

# Geometry in nature and Persian architecture

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## Abstract

Nature displays profound preference for certain specific ratios to design her life-forms. These are geometric relationships that are transcendent and originated from Sacred Geometry. The view that geometry had a ritual origin is a part of a wider view that civilisation itself had a ritual origin, and therefore the history of utilisation of Sacred Geometry by man goes back to many centuries ago. The Pythagorean tradition, and the Egyptian and Babylonian sciences from which it derived, and Persian mathematics, a part of which reflects a Pythagorean intellectuality, are based on the sacred conception of numbers and their symbolism. In the traditional world, geometry was inseparable from the other sciences of the Pythagorean *Quadrivium*, namely arithmetic (numbers), music and astronomy. Traditional geometry is related to the symbolic configurations of space. Geometric forms such as the triangle, square and various regular polygons, the spiral and the circle are seen in the traditional perspective to be, like traditional numbers, as aspects of the multiplicity of the Unity.

Architecture itself has always had a sacred meaning to all traditional civilisations through millennia, by which means man has tried to provide for himself a manifestation of heavens. Persian architecture always emphasised on Beauty, and by means of Sacred Geometry Persians measured the proportions of heaven and reflected them in the dimensions of buildings on the earth. A comprehensive utilisation of proportions in Persian architecture, such as in the design of plans, elevations, geometric and architectural patterns, and mechanical and structural features, can be proved through geometrical analysis of Persian historical buildings.

In this paper, the sacred conception of geometry and its symbolism in the Pythagorean tradition, and Sacred Geometry and proportions in natural life-forms will be explained. The use of the science of geometry in design of a number of Persian historical buildings will be presented. The geometric factors upon which the design of these buildings, from both architectural and structural viewpoints, is made will be discussed.

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## 1. Introduction

In Persian and Arabic, the term *muhandis* (engineer) is derived from *hindisah* (the common word for geometry) with the meaning of measuring and it is used for both the sciences of geometry and architecture. The Greek *γεωμετρία* (geometry), composed of *γεω*—combination form of *γη* (earth) and—*μετρία* (measuring), in etymological sense means *the art of measuring ground*.

The word *architect* is derived from the Greek *ἀρχιτέκτων*, composed of *ἀρχι*—(chief, principle, first in authority or order) and *τέκτων* (builder, craftsman); thus, the word literally means a master-builder or a skilled scholar of the art of building. As an architect skilfully builds up the reflection of Divine Beauty in Universal Order, the word architecture is close in meaning to the Greek *κόσμος* (cosmos), which means at once the world, order and beauty, and to *ἰσθησις* (aesthetics), perception by the senses especially by feeling.

The emphasis of Persian architecture was on Beauty. Persians always placed a high value on beauty through

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many centuries; and *scientia geometriae* was the powerful tool of the Persian *muhandis* by which he was able to measure the proportions of heaven and create equilibrium, harmony and beauty on the earth; to put beauty in order. Geometry was both *scientia* (science) and *ars* (art).

The ultimate object of Persian traditional architecture was the Absolute. Architecture was a symbolic language by which Archetypal Ideas could be expressed in patterns which were conceivable by human understanding. As the object of architecture was in the realm of spirit and wisdom, geometry as a tool by which Persian architects built up the shapes of planes and bodies had to be holy in itself.

If the origin of sacred geometry is to be found, it would suffice to return to the oldest known civilisations in which geometry did govern the design of sacred buildings destined to represent the imagined structure of the Universe as the domain of the Absolute, and such a geometry is holy by virtue of its power to please and attract the Divine Nature. The most obvious instance is the structure of the domed temple in its geometric form symbolising the heavenly sphere above embracing the earthly circle or square below.

The Universe, and Nature, created by the Absolute as a rational and therefore mathematical reality, the highest manifestation of Divine Wisdom, are reflected in a mystic and symbolic language by the sacred architectural buildings to express Divine Order, Harmony and Beauty. Certain geometric patterns and their related numbers, as references to cosmological concepts, play a symbolic role in this architectural creation.

## 2. The universe as geometrisation of Divine Unity

### 2.1. Geometric progression

Plato (c. 427–347 BC) has great respect to Pythagoras (582?–500? BC) and the *Musica Mundana*, the Music of the Spheres, and in his book *Timaeus* [1] describes the geometric creation of the world.

In the *Timaeus*, he presents the idea that the Creator created the visible world similar to a geometric progression. The *Platonic Solids*, five solids, make up the four elements and heaven.

On geometry he writes in his *Republic* [2], “[geometry is]...persuaded for the sake of the knowledge of what eternally exists, and not of what comes for a moment into existence, and then perishes...[it] must draw the soul towards truth and give the finishing touch to the philosophic spirit”.

Over his academy door were the words *ἀγεωμέρητος μηδεὶς εἰσέλτω* meaning, “let no one enter who is lacking in geometry”.

In the *Timaeus*, Plato describes the need for the four elements. Firstly, *fire* to make the world visible, and *earth* to make it resistant to touch. Fire belonging to heaven and earth to earth, these are the two *extreme* elements. He writes, “...it is necessary that nature should be visible and tangible ...and nothing can be visible without fire or tangible without earth...”. Secondly, they need a third as a bond to be connected together, “...but it is impossible for two things to cohere without the intervention of a third...”. Thirdly, the best bond is the geometric proportion, “...[and] the most beautiful analogy is when in three numbers, *the middle is to the last as the first to the middle*, ...they become the same as to relation to each other”. Fourthly, the primary bodies are solids, and must be represented by solid numbers (cubes). One mean is enough to connect two plane numbers (squares), but two means are required to connect two solid numbers, “but if the universe were to have no depth, one medium would suffice to bind all the natures it contains. But...the world should be a solid, and solids are never harmonised by one, but always by two mediums”. Therefore, the Creator put *water* and *air* in the middle of fire and earth, making them in the same ratio to each other; so that *fire might be to air as air is to water and that water is to earth*.

$\text{fire/air} = \text{air/water} = \text{water/earth}$ .

As the ratio between successive elements is constant, it gives a *geometric progression*.

In the *Timaeus*, Plato describes that all that exists is a Unity, “God, purposing to make the universe most nearly like the every way perfect and fairest of intelligible beings, created one visible living being, containing within itself all living beings of the same natural order”. For Plato the harmony and proportion throughout the creation, be it architecture, art or music, make the multiplicity of things as a single reality. The harmoniously interdependent relationship of parts within the visible world is itself a reflection of the same harmonious relationship within invisible world and also between the visible and invisible worlds. Harmony and proportion have close relationship with Universal Order and thus lead to the concept of Aesthetics, Beauty, and of Cosmos. The Creation is Beautiful because it *harmoniously* and *proportionally* reflects Divine Beauty who made it according to that Beauty.

### 2.2. Systems of proportions

The selection and use of systems of proportions has always been an important concern for artists and architects. There were not only specific ratios used, but also some *systems of proportions* were preferred. Some systems of proportions were based on the musical intervals, the human body, and the Golden Ratio.

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