

Jaalis

Lattice Screens of India

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Abstract: – In India, Lattice screens i.e., Jaalis are extensively used for ventilation and light inside the building. The way lattice screens have been conceived around the world, history has witnessed a massive change. To understand the designs of lattice screens over the last period and its different attributes according to geography, culture, and the multitude of factors to its modern interpretations and adaptations by contemporary architects in the design of sustainable buildings, in India, the study has been done. The aim of the research is to study the design of Jaali over time and its varying attributes, according to climate, culture, and multiple factors to its modern adaptations by contemporary architects.

IndexTerms - Jaali, Architecture, Buildings, Lattice Screen, Design, Ventilation, Climate.

I. INTRODUCTION

Jaalis are used as ornamental or geometrical punctures on wall surface for allowing light which forms dramatic shadow effects inside the building, ventilation and visual barrier are two other functions of the lattice screens. Jaalis physically functions acts as a climate control device for different parts of India, as it lowers the amount of light enters interiors to reduce its blinding glare, to permit the passage of air but block strong gusts. For ages Jaalis have been extensively working in Indian construction. They have been seen in both Islamic and Hindu architecture.

The slabs which are latticed and perforated of stone and wood have been beautifully exhibited by generations of skilled labours to provide coverings for window, room dividers and railing for balconies. These jaalis are important element and has been significantly indulged by Mughal builders. Jaalis provided feasible purposes such as protection from direct sunlight, air circulation, as well as privacy in addition to artistic bent to the spectacular wonders of architecture of this golden era of Indo-Islamic Architecture.

Origin

The word Jaal refers to net which is originated from Urdu. “Jaali” term is used for a perforated stone or lattice screen, usually with an ornamental pattern. This form of decoration is common in Indo-Islamic architecture and more usually in Mughal Architecture.

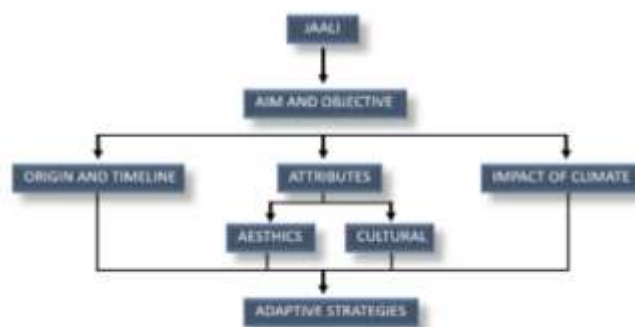
1.1 Background

Early jali work was built by carving into stone, generally in geometric patterns, while later the Mughals used very finely carved plant-based designs. Jali describes a perforated stone screen, usually with an ornamental pattern. Containing minute carved, delicate geometrical and floral designs, these perforated screens were an integral component of Mughal architecture. Constructed primarily using marble or sandstone, their form includes windows, railings, dividers, and outer walls, which provided ventilation and screening from light, imbuing their surroundings with a calm, cool and airy environment. During the day, as sunlight streams through the jaalis, the patterns form magical shadows and reflections that grace the adjacent floors and walls, entrancing and mystifying all who see them.

1.2 Objective

- To explore the origin and timeline of Jaali (traditional screens) in India.
- To study about the fundamentals of Jaali.
- To know the impact of climate into spaces with Jaali.
- To bring out some possible adaptive strategies.

1.3 Methodology



1.4 Scope

- Study the different typologies of Jaali.
- Study on aesthetics and functional aspects of Jaali in built environment.
- Analyse Jaali with respect to its patterns, cultural aspects, and climatic performance.
- Study the possibilities of absorbing learning from traditional perforated screens in the contemporary context.

1.5 Limitation

- The study is limited to typologies of Jaali and their ecological responsiveness and applications only.
- The case study is limited to jaali built in 16th century.
- The study excludes and construction techniques.

II. HISTORY OF JAALI IN INDIA

Its origin and evolution don't seem to be clear, however it's been extensively utilized in the Indian landmass, together with within the southern Indian areas of Kerala and Konkan too. trailing jaali within the Indian design, it's noted that Harappan design had no window openings. Ajanta Chaitya openings were carved in stone and were just like the modern byzantine openings with lattice like framework. The earliest examples square measure at the Ladh Khan Temple, a building that had a long-lasting influence on the long run Hindu Temple design. The stone slabs on the facade exhibit heavily worn composition of straightforward sq. perforations and relief sculptures, lighting up the tiny dim interiors.



Figure 1 Ladh Khan Temple



Figure 2 Hoysaleswara Temple

Hoysaleswara Temple, Halebid, built in 1120, are the next outstanding example of the jaalis between the columns standing over a continuing of friezes. The jaali is a lot of outstanding than in previous examples and is shaded with broad overhang.

With the arrival of Mughals, design remodeled greatly. In Kashmir, native artisans, specialists in picket temple design carving, over generations began innovating new ornamental components. a significant contribution by the imperials was of the fretwork known as Pinjara, that was adopted by Himachali artisans of Rampur Bushahr.

Woodwork craft in geographical area was influenced by the Hindustani vogue. Small human figures, foliage and animal figures were inscribed with delicate Pinjara work. Hindu craftsmen, the Pahari's inscribed, whereas Muslim craftsmen from Chiniot inscribed fine jali add Rajput vogue.

2.1 Muhammad Ghaus Tomb, Gwalior

The mausoleum of a Sufi saint Muhammad Ghaus Tomb in Gwalior (Madhya Pradesh in India) is a great example of perforated lattice jaali work which is commissioned by the great Mughal emperor Akbar. Its construction completed in 1565, the starting of Mughal Architecture explosion. It is a traditional Mughal Architectural monument which has the domes and very delicate lattice work on the walls.

It is also a best example of Mughal Architecture of 16th century. This tomb is formed from red sandstone. Tomb of Muhammad Ghaus was built for the Saikh Sufi Saint Muhammad Ghaus who was the teacher of Humayun. Humayun was the father of great emperor Akbar and a Tansen tomb is placed behind the tomb for the great musician from Akbar's court and Muhammad Ghaus was also his teacher. This study examines that tomb built in the form of hexagonal towers. The corners of this tomb surmounted by the domes. The entire body of the structure is enclosed and perforated on all sides by the carved stone lattice work that is elaborate and delicate style. This tomb is whole crowned by a large dome.

The Mughals have mostly used geometric jaalis with curved and straight lines both and they have also used arabesque designs and floral designs for carved on the stone walls. In Muhammad Ghaus tomb geometric pattern is mostly used to adorn the facades of tomb and give the proper light effect in the building and the geometric patterns like hexagon, and inclined and straight lines are joined in the form of a delicate pattern. The geometric patterns have taken from the Ammann Beenger tilling a non-periodic tilling. Due to these jaali works the cooling can feel in the tomb and there is always a difference of 5degree between the of outer and inner temperature. The temperature of inside the tomb is always 5degree less than the temperature of outside the tomb.



Figure 3 Jaali at Tomb of Muhammad Ghaus

Geometric Patterns

The key to understand the symbol of jaali screen is the hexagon pattern which is mostly used as geometric pattern in jaali screens. In Islamic architecture symbolism the figure

hexagon represents the heaven.

The concept heaven related to the world of nature and the world of faith. The six sides of the hexagon have depicted the meaning itself. In the Isma'ili sates that God has sent six Major Prophets to guide, Noah, Abraham, Moses, Jesus, and Muhammad.

These six words reflect the six sides of human body i.e., front, back, right, left, above, beneath. Adam came from above, Noah came them from left, Abraham came them from the back, Moses came them from beneath, Adam – opposite, Jesus came them from right, opposite to Noah, Muhammad depict the peace and upon and came them from front, opposite to Abraham. The center part of the hexagon, the inner atrium represents the Lord of Resurrection through whom humanity can have a spiritual meaning. There are more examples of geometric pattern like Akbar's Tomb (Delhi, India), Taj Mahal (Agra, India), Hawa Mahal (a Rajputana's structure, also a great example of indoislamic architecture, Gujarat India).

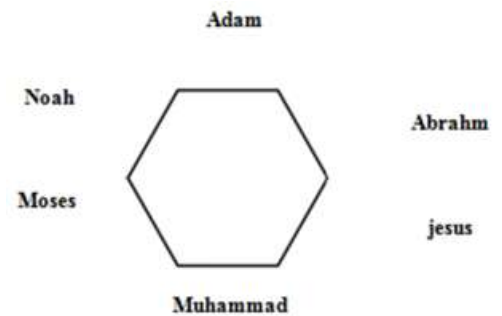


Figure 4 Hexagonal Concept

2.2 Sidi Saiyyed Mosque, Ahmedabad

Built in 1573, the last year of the Gujarat Sultanate before the Mughals invaded, the mosque is one of the finest specimens of the prodigious architectural accomplishments of the Sidis in India. The ornamental framework adorns the 10 nearly curved windows of the mosque, with some displaying complex geometrical designs and others carved in the manner of intertwined trees and foliage. The most impressive of them all is the Sidi Saiyyed Jali, located at the right of the central walled arch. Sixteen feet in size, the carvings on this jali represent the Tree of Life motif, which is an inventive illustration of a tree believed to grow in paradise in keeping with Islamic mythology.

The two minarets of the Sidi Saiyyed mosque are not higher than the prayer hall – a common feature in Ahmedabad, where most of the minarets were brought down by the 19th century earthquakes. However, the case of the Sidi Saiyyed prayer hall is totally different – written sources report that it never had tall minarets: it looks that the minarets were never completed, which might be explained by the conquest of Ahmedabad by the Mughal Emperor, Akbar, in 1573-74.



Figure 5 The Arches



Figure 6 Tree of Life

The east facade is flanked by two spectacular tower bases and presents five large openings, produced by pillars supporting arches. For this reason, and since the east facade doesn't have a wall, the monument classified as an "open facade type". This sort of prayer hall, the facade seen from the courtyard presents a pair of minarets built on either side.

All the windows are filled with jaalis carved intricately in stone. However, the central window has been left devoid of any jali, which leads us to assume that the structure may have been left incomplete due to the Mughal invasion of Gujarat. The twin jaalis positioned on its side have been carved from a single stone in the design of a tree with palm leaves and curved tendrils, and, thus, it is often referred to as the 'Tree of Life'.

The entrance to the mosque is from the front. The front door opens to a courtyard, that consists of a wazoo khana (a small pond for ablutions) on the left, a couple of graves by the edges and straight past it, two steps result in the main prayer hall. The prayer hall is characterized by high bowed arches supporting a flat roof on top. The jaalis on either side of the central aisle seem on the qibla wall (the wall facing Mecca) and are single-stone slabs carved in floral styles of tangled trees and foliage and a palm motif. The plants shown within the intricate carvings of the jaalis are date palms. There's significance in selecting date palms for the stone traceries

within the mosque window. Date palm was Prophet Mohammed's favorite food, and he broke his fast with it. Even today, it's the primary food devoured by the Muslims once breaking the fast-during Ramadan. Jaalis in floral and geometric styles are a necessary part of the architectural language followed by the Sultanate dynasty. The jaalis in the saint's tomb at Sarkhej Roza also supports this proclivity. Simply behind the precinct of the mosque is a garden that has been developed by the Ahmedabad Municipal Corporation and has a wire-meshed fence.

2.3 Humayun's Tomb, Delhi

Akbar's son Humayun built this tomb in 1570. He has set the trend of garden tombs among Mughal royalty that culminated with Taj Mahal. The total area is 27 hectares. It is a notable example of Charbagh. Four-quadrant garden with four rivers of paradise represented. When its restoration began, the structure was in fine condition.

The design of the tomb is recognized by Sayyid Muhammad and his father, Mirak Sayyid Ghiyath (Mirak Mirza Ghiyas), Persian architects and poets lively within the Timurid and later the Mughal courts. The tomb is located in south of the Purana Qila, on the eastern side of Delhi. It is right middle of a garden in the classical Mughal char bagh pattern. A high wall surrounds the garden on three sides, the fourth aspect being finite by what was once the bank of the river Jamna, that has since been diverted. The garden is divided in four parts by two dividing water channels with paved walkways (khiyabans), which terminate at two gates: a main one in the southern wall, and a smaller one in the western wall.

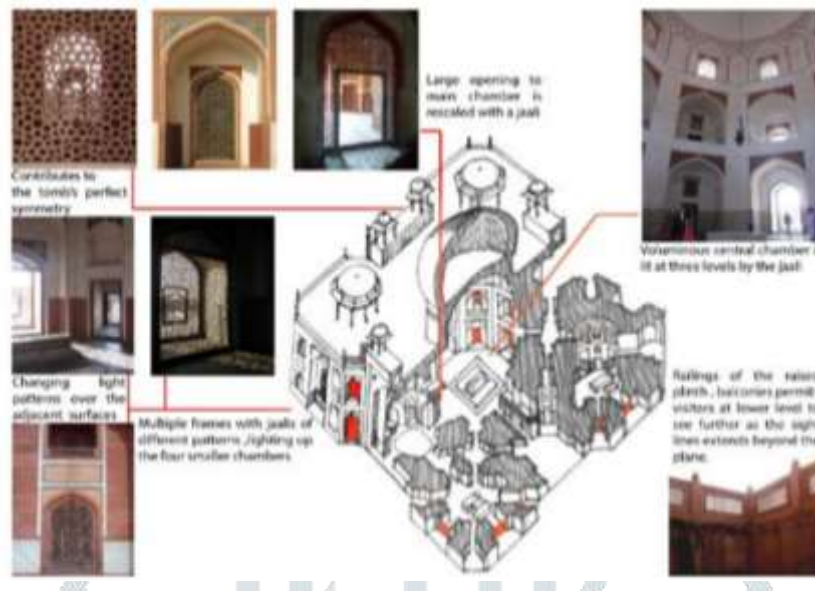


Figure 7 Parts of Humayun's Tomb

Humayun's tomb, where a magical quality was given to the space, absorbing the visitor, where one can 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.

III. ATTRIBUTES

Jaalis are being used on the cause ways, as railings, and edges of the chhajjas, jharokhas and garkhs (a Mughal word which is used for the balconies). Jaali was gorgeously used for the openings, windows and doors for the ventilation and the effect of light. These jaalis permits free air, and temper daylight. It is also a excellent ventilator in rooms. These jaalis work essentially used in architectural accessory, the Mughals made it as artwork. Lattice jali works has include completely different patterns geometrical or floral styles and these patterns have unity, symmetry that reflects the aesthetics of structure.

3.1 Aesthetic Aspect

The jaali can metaphorically be equated to a shady tree branch, sheltering the person bellow from the sun, making exquisite patterns of light on the set up a poetry of nature. A jaali being fastened is image windows, framing scenery inside. They'll offer higher aesthetics alongside maintaining view and climatic comfort, higher than glass.

3.1.1 Patterns

Islamic jaalis exhibit repetition of hexagon together with different shapes. Hexagon represents the heaven, with half-dozen sides expressing 6 days of creation as per the quran 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 shariah, 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 religious meaning of all the previous prophetic revelations and faiths. The hexagonal shape is a mark of protection belief and faith of the followers. 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.

3.1.2 Repetition

Most geometric jaali patterns are created from repetition of a module. However, complicated pattern might seem to be, they'll be known to be created on a grid. The modules are made of triangles, squares, or hexagons. The continuity makes the eyes yield the composition.

3.1.3 Infinity

Due to replication of a module over and over, they seem to continue on the far side the physical boundary of the frame. It's tough to spot the beginning, also the finish patterns. This intentional repetition is symbolic of infinite nature of God. It's therefore as a result of Muslims believe that human cannot imagine a stable palace for God.

3.1.4 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.

3.1.5 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 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.

3.1.6 Visibility

It screens the inhabitants from the gazes of the passer-by, providing privacy because of the sunshine distinction. At the equivalent time, a visible continuity at the bottom level and clerestory is maintained between the interiors and exteriors.

3.2 Cultural Aspect

The wind issue, the jali cuts out the direct glare of the sun and sunshine. Whereas from among the jali one can see the happenings outside, those standing on the surface don't get a transparent view within. This enables the jali to be an ideal privacy provider, at identical time not setting apart those among the world outside.

The jali therefore, acted as the perfect screen for the ladies of each the Mughal and Rajasthani's royals. The designs flourished the foremost throughout the 16th to 18th century in northern India have become a source for the women to access and see the outside life without prying eyes offensive their privacy. The lattice screens were used as window screens or dividers among rooms for queens, princess and different ladies of the home. The jali was therefore a purdah, as seen in the Hawa Mahal.

However, the jali has been a famous device until date in various interior and exterior designs. Whether it be on balconies, platforms, terraces, or even as decorative screens, the jali has continuing to search out its approach in our homes and interiors quite seamlessly. Even these days jaalis are used as partitions, for separating areas or units, as wall panels, on ceilings, on furnishings and as decorative accessories.

IV. IMPACT OF CLIMATE

The small holes increase the speed of air because it passes through them, just like the perform of a funnel, enhancing even the gentle breeze outside and permits for deeper penetration. The air additionally cools down whereas moving through the little apertures that 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 result. In desert areas, the mesh like structure filters out the dust accompanying strong winds in the region. 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 like 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 daytime when the environment is hotter. 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 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 sunshine and air. Adding to the colorful painted wall and roof surfaces within the interior. Some have stained glass fitted to the apertures as seen at Junagarh Fort, Bikaner. Some jaalis have shutters which will be shut during the winters to cut back the inflow of cold air. As jaalis control the light entering in, reflecting some light back from the outer surface, they also reduce the warmth related to it. Unwanted glare is reduced with controlled illumination. The rounded balusters soften the contrast between the darkness of the opaque balusters and glare entering in. The sticking out balusters produces a silhouette that carries the eyes vertically and horizontally across the interstices.



Figure 8 Fenestrations at Bikaner

V. ADAPTIVE STRATEGIES

Even though most of the examples have predominantly fastened jaali from history, there square measure sure accommodative options to be noted in every case. The accommodative options involve gap the screen more or less, reckoning on the necessity of ventilation and shading. The wet conditions have additional accommodative options, as they need the screens to be as operable as doable for optimum ventilation. The ones found in dry conditions have terribly tiny windows that are simply the dimension of the face in some cases. Operable windows are present however terribly tiny in size, as access wind isn't welcome within. The screens found in Philippines may be utterly moved aside or utterly closed as they expertise cyclonic winds on one. Givoni 19 noticed that cross ventilation won't continuously bring comfort in hot climates unless the comfort is achieved within the out of doors temperature. This is the often the condition is applicable once there are regular glazed windows, that either brings in wind or altogether shuts it off, within the sweet condition can style areas with correct amount of jaali bring in a temperature distinction until 4.5C at a specific time of the day. The positive and negative pressure created by the areas and well-designed jaali ventilates the space sensibly without making it utterly exposed to outside.

VI. RESULTS AND DISCUSSION

It can be concluded that Jaalis have survived and evolved over centuries because it is a great combination of form and function. In the world of technology and inventions, we found the comfort in the technology electronic objects like air conditioner, we forget about the use of our traditional architecture. Our traditional architectural buildings have such an excellent natural cooling technique in which the jaali is one of the most common used as a cooling effect in the historical buildings.

Play of positive and negative area of sunshine and shadow, lends an enticing softness to associate otherwise solid surface material development. To grasp the jaalis aesthetic, we should look at Islamic style. Given the non-secular philosophy's non-figural mandate, craftsmen john drew on principles of art, history and arithmetic to evolve what we tend to currently recognize as Islamic geometric style. In essence, a pattern is made on tessellation — a straightforward patterned advance — of one kind. The repetition is claimed to be representative of the infinite nature of the divine. Geometry was typically not to mention hand and botanic forms.

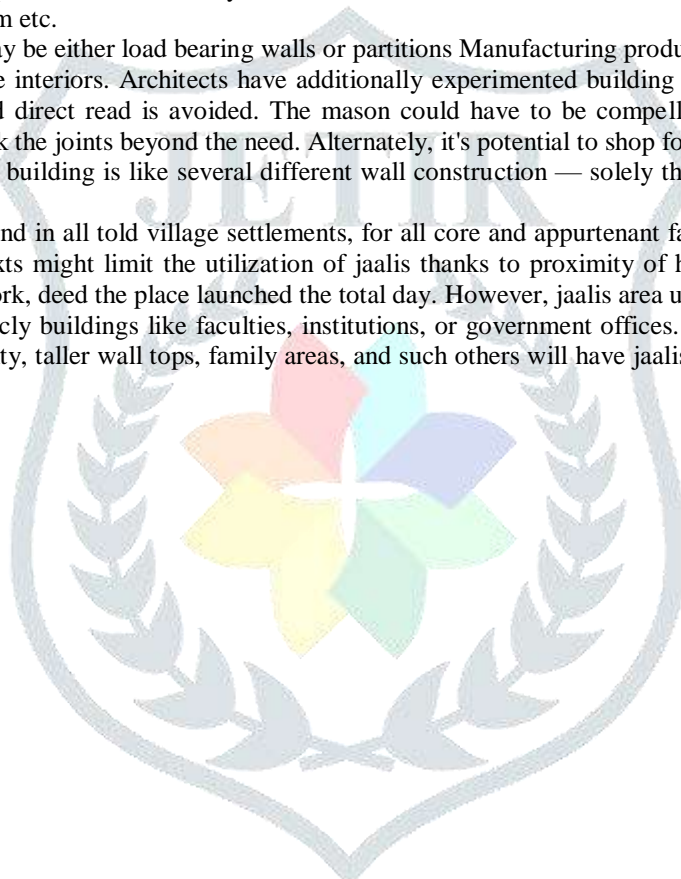
One can also totally include jaali designs in your home interiors.

- It segregates space but does not eat up space.
- A jaali does not block air or light.
- It is s a statement and affordable too.
- They fit into any kind of setup.

Jaali screens show as a decorative ornamental of the building, however this delicate works offers the passive cooling within the building because of the fine carve patterns on the jaali screens. It's not solely associate aesthetic design, it provides us thermal comfort, security, privacy, cooling effects in an exceedingly building. It might be used more and more within the present era of architecture to secure the atmosphere. There are many materials are based within which the lattice carving possible like bricks, mixture of alloy, steels, aluminum etc.

Though perforated, jaalis may be either load bearing walls or partitions Manufacturing producing the inclined jaali blocks that provides complete privacy to the interiors. Architects have additionally experimented building the wall block itself in an angle, specified no rain penetrates, and direct read is avoided. The mason could have to be compelled to take additional care not to unnecessarily spill mortar or pack the joints beyond the need. Alternately, it's potential to shop for the jaali block created with clay or cement. later, the task of jaali building is like several different wall construction — solely the regular brick is replaced by the jaali block.

Jaali walls area unit still found in all told village settlements, for all core and appurtenant facilities like house, college or the assembly shed. The town contexts might limit the utilization of jaalis thanks to proximity of homes or apprehension regarding security once all the residents work, deed the place launched the total day. However, jaalis area unti however an eminent risk even during a town, particularly publicly buildings like faculties, institutions, or government offices. Also, residential walls enclosing appurtenant areas like wash, utility, taller wall tops, family areas, and such others will have jaalis, beautifully contrasting with the remainder of solid walls.



Figures and Tables

Figure Table

Figure No.	Content
1	Ladh Khan Temple
2	Hoysaleshwara Temple
3	Jaali at Tomb of Muhammad Ghaus
4	Hexagonal Concept
5	The Arches
6	Tree of Life
7	Parts of Humayun's Tomb
8	Fenestrations at Bikaner

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