

Sacred Geometry and Climate Responsiveness: Sustainable Techniques in Ancient Indian Temple Design

Rohan Koner*

Abstract

This study explores the intricate relationship between climate-responsive design and sacred geometry in the construction of ancient Indian temples, emphasizing its continued significance for modern sustainable building techniques. Based on the ideas of Vaastu Shastra and Shilpa Shastra, these temples use careful geometric design, including yantras, fractal patterns, and mandalas, to maximize spatial utility and conform to cosmic order. Renowned temples, like Kailasa, Konark Sun Temple, and Brihadisvara, are prime examples of how natural adaptations and metaphysical symbolism can co-exist. The architectural plan integrates passive climate-responsive strategies such as raised mandapas and courtyards for natural ventilation, temple tanks and drainage networks for water management, thermally insulating materials, and strategic sun orientation. Locally produced materials that minimize embodied energy and provide climate adaptation, such as granite, laterite, and timber, further improve sustainability. The microclimates created by these tactics work together to control humidity, preserve thermal comfort, and increase resistance to weather extremes. This report highlights how ancient Indian temples served as both communal and spiritual havens, exhibiting an ecological wisdom that is becoming increasingly important in tackling today's environmental issues. It does this by conducting a thorough review of literature and presenting case studies. It illustrates how combining sacred geometry with practical environmental design produces long-lasting, sustainable architectural environments in addition to improving aesthetic and spiritual experiences. Modern planners and architects can create durable, energy-efficient buildings that align with ecological demands and cultural values by revisiting and modifying these tried-and-true ideas. The significance of the ancient Indian architectural legacy as a wealth of resources for developing modern sustainable design globally is affirmed by the research.

Keywords: Climate-responsive architecture, sacred geometry, sustainable temple design, traditional Indian architecture, Vaastu Shastra

INTRODUCTION

Indian architecture rests on the core foundation of ancient Indian architecture. The Golden Age of Indian architecture can truly be seen through the walls of ancient Indian temples. The Brihadisvara

*Author for Correspondence

Rohan Koner
E-mail: mail.me.rohan98@gmail.com

Sustainability Consultant, Department of Environmental Sustainability, Oxford Brookes University, Kolkata, West Bengal, India

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Temple, the Sun Temple (Konark), Khajuraho Temple, and the Kailasa Temple (Ellora) stand today to tell the tale. The foundation of this architectural tradition is sacred geometry, an age-old field with deep roots in Vaastu Shastra and Shilpa Shastra which dictated geometric symmetry, proportions of building elements, and most importantly the cosmic alignments with the temple design [1].

Temple complexes are carefully designed with fractal designs, such as concentric squares and circles, as well as mandalas to represent global

order and give a spiritual resonance to physical locations. In addition to reflecting cosmic principles, the design of the Sun Temple in Konark actively integrates elements like solar alignment and timekeeping using specific architectural elements like sundials [2, 3].

In addition to spiritual value and sacred geometry, Indian temples also serve as examples of sustainable environmental practices. To accommodate various zones, ancient builders used architectural elements like open courtyards, thick insulated walls, elevated plinths, and well-placed ventilation systems. Some temple structures in the state of Tamil Nadu possess thermal comfort and effective waste management. These temples are prime examples of the utilization of locally sourced materials, such as stone and timber, which reduces environmental impact. Use of large ponds and advanced drainage systems can also be seen in these temples, which demonstrate techniques for temperature control and rainwater collection.

Overall, the fusion of climate-responsive design and sacred geometry in ancient Indian temple architecture provides a rich model for modern sustainable environmental practices. These architectural wonders inspire both devotion and responsible innovation in connection with nature by understanding the physical as a reflection of the cosmic while balancing spiritual goals with ecological considerations.

SACRED GEOMETRY IN INDIAN TEMPLE ARCHITECTURE

In traditional Indian temple architecture, spatial arrangements are significantly influenced by sacred geometry. These prime examples can be found in temple structures and religious documents.

Philosophical and Mathematical Foundations

Vaastu Shastra

Vaastu Shastra describes a geometric depiction that usually takes the form of a square grid and represents cosmic order and metaphysical principles. Each segment of the mandala is linked to a separate deity or energy. The modules are typically 64-grid (8x8) or 81-grid (9x9) systems. Cardinal directions are carefully reflected in the floor arrangement of the temple.

The idea that “as in the universe, so in the body” reflects the unity of the microcosm and macrocosm; the central point (Brahmasthan) represents the seat of the divine, with Lord Brahma ruling. With spatial layouts directing movement, hierarchy, and ceremonial activity, Indian temples are designed to channel cosmic energies through this grid [4, 5].

Shilpa Shastra

Shilpa Shastra elaborates upon cosmological arrangements, describing the proportions, symmetry, and ratios of all temple components and iconography. Forms, like the vimana (tower), mandapa (pillared hall), and garbhagriha (sanctum), are examples of how geometric principles guarantee structural stability and aesthetic harmony while fostering balance, rhythm, and spiritual resonance.

Exceptional temples even experiment with non-square harmonic ratios for creative expression. Temples are characterized by fractal geometry and layered symmetry, with repeating and mirrored motifs signifying cosmic balance and order [6].

Mandalas and Yantras

Mandalas and yantras are basically diagrams that shape the spiritual space. The focal point of a temple’s design consists of mandalas, which are geometric representations of the cosmos that use triangles for spiritual elevation, squares for stability, and circles for unification (Figure 1). They align physical and spiritual dimensions, arranging everything from door orientations to room measurements. Yantras are divinely inspired symbolic designs that combine sculpture, space, and cosmic symbolism. One example of a yantra is the Surya Yantra at Konark [7].

INDIAN TEMPLE ARCHITECTURE USING CLIMATE-RESPONSIVE TECHNIQUES

Several passive climate-responsive techniques were used in Indian temples, which were constructed centuries before the contemporary idea of “green” building, to make them sustainable and livable for residents. These tactics have roots in spiritual philosophy as well as environmental adaptability.

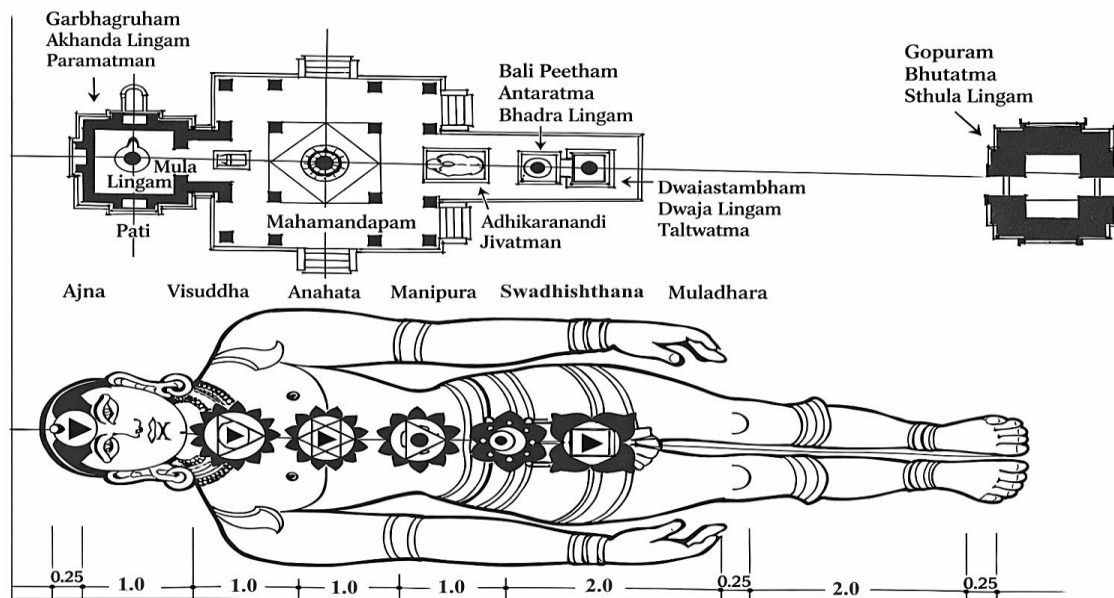


Figure 1. The expressions Mandala, Chakra, and Yantra (Sreenivasa Rao, 2012).

Key Passive Design Features

Natural Ventilation

Airflow is improved by large courtyards and perambulatory walkways; maximum cross-ventilation is made possible by clerestory windows and raised mandapas (pillared halls), which sustain airflow even in enclosed areas.

Thermal Comfort

Round sanctums and small forms are used to reduce exposure to outside heat. Double walls reduce heat gain by serving as insulating barriers. Warm, humid interiors are kept comfortable using insulating materials, like stone, laterite, and clay, which regulate heat, particularly in areas like Kerala.

Solar Orientation

Temples are positioned to minimize direct solar gain during hot months and maximize daylight for ritual scheduling like sunrise or sunset. Both ceremonial and climatic comfort are served by this orientation.

Water Conservation

Rainwater is collected and stored via temple tanks, step wells, and integrated drainage systems, which guarantee water supply for community requirements and ceremonies, particularly during dry spells.

Landscaping

Many temples are situated in gardens or groves, which provide natural shade and the cooling impact of evapotranspiration. This type of landscape design aids in the regulation of the microclimate.

Material Sustainability

To ensure that the temple matched its surroundings, the builders gave top priority to using locally sourced materials such as stone, wood, clay tiles, and laterite. Using locally sourced materials reduced embodied energy and ecological disturbance while improving the building’s durability, insulation, and adaptability to changing local climates.

Sacred Geometry and Climate Responsiveness

Energy-Efficient Microclimates

Geometric patterns encourage passive cooling and the best possible distribution of natural light, and temples are frequently designed using sacred geometry, which affects spatial formations that can resist heat and humidity.

Resilience and Longevity

One example of advanced geometric and structural engineering is the earthquake-resistant foundations of the Kanchi Kailasanathar Temple. The lifespan and safety of the structure are guaranteed by these design features.

LITERATURE REVIEWS AND CASE STUDY

Utilizing both contemporary ecological consciousness and traditional traditions, like Vaastu Shastra, recent scholarly works explore how Indian temples incorporate climate-responsive and sustainable architectural concepts.

Key Papers and Their Contributions

Climate Responsive Design Principles in Dravidian Temples Pongomathi S (2021) [8]

- *Focus:* Nellaiappar Temple analysis.
- *Findings:*
 - *Orientation:* Temples are positioned to maximize thermal comfort by regulating sunshine exposure.
 - *Spatial Organization:* Perambulatory corridors, segmented layouts, and expansive courtyards promote natural ventilation.
 - Cross-breezes are permitted in ventilated corridors, which control temperature and humidity.
 - *Sustainable Planning:* The use of substantial stone walls and thoughtful site design guarantees resistance to weather variations and fosters long-term comfort.

Analyzing the Applicability of Vaastu Shastra Under Various Climatic Regions of India

(Dr. Nandini Kulkarni, Dr. Purva Mange, 2022) [9]

- *Focus:* How Vaastu Shastra principles adapt buildings to diverse Indian climates.
- *Findings:*
 - *Layout and Orientation:* To maximize natural ventilation and sunshine, sanctums, entrances, and structures should be oriented cardinally.
 - *Climate:* Adaptability in design guarantees that structures accommodate hot, dry, or humid conditions for increased comfort.
 - *Sustainability:* Layout decisions optimize the use of locally available renewable resources and minimize the need for artificial heating and cooling.

Integrating Vaastu Shastra with Sustainable Building Practices

(C. Yathin and Dr. Nischay N. Gowda, 2024) [10]

- *Focus:* Sacred geometry and green buildings in harmony.
- *Findings:*
 - *Ventilation:* Vaastu-based door, window, and corridor placement improves airflow.
 - *Lighting:* Sacred geometry directs the arrangement of spaces, maximizing natural light and reducing glare.
 - *Material Selection:* Encourages use of locally accessible, low-embodied-energy materials to promote ecological harmony.

Case Studies

Brihadisvara Temple (Thanjavur)

- *Orientation:* Oriented eastward, allowing the sanctum to be illuminated by morning sunshine.
- *Passive Design:*

- o Airflow is facilitated by the tall vimana (tower) with vented apertures.
- o Strong granite walls provide protection from intense heat.
- o Surface heat transfer is decreased on elevated platforms.
- *Material Use:* Granite supplied locally guarantees durability and thermal stability.
- *Landscape:* Rainwater harvesting is supported and cooler microclimates are maintained by surrounding gardens and water features (Figure 2).



Figure 2. Brihadisvara Temple – Hindu Temple in Thanjavur.

Konark Sun Temple (Odisha)

- *Orientation:* Symbolically and for daylighting purposes, it is made to depict the rising sun.
- *Passive Cooling:*
 - o Shade and airflow pathways are produced by sculpted exteriors and perambulating hallways.
 - o The open design and location of the temple capture breezes from the Bay of Bengal.
- *Material Use:* Khondalite and laterite stone offer strong insulation.
- *Sacred Geometry:* The layout of the chariot maximizes air and sunlight flow while reflecting cosmic principles (Figure 3).



Figure 3. Konark Sun-Temple in Odisha.

INSIGHTS FOR CONTEMPORARY SUSTAINABLE PRACTICE

The combination of ecological and philosophical knowledge in temples offers practical solutions to modern environmental problems:

- Use site design based on geometry to achieve the best possible ventilation, daylighting, and temperature control.
- Utilize regionally appropriate, low-carbon building materials and construction methods derived from historical precedent.
- Resurrect traditional water management systems, such as step wells, temple tanks, and permeable courtyards, as models for rainwater collecting, aquifer recharge, and urban cooling.
- Public areas should be designed as havens that promote both physical health and social concord, in keeping with the dual function of temples.

CONCLUSION

The use of climate-responsive design in ancient Indian temples demonstrates a deep fusion of environmental pragmatism and metaphysical philosophy. Sacred geometry was not a standalone aesthetic; rather, it arranged areas to be naturally ventilated, thermally comfortable, and lighted while balancing with broader ecological cycles. Because rituals and surroundings were intertwined, spiritual experience and physical health went hand in hand. As a result, temples provided both community and spiritual refuges, with sturdy constructions resistant to weather extremes, cool interiors shielded from hot summers, and water available during dry spells. Ancient Indian temple architecture is a prime example of how climate responsiveness and sacred geometry may coexist to create sustainable constructed spaces that meet ecological and spiritual demands. During a period of increased environmental concern, these ideas – which are embodied in famous temples and recorded in canonical texts – guide modern sustainable conduct. Today's robust, energy-efficient design can benefit from revisiting and modifying these principles.

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