Analysis Of Fractal Geometry In Dravidian Temples

Abstract

Architectural composition is a progression from large spaces to intimate details. Fractal geometry is the formal study of such progression of self-similar detail and serves as a framework to broaden the perspective and understanding of art and architecture. The case in study for this research is Indian Dravidian temples. Dravidian-style temples originated in the Pallava Dynasty who ruled present-day Tamil Nadu. In Dravidian temple architecture, the existence of self-similarity has been observed and fractal geometry is seen to play an important part in understanding the structure and composition of these temples. Fractal analysis of these temples will help understand the deep relation between geometry and temple architecture.

This research paper aims to study Dravidian temples and the significance of fractals in the field of architecture. It also correlates and analyzes the Dravidian temple architecture through fractal geometry with respect to the fractal sets it is composed of. It aims to understand the benefits of using fractals and draw inferences based on the comparative analysis. In conclusion, the paper also suggests some design implementations of fractal geometry in present-day life which incorporate the environmental and aesthetical aspects in the design.

Keywords: Fractal geometry, Dravidian temples, Fractal design, Design principles, Fractal analysis, Design architecture

1.0 Introduction

1.1origin

The presence of fractal principles in nature, art and architecture has been a phenomenon in all times and it is not restricted to the period after the mathematical understanding and analysis of fractals.

The term ‘fractal’ was created by Benoit Mandelbrot in 1975 to describe the geometry of fragmented forms of nature that were perceived as amorphous such as clouds, trees, etc and were not easily represented in Euclidean geometry. He coined the term fractal set to collect together examples of mathematical ideas and apply it to natural phenomena like clouds, coastlines, branching of blood vessels, etc.

The origin of the word is from the Latin term ‘fractus’ which means broken or fractured. Fractals are self-similar patterns composed of the same sets in different scales. Fragmentation of these sets tends to recur identically at different scales.

Fractals can be found everywhere from natural rough lines to clouds, plants, art forms and also in architecture. There are many types of fractals like natural fractals, abstract fractals and geometric fractals based on their formation and shapes (as shown in figures a).

Fractal geometry has been applied in architecture widely in ancient times. Fractal principles are

also observed in the traditional arts and crafts, in the ancient civilizations, gothic structures and temple architecture of India.

1.2 History

Construction of temple architecture started in Southern India in the early 2nd A.D. century during the Pallava rule. The architecture of these temples was inspired from Buddhist architecture. This type of temple architecture was named the Dravidian architecture and originally took root in Tamil Nadu. The state was subject to rule of four great dynasties: Cholas, Cheras, Pandyas and Pallavas and all these dynasties greatly influenced the temple architecture of the state. These evolved from simple rock-cut temples to complex townships and temple cities.

The Pallava dynasty was an Indian dynasty that existed from 275 CE to 897 CE, ruling a portion of southern India. The first stone and mortar Dravidian temples were constructed during this period and were based on the brick and timber prototypes. Some of the best examples of architecture are: Kailasanathar Temple, The Shore Temple and the PanchaRathas of Mammalapuram present day Mahabalipuram.

The Pandya Dynasty, also known as the Pandyas of Madurai, was a dynasty of south India. They contributed immensely in the field of architecture. Gopuras, Prakaras, Vimanas, Garbagrahas (as shown in figure) are the special features of the Pandya temple architecture. Some examples of Pandyan architecture: Madurai Temple, Srirangam.

The Cholas were another dynasty of South India. They were prolific temple builders. They built the largest and tallest of all the Indian temples of their time. They promoted the construction of a large number of temples that were spread over most of Chola Empire. Brihadisvara temple located in Thanjavur is one of the greatest architectural marvels in this era.

Analysis of Dravidian temples elaborates on the uses of fractals in the following ways:

- Repetition of shapes in the planning of temples.
- Repetition of geometrical towers
- Mirror images of similar geometrical towers at various levels and different scales.

Repeating these distinct elements in different scales gives a sense of infinity and an illusion of an object as a whole. Fractals give a sense of universal appeal and a virtually satisfying sense of scale. This research aims at studying fractals and Dravidian temples individually and analyzing the relation between them and understanding the advantages of fractals and using the principles of fractals in present-day scenarios to increase high-performing structures which incorporate psychological environmental as well as aesthetical aspects in the design of a structure.

2.0 Methodology

This research paper aims to understand about the concept about fractals and their usage in architecture. Also aims in using quantitative and qualitative methods to analyze the fractal geometry in Dravidian temples. Fractal analysis of Dravidian temples helps in finding out the

techniques and methods which were used for implementing fractals in these temples. And also understanding the benefits of fractals and how it can be implemented in present-day structures to gain the utmost advantages of the fractals.

3.0 Relation between Dravidian Temples and Fractal Geometry

Ancient Indian architects were very skillful in geometry and they used this knowledge to derive many conclusions. It was realized that the concept of progression could be applied in real life and the outcome of this progression was aesthetically beautiful structures. This progression later came to be known as fractal geometry. Fractals when used in architecture acts as mode of expression to reveal the beauty in complexity. Early Indian architects followed these principles in their temples and the results can be seen in the case studies discussed below.

3.1 Case studies:

3.1.1. Pallava dynasty:

Pallava architecture represented an early stage of Dravidian architecture. The first stone and mortar temples were constructed during this period and based on brick and timber prototypes. The Pallava architecture shows the transition from rock-cut temples to stone-built temples. The monolithic temples gave way to structural temples like the Shore temple in Mamallapuram. Shore Temple is a granite-made temple at Mahabalipuram built during this period. This group of temples is a UNESCO World Heritage Site and is one of oldest structural temple in India. [image: image2.jpg]

3.1.2. Pandya dynasty:

The period of the Pandya rulers saw the development of elegant Vimanas, Gopurams and Shikharas in the temples. Pallavas used bricks as the main material for their construction of temples.

Meenakshi Amman Temple, also known as Minakshi-Sundareshwara Temple, is one of the oldest and most important temples in India. Located in the city of Madurai, the temple has a great mythological and historical significance.

3.1.3. Chola dynasty:

The Chola kings built many temples throughout their kingdoms. These Chola temples reveal the gradual evolution of the Chola art and architecture. The earlier built brick temples and later moved on to build stone temples.

The greatest landmark in the history of South Indian architecture is the Brihadeshwara temple at Tanjore. It has a great architectural significance. This is the largest and tallest temple in Tamil Nadu. [image: image4.jpg]

3.2 Analysis:

The geometry of the plan starts with a line forming an angle and then evolving into a triangle.

Then triangles then combine to a form a square and distinctly into a circle thus deriving the complex forms (as shown in figure e). This results in self-similarity and further leads to the occurrence of fractal geometry. The fractal geometry gives a feeling of spaciousness because it helps optimize space without increasing the dimensions.

Considering the visual language of the elevation of the temple, the gradual progression starting from the base to the top of the temple is seen prominently. The elements have been repeated in different scales forming a pyramid-like structure (as shown in figure m). The elevations of these temples give off a character of harmony and rhythm leading to the aesthetical beauty which is due to the proportional relationship of the geometry of the elements and forms.

Fractal geometry was so vastly used in the temples as they brought a sense of completeness to the structure. It generates an identity of elements and forms and brings strength structurally and visually. It brings modularity in the structure which saves time and resources and offers ease of construction. The geometries used help create aesthetically enthralling elevations and build timeless structures.

4.0 Implementations of Fractal Geometry

Fractal geometry is a design process that can be used in different ways to build aesthetically beautiful structures which give a sense of completeness and adopts most of the design principles like harmony, rhythm, balance and shows movement in these structures (as shown in figure f,g).

- Progressive Multiplication: The elements or forms are multiplied in progression in either in the vertical direction or the horizontal direction.
- Expanding Repetition: Using the same element, shape or form and repeating it in different scales.
- Projection: Projecting out the elements or forms from the surface of the structure typically above ground level.
- Staggering: The elements and forms are staggered; usually this helps in showing movement.
- Splitting: Splitting up of elements and forms into smaller components and repeating them.
- Bursting of boundaries: The elements are projecting out of the outer boundaries of the structure.
- Gyration: Rotating the forms and elements in different directions and repeating them.

These are some ways in which fractal geometry can be implemented in structures. One important aspect of fractal geometry is the use of hierarchical scales, without the use of scales it will create a disconnection from the environment. Balance and harmony can be achieved through the proper composition of the elements. There are certain rules of proportion and geometry that help the structures look as one with the environment. The basic concept of fractal geometry is to create complex structures using simple forms and shapes.

5.0 Examples:

A) Palmer House, F L Wright

Palmer House is designed by Architect F L Wright. In fractal architecture, usually, one module is considered as the main element. In this house, an equilateral triangle is considered as the main conceptual building block and the whole planning and elevations are based on this block.

In the planning of the house, the equilateral triangle is repeated in the floor plan in at least 7 different scales. Progressive multiplication and staggering of triangles can be seen in the planning.

The elevations and the roofs of the house have an interesting use of triangular forms. The triangular building block is rotated, expanded and projected out.

Palmer House is a very great example of using fractals in architecture. The house is very aesthetically beautiful and very unique due the use of triangular blocks and fractals (as shown in figure h).

B) Habitat 67, Moshe Safdie

Habitat 67 is designed by Architect Moshe Safdie. In this residential complex, the building block is a simple square block where two building blocks are combined to build L-shaped blocks. The L-shaped building blocks are a module and then the modules are placed one above the other. The modules are rotated and progressively multiplied to give the whole residential complex a unique balanced composition and in sync with the environment. This can be seen in the elevations and as well as in the plans of the complex (as shown in figure i). The modules when used here give ease of construction and saving of the resources.

The above studies show that fractal geometry can be implemented in the present-day structures too using the fractal techniques and principles.

6.0 Conclusion

Fractals have always been present in the nature and the surroundings. Fractal geometry when used in architecture can help the architects build complex structures using simple elements, shapes and forms. From ancient times, fractals were used in various architectural structures and Dravidian temples is one such example.

Various techniques of fractal geometry were used in the Dravidian temples to make the structures more appealing, have a balanced composition and be structurally strong. The use of fractals made the construction of these temples easier and also saved on a lot of resources.

Fractal geometry contributes to a progressive transformation of the building and optimization of spaces. Also using fractals helps avoid monotony and dynamic facades with visual balance can be created. Architects can build organic and complex structures which fit harmoniously in the natural environment and interact with it. This increases the efficiency of the structures built using the fractal principles.

This is seen in the modern day examples which use the fractal geometry and its modularity to build structures which are aesthetically beautiful, very efficient and high optimization of spaces. The fundamental concepts and properties of fractal geometry is very essential to architecture

design and its implementations in the structures will strengthen the building visually and structurally.

7.0 References

1. George Michell, Michael W. Meister (Editor), M. A. Dhaky: Encyclopedia Of Indian Architecture, South India pg.no300- 420
2. Arturo Ponce de Leon, Ninon Fregoso, Michael Rice (, Dan Winter: Sacred Geometry and architecture pg.no80-100
3. Bovill Carl: Fractal Geometry in Architecture and design
4. Shobita Jacob: Fractal Design pg.no 20-45
5. ALIK Belma: Fractals and Fractal Design in Architecture pg.no 2-10