



## OUR HERITAGE

ISSN0474-9030 -Vol-68, Special Issue-11

One Day Interdisciplinary National Conference on "Arts, Sculpture and Architecture in Marathwada"

Organised by: Department of History, Pratishthan Mahavidyalaya, Paithan,  
Tq. Paithan, Dist. Aurangabad -431107, (Maharashtra)

Held on 1 February 2020



## Geometrical Analysis of Architecture of Ellora Caves

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### Abstract:-

Mathematics and Architecture go hand in hand. Mathematical precision and conceptual clarity gives shape to marvelous monuments and buildings all over the world. Measurements and Concepts of Mathematics are utilized in the creation of caves and sculptures. Symmetry has been the measure characteristics of architectural designs of temples, caves all over the world. Marathwada is significant location in the world tourism map due to its world heritage sites like Ajanta and Ellora Caves. The magnificent caves are supreme example of admixture of architecture, aesthetics, literature, philosophy, religion and culture of contemporary India. It is thing of contemplation that how engineers and architects have meticulously used the mathematics in the creation of these caves.

Present paper is an attempt to explore the use of geometrical concepts in the design and building of Ellora Caves.

**Keywords:** Geometry, Symmetry, Mathematics, Architecture, Ellora Caves

### Introduction:

Mathematics and Architecture go hand in hand. Mathematical precision and conceptual clarity gives shape to marvelous monuments and buildings all over the world. Measurements and Concepts of Mathematics are utilized in the creation of caves and sculptures. Symmetry has been the measure characteristics of architectural designs of temples, caves all over the world. Marathwada is significant location in the world tourism map due to its world heritage sites like Ajanta and Ellora Caves.

### Relation of Mathematics and Architecture:

Mathematics and architecture are related to many of arts. Mathematics is needed in engineering, designing buildings. In Architecture, architects use geometry to define the spatial form of a building. From the time of Pythagoras, mathematics was considered important to plan, design any form in harmony and proportion to other components. So to design the plans of the buildings, architecture has given more importance to geometry in the mathematics.

From the ancient time, Architecture is considered as a mathematical discipline. Perhaps once one realizes that mathematics is essentially the study of patterns, the connection with architecture becomes clearer.

Pythagoras left the first remarkable mathematical influence on architecture. The followers of Pythagorean believed that *all things are numbers*. It had great significance in architecture. It is an imperative to consider the relevance of mathematics in architecture. Pythagoras established the ratios

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of the sequence of notes in a scale. These are still used in Western music. These beautiful harmonious sounds depended on ratios of small integers. This led to architectural designing buildings using ratios of small integers.

Pythagoras also believed that numbers had geometrical properties. The Pythagoreans spoke of square numbers, oblong numbers, triangular numbers etc. Geometry is the study of shapes. The shapes were determined by numbers. The Pythagoreans developed the notion of aesthetics based on proportion. Geometrical regularity meant beauty and harmony. This was applied to architecture with the use of symmetry. Symmetry to a mathematician suggests an underlying action of a group on a basic configuration. It indicates the repetition of shapes and ratios from the smallest parts of a building to the whole structure. In this context, it would be clear that *all things are numbers* and what it means to the Pythagoreans and how it was to influence ancient Greek architecture.

### Geometrical Concepts used in Architecture:

Islamic Architecture makes great use of geometric patterns. It is developed over the centuries. Many of these are derived from the influence of various earlier cultures i.e. Greek, Roman, Byzantine, Central Asian, and Persian. Architecture in Islamic culture has usually been based on curving and branching vegetal forms. It has also used fragment and linear geometric patterns which are combined in a single design. On the other hand, it also has some purely abstract linear patterns which are adopted in designs. These geometric designs have evolved into beautiful and highly complex patterns. These are still used in much modern day architecture. The square and rectangle are significantly used in Islamic architecture. The brick works in facades are usually in rectangular bricks. It was meant to have some effect on light and shadow in desert to create the three-dimensional effect.

### Geometrical concepts used in Ellora Caves:

Ellora is located 26 kilometers north of Aurangabad. Buddhist monuments are in the southern part, Hindu monuments in the middle and Jain caves are in the north. These are arranged in linear mode. The most magnificent is Cave 16, the Kailash Leni. There are many structures available in the Ellora Caves. But Kailash Leni is far more superior to all as far as architecture and art is concerned.

Ellora caves date back to the period from 600-1000 CE. It is well known for its architectural marvel for its technique of cutting rock from upside to down i.e. Kailash Leni. It consists of Buddhist, Hindu and Jain monuments. These all caves have contemporary artwork. Cave 16, in particular, features the largest single monumental rock excavation in the world, the Kailash temple, a chariot shaped monument dedicated to Shiva.

### Roof of the Rangamandapa was decorated with moving lions:

It rises the height of approximately 100 feet. Its length is about 145 feet nearly 250 feet deep and 150 feet broad. While making an architectural plan, Percy Brown had observed, "Three trenches were made at right angles (90°) and cut down at right angles to the level of the base of the hill".

The mass of rock 200 feet long wide and 100 feet in height was isolated. The mass was hammered into shape. Then the sculptors began their work.

Admission to the temple is supported by the elephants:

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The work was commenced by cutting three mighty trenches in the solid rock. two of them are at right angles to the front of the rock. These are more than 90 yards in length, and the third connecting their inner ends, over 50 yards long and 107 feet deep.

### River Goddesses Shrine:

A shrine is twenty-three and half feet long by nine feet deep and eleven feet high. It has two pillars in front. It is just behind the northern elephant. The pillars have molded bases, sixteen sided shafts, and massive capitals with a double bracket above. The floor is approached by five steps, with an elephant's head and front feet on each side of them. The rest of the podium is divided into three panels on each side, containing small sculptures.

The ends also had the heads of elephants. The front was terminated by huge *dvarpalas* with several arms and wearing high tiaras. The doorway of the shrine is intricately decorated with geometrical patterns and human figures.

### Conclusion:

Ellora Caves, the magnificent caves are supreme example of admixture of architecture, aesthetics, literature, philosophy, religion and culture of contemporary India. It is thing of contemplation that how engineers and architects have meticulously used the mathematics in the creation of these caves.

### References:

1. Brown, Percy. Development of Buddhist Cave Architecture at Ellora. Ph.D. Thesis, Shodh Ganga. <Shodhganga.in flibnet.ac.in>
1. <http://mathshistory.st-andrews.ac.uk/HistTopics/Architecture.html>
2. <https://www.sahapedia.org/the-architecture-of-ellora-caves>

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