of providing air, privacy , light. The configuration has been derived out of modern method of computational shadow analysis



Fig.16 Pearl Academy of Fashion
Source - Roof and Facade Asia: Sustainable and Traditional Design, 2009

4. Conclusions

With advancements in technology and deviation from and loss of knowhow of traditional architecture, Mechanical air-conditioning has become the easiest solution to creating comfortable interiors. It is difficult for people now to imagine a life without them, but the degradation of the environment caused by ozone depletion and persisting problem of global warming, it is be advisable to look back at passive cooling techniques for inspiration. An understanding of jaalis is essential to effectively use them in the design to ensure greater thermal comfort.

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