

Taj Mahal: Philosophical Experience, Art Interpretation and Fractal Analysis

Prof. M.Y. Shishin* and Ismail Kh.J.

*Altai State Technical University, Barnaul

Abstract

This paper presents approaches to the philosophical interpretation of the art ensemble of Taj Mahal in terms of the artistic expression due to its compositional characteristics (shape of the dome, minarets, etc.). Represented results of the fractal analysis are based on the box counting dimension method (DB) and the spatial coherence of the basic and artistic characteristics (landscape plan, section, elevation, floor plan and ornamental motif). A direct dependence of a high degree of the fractality of the monument is substantiated on its artistic and aesthetic features.

Key words: Taj Mahal, Architecture, fractality, Fractal Analysis

Taj Mahal is an Indian architectural masterpiece of Mughal period included in the UNESCO World Heritage List. The masterpiece finds mention in many multi-faceted researches and literature. Abstractness remained the main error for everyone who made an attempt to explain it. However, it is obvious that this grandiose monument will be always of interest for contemporary researchers who will unveil its new secrets. The admiration for the genius who shaped Taj Mahal as well as the aspiration to have closer understanding of nature of harmony embodied in the monument is the main motivation behind writing this article. An effort has been made to elucidate the known historical facts of this monument which have been explained by different scholars [2, 3, 4, and 7].

The monument was built by Akbar's Grandson, Shah Jahan during the period between 1630- 1652 in memory of his wife Mumtaz Mahal. Before her death, she expressed her wish to erect a monument. The deep love for his wife and immense pain gave him the power to implement the idea. It is pertinent to mention that the final plan included construction of similar architectural structure on opposite side of river Yamuna. However, the complex which Shah Jahan planned for himself was to be made in black marble, and both mausoleums were supposed to be connected through a black-and-white bridge. Today, even in an unfinished form, Taj Mahal is not only a monument portraying the love of two trustworthy hearts, but is embodiment of Love & spiritual values- beauty, harmony and love in their everlasting unity.

Taj Mahal is most commonly associated with Mumtaz and Shah Jahan's marble monument. However, this is only partly true because this monument is the central part of the well-designed complex which comprises parks, palaces, fountains, and even the wall separating it from the outside world and ceremonial gates. This is an ensemble in the classical sense where all the elements from the smallest - the ornamental motif - and to the palace buildings have profound unity. The monument simply reveals to visitors the idea of integrity and consistency of all elements of its pecking order. This complex reminds of the ancient philosophical idea of integrity of world and its hierarchical order. Even a



Fig.1: The central elevation of *Taj Mahal*

superficial act of perception and, of course, the contemplation and immersion (spiritual fusion) related to the monument are called on to reinstate the relationship between man and world to invoke religious feeling.

The shrine, the main architectural object, is a five-domed building with the height of 74 meters and is placed on the high platform with four slender minarets at the corners slightly deflected from the vertical axis. The simplest and most common explanation for this curvature is functional: in case of earthquakes, they will not cause any damage to the basic shrine. However, this elucidation for such a complex architectural method, in our view, is not comprehensive. The entire complex depicts a high sense of aesthetic excellence and reasoning in every detail that makes spectators to hunt for a deeper interpretation of such a construction technique (Fig. 1).

The most peculiar and meaningful view of the monument can be found in the most valuable position, the grand portal. Walking under its shadow, the viewer sees the snow-white monument through the dark-walled frame of the portal. It's like the representation of the main theme of a big symphonic work. At the same time a number of subsidiary themes are offered to the viewer. For example, a shining white monument directed high into the air and surrounded by the darkness can be metaphorically interpreted as the eternal struggle between the life and the death. The location of the monument is strictly along the axis of the portal. It is a carefully considered compositional technique. Two elements, the shining monument and the dark portal, are inseparably linked to each other and complement each other (Fig. 2).

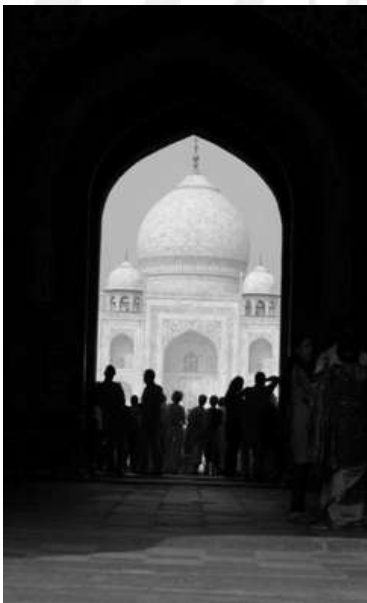


Fig.2: The view of the Mausoleum through the entrance portal

The “dark frame” emphasizes the whiteness of the gate of the Mausoleum and at first sight there is no sense of a dense mass of the stone but the subtle vibrating substance (the Mausoleum’s outline is blurring in the streams of the hot Indian sun). One can see supposedly solidified flow of light, and it corresponds exactly to a certain metaphysical program of the monument. These details will be discussed below.

The subsequent perception of the Mausoleum progresses according to a well thought-out drama. Having passed the gate, almost everyone stands still stunned by its beauty and harmony. A well-planned park with fountains, beautiful walkways and palaces looks like a decoration of the Mausoleum of Mumtaz Mahal and Shah Jahan. Everyone can intuitively grasp the strict proportional ratio of the park and the monument even without an exact calculation. If one compares it with music, one can recognize the central theme of the symphony, given in the form of a powerful chord. At this point, the attentive viewer can observe the strangeness of the composition - minarets are deflected a little from the vertical axis but the visual image of the

monument clearly dominates all over other impressions and imperiously calls for itself. The theme of minarets retreats to a long-range plan but it is still auxiliary. This is a well-considered art-directing plan. Its aim is to prepare the viewer not only for the strong impressions, but also for the process of achieving a definite placidity and a spiritual balance in order to search for the nuances and coherence of the main and subsidiary subjects. And only then it is the time for new discoveries which require the viewer’s high-observation rather than the admiration and superficial examination of the assembly.

A viewer enters a new shape layer when other symbolic and semantic lines of the monument are discovered. Thus, Taj Mahal is truly a symphony in the stone where the main theme is supported by the auxiliary motives, and they are all perfectly connected with each other. These auxiliary motives can be found in a great number of details but we consider only one detail in order to illustrate what was mentioned above and to prepare the reader to the fractal analysis which will



(Fig.3) A fragment of the ornamental motif



(Fig.4) *Shah Jahan*

be carried out taking account of these coherences and relationships among various elements.

The motif of the lancet arches is revealed to the viewer delicately, gently and even softly in the ornamental decoration of the exterior walls. The beautiful patterns of arches with multitude variations attract viewers' attention and engrave on the viewer's memory. But, since the audience gets a strong impression of the grand gate and then of the monument itself, the image of the arch in the

ornament of the mausoleum is shaded and sounds as a quiet leitmotiv of the general background. It will take some time to survive the admiration of the

ensemble and of the monument, and only then people start considering the details and here a new discovery can be found. The viewer suddenly recognizes the form of the familiar lancet arch which one come across in the decoration at the entrance, in the fillet of marble, covering all sides of the platform. A person gains an insight into a single motif of the dome of the monument, and its portals, and the contours of the windows, etc. It runs through the entire ensemble and serves as a form-building formally-rhythmical compositional method. In the second part of this article we present the proof of this unity basing on the fractal analysis. Considering the method of rhythmic repetition and scaling in the composition of the monument as the leading one, we should look at the details and listen to our own feelings. We know that the architect had to apply it several times; so, we can try to find a semblance of minarets and their compositional movement - a slight deviation from the vertical line - in other details, such as an ornament. One of the most popular and abundant motif in the ornamental design of Taj Mahal is a blossoming red flower. It is curious that Shah Jihad holds it in one of the miniatures (Fig. 3, 4).

A flower is iteratively repeated in different ornamental compositions, and if one looks at it, one can notice that it always is in the same state - its petals are slowly blossoming, spreading from the center. This multiply repeated movement is tenaciously captured by the mind, and its meaning offers the illumination when the viewer glances at the complex of Taj Mahal coming out of the gate. The sense of similarity of minarets' motion and of flowers' petals movement overtakes the viewer. In the artistic perception grouping all known movements on the principle of similarity, the mind can bring together the flower's petals blossoming in the ornament and deviating from the centre minarets. Further we can complete the image of a huge stone flower - monument-Mausoleum of Taj Mahal. Moreover, the deviation of the minarets seemingly creates an impulse of the force in the center of the platform where actually the monument is situated. In comparison with minarets, it is more massive; the irregularity of the surface of the walls by windows, portals, decorative elements creates the change of light and shade that gives it more stability and solidity. Here again the contrast arises- the monument contrasts with the elegant thin minarets which seem to lose the stability and balance. This well thought-out artistic technique creates the illusion of the ejection of the

monument out of the massif platform. One seems to witness a miraculous breakthrough, emerging from the mysterious depths of an ideal smooth surface of the upper platform of the monument.

The subject is not exhausted by the contrasting movements. All those who have seen Taj Mahal admire the beauty of its dome. The dome is the compulsory element of Islamic mosques. However, the contour of the dome in various mosques has a different profile. As a rule, it is massive and is connected with the drum in its widest part. The image of the tectonic efforts occurs at the junction of the drum and the dome. This is how the idea of the aspirations from the Earth to the Heavens embodies as if breaking the oppressive materiality. The dome of the mosque at the same time symbolizes the image of the vault of heaven which is emphasized in the blue glazed tiles covering it. In the decoration of the dome the gold is applied which also adds the solemnity, power and strength to the architectural element (for example, the Dome of the Rock Mosque in Jerusalem).

Having carefully examined the dome of Taj Mahal, we now observe a very impressive technique in its design. The highest point of the dome, the spire, which is decorated with Islamic symbols, expands gradually. Traditionally the dome is picked up by the drum in the place of its maximum diameter, but the dome of Taj Mahal is an exception, it begins narrowing and is caught by a graceful arched ferrule. This reminds of a drop which is supposedly frozen by touching a surface or encountering the resistance. Having counted the search for similarities, one could view the image of frozen Heavens tears, grieving for the death of Mumtaz Mahal and for the breaking of her earthly love with Shah Jehan-(Fig. 5). Now we try to explain the use of the extremely beautiful white marble in the whole decoration of Taj Mahal which is a unique case in Islamic architecture. The closest analogue is the tomb monument of Salim which concedes Taj Mahal in size and beauty of the decoration. The use of the white marble which had to be delivered through 300 kilometers was a deeply thought-out artistic step. The monument responds to the flow of the light. During the day it shines white, in the rays of the morning sun it is tenderly pink, and under the moonlight it is converted into a single silver-blue transparent crystal.

The category of the Light is the central in the Islamic metaphysics, and within the framework of this article it seems sufficient to refer to existing researches on this issue [1,5]. Applying this metaphysics to Taj Mahal, we can say that it embodies theatrical act - the flow of the blessed light pouring from the heavens, hardening, creates a form of the monument, and Taj Mahal is actually the manifestation of the Light of all lights in the universe. The proposed interpretive approaches, of course, does not cover all range of themes and images of Taj Mahal, however, we do this because we would like to consider its architect and then to present the fractal analysis of the ensemble.



Fig.5. The central dome of Taj Mahal

It is known that the construction of Taj Mahal lasted for 22 years, 20 thousand people of various specialties participated in it. We also know that these works were led by the council which consisted of a few people. Of course, Taj Mahal is the result of the collective work, but still one person of the council had a special mission to be the main architect. There are different names in different sources: Turk Ustad Isa, Ustad Ahmad Lahori (it is supposed that it is one and the same person). The European artists and architects, for example, Geronimo Veroneo from Venice was a member of council [8]. It is known that Shah Jahan took a great interest in architecture and actively

participated in the development of the model and the site plan of the monument. Ustad Ahmad Lahore is most often mentioned as a chief architect; at least he made a decisive contribution to the design of Taj Mahal. It is also confirmed by the opinion of Professor H.I.S. Kanwar [6].

Despite the difficulties with the master's biography reconstruction, we can suppose that he was endowed with a number of rather obvious qualities. Evidently high professionalism and high artistic talent were inherent to him. In addition, he was endowed with a holistic world view and a special intuition. The unity of the world was discovered by the architect, and he was able to cast his insight into the beautiful architectural forms. Of course, we do not dispose of a direct identification evidence of his high metaphysical (transcendental) experience, but, in our opinion, his work is the best proof. In this regard, we note that researches on the transcendental insights of the great artists and their reflection in works of art are still waiting in the wings. But in all cases, the architect had to be familiar with the depth of Arabian philosophical thought which, in its turn, was associated with Greek philosophy. As we know "Fedon" and "Timey" are among the most profound dialogues that reflected the transcendent experience of Plato. They were known to Abu Rayhan Biruni, who used them in his conceptual developments, for example, in "Comments" at the Neoplatonist Proclus. Aristotle's "Physics" and "Metaphysics", the works of the major seer Apollonius of Tyana and other related works were known to Biruni who seriously influenced the philosophical thought of the Central Asia. He was the recognized authority and, of course, the architect of such a high level had to know his works which unfolded the idea of the United, Supramundane, Harmonic reality, essentially proceeding and inspiring a material and a dense plan of existence. A number of important topics are developed in the Islamic philosophical and theological traditions. For instance, there was a concept of "benai" which "... literally means "... speculation", i.e. an abstract insight into "things", implying the existence of special, extremely sensitive feelings of anesthesia ..." [5]. We should remember the works of an outstanding Russian thinker of the 20th century Lossky N.O. who identified and substantiated three types of intuition - sensory, intellectual and mystical. The implication is that all these types of intuition were developed and synthetically merged by the main architect of Taj Mahal.

This, in particular, helped him to merge into a single complex of Taj Mahal such architectural traditions as Persian, Central Asian and Indian. He was able to feel their essential unity, to find a similar proportional relationships and compositional approaches. All these bring us again to the name of Ustad Ahmed Lahore, the hereditary architect, whose father came from Herat and, therefore, was well aware of the Central Asian architecture, and his son, born in India and, according to witnesses, studied mathematics and architecture with the help of the prominent architects from Turkey and Iran for a long time, became the architect of Taj Mahal. Now we uncover some of the principles of the harmonic composition of the ensemble in Agra, relying on modern methods of the fractal analysis.

Fractal analysis of Taj Mahal ensemble

We can define our as searching for the self-similar structural patterns in the ensemble of Taj Mahal. Let us state as a hypothesis that all the elements of the monument, from the smallest to the ornamental motif of the park plan have the structural self-similarity and below we will try to prove it.

In this part of research, we rely on the sufficiently known fractal analysis of architectural monuments [13]. With regard to Islamic religious architecture, this kind of research as we can judge from available sources is made for the first time, especially with respect to the ensemble of Taj Mahal. Therefore, we should mention that all the provided calculations are preliminary and, of

course, their clarification and discussion are necessary. We will try to expose a landscape plan, a floor plan, elevations, sections and ornaments to the fractal analysis. It will make possible to compare and determine the consistency of various architectural features (spatial modi) in the ensemble. The method is based on the researches of W.E. Lorenz [9] and C. Bovill [7] who proposed the box counting dimension method (DB) for calculating the level of fractality in the architectural forms. It allows working either with self-similar or non-self-similar structures, revealing the degree of fractality of the object. That proves the accuracy and universality of this method. Using this method it is easy to determine the fractal dimension of a complex image that cannot be described by other traditional methods. It is based on the fact that visually the fractal dimension expresses the degree of "roughness" and "irregularity" of the structure, which defines the degree of complexity of the object [7,9].

This method is used as follows: The grid of a certain size (S1) is superimposed on the image and then can be calculated the number of cells, including details of the image (N1). Then the size of the grid is reduced (S2) and again the number of cells are counted (N2). The fractal dimension between two scales is calculated by subtracting Log N1 from the Log N2, and then by dividing on the difference between Log S1 and Log S2. This calculation can be expressed mathematically by the equation:

$$DB(1-2) = [\log N(s_2) - \log N(s_1)] / [\log 1/s_2 - \log 1/s_1] \text{ or } DB(1-2) = [\log N(s_2) / N(s_1)] / [\log s_1 / s_2]$$

S - size of the grid, N - number of cells that cover the image details. [7]

A comparative fractal analysis of the key elements of Taj Mahal in several scales is explored [12]. The application of this method for the fractal characteristics calculation of the elevation and the plan are given in the tables and graphics. It should be noted that the analysis is multistage. Firstly, the fractal dimension of the object (it determines the level of the fractality of the plan and the elevation, etc.) is defined in details. There are criteria which were taken to calculate the fractality:

High degree of fractality in the object - $1 < DF$ (the overall fractal dimension of an object) < 2 .

Low degree of fractality in the object - DF (the overall fractal dimension) ≈ 1 or ≈ 2 .

Secondly, the consistency of the data of fractality for each scale of a specific element was calculated. One can distinguish two variants of the consistency of the data when one sees it closer for the first time:

In the first case, the graph of consistency data of the multi-scaled analysis will represent a straight or a smooth line. This means that the level of consistency in this case is high;

If the graph will represent the broken (unsmooth) line, it means that the level of the consistency is low.

Such a study is justified by the fact that, firstly, the level of fractality of the selected item is analyzed; secondly, the level of harmonization of the various scales of the element (for example, the consistency of elevation in different scales etc.) is analyzed. Here one must be sure that the data of fractality of various scales of the element have a high level of consistency. This is a key stage of the fractal analysis of architectural monuments. In other words, the transition to a coherent analysis of the various elements of the architectural complex passes through this procedure. The consistency of the fractal dimension of the object is calculated by using an aggregate function "STDEV". This

function is well justified in the software product EXCEL. It defines how different data deviate from their average. “STDEV” function is computed using the following formula:

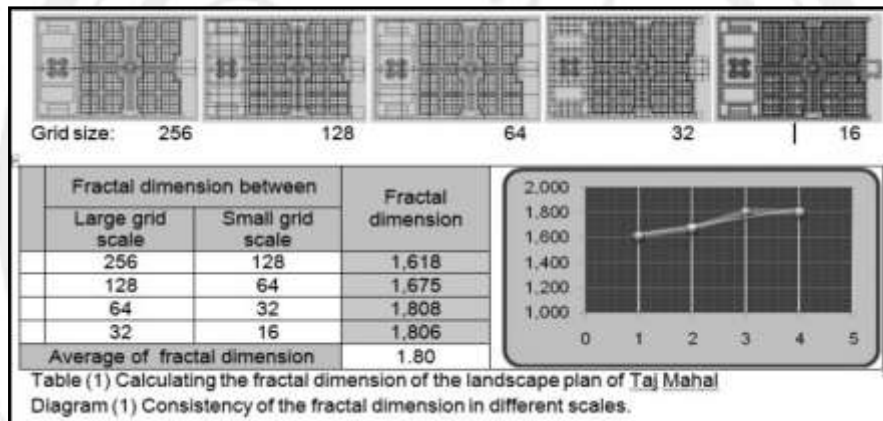
$$STDEV(x, y) = \sqrt{\sum (x-x)^2 / n}$$

where x - the sample mean value (the number 1 and number 2, and n - sample size [4]. And finally, the third stage of analysis is the harmonization of the data of the multi-scaled fractal analysis between the different elements. A deep fractal analysis by comparing the levels of fractality in various scales between different elements (for example, between plan and elevation, etc.) was carried out. The software EXCEL through the function “CORREL” which shows the level of correlation between the graphs of various data sets can be effectively applied for more objective analysis of the consistency (similarity) of two levels of fractal graphs. The equation for the correlation coefficient is as follows:

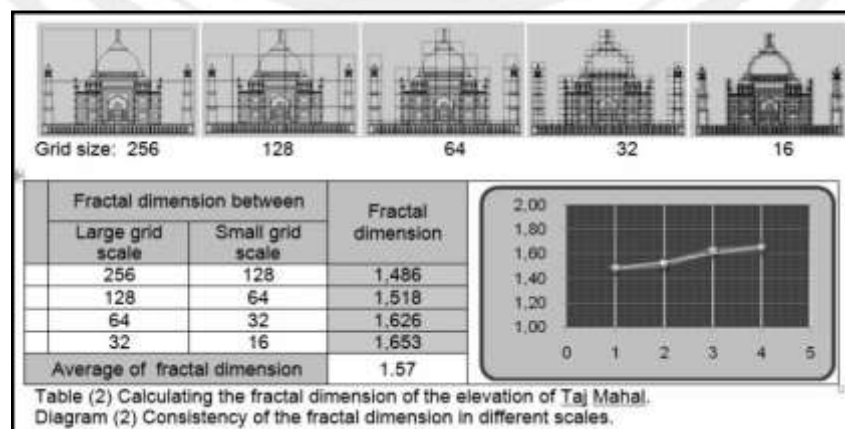
$$CORREL(x, y) = \frac{\sum (xx) (yy) - \sqrt{\sum (xx) \sum (yy)}}{\sqrt{\sum (xx) \sum (yy)}}$$

where x and y - average means of samples AVERAGE (array1) and AVERAGE (array2) [4].

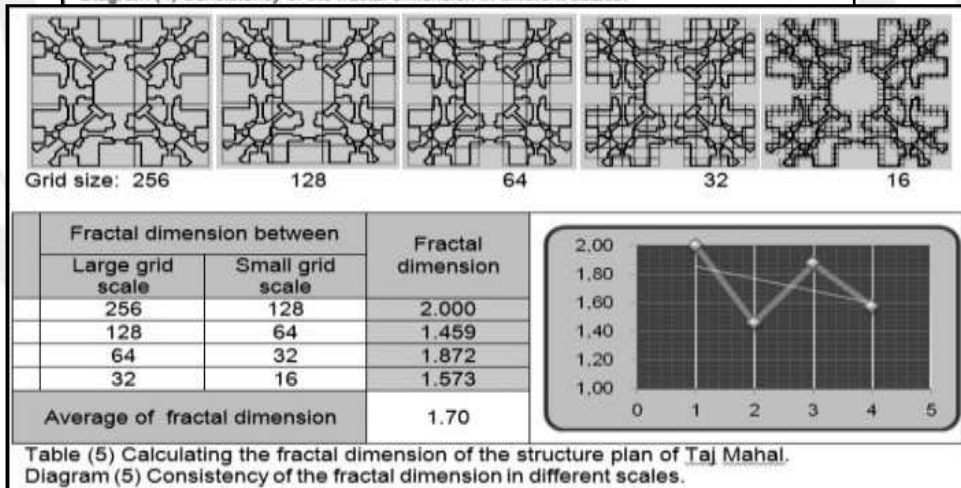
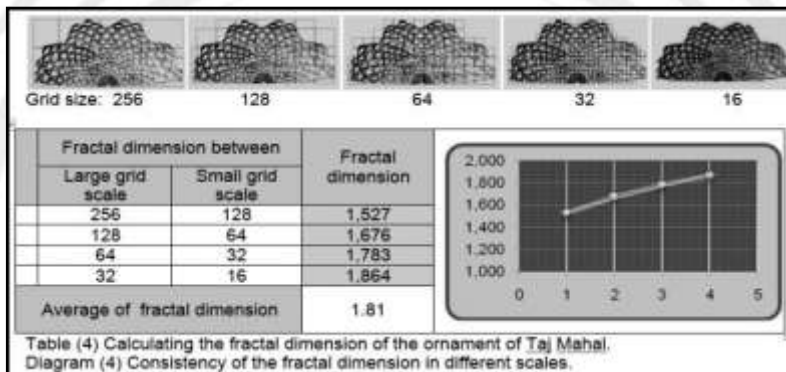
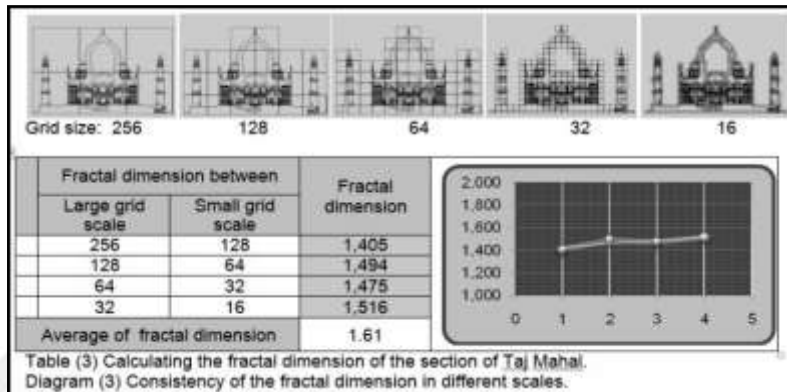
The calculation of the fractal dimension of the landscape plan of Taj Mahal (Table 1) was carried out as follows. The high consistency of the fractal analysis data in various scales is clearly seen and the line of the graph is smooth (Diagram 1).



Then the calculation of the fractal dimension of the elevation of Taj Mahal (Table 2) was done. The fractal dimension of elevation in different scales also shows high consistency of the fractal analysis data (Diagram 2).



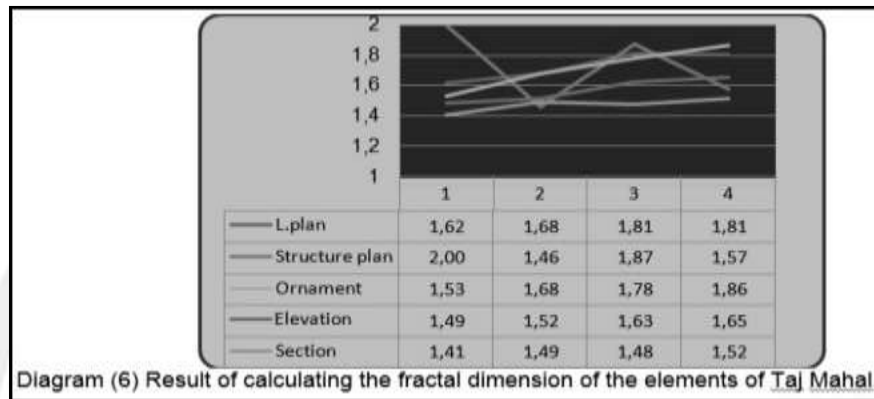
The fractal dimension of the section of Taj Mahal (Table 3) was carried out. The fractal dimension of the section at different scales is shown by the smooth line which testifies a high level of consistency (Diagram 3). This is proved as below.



(Fig.6) Ornamental motif inside dome space.

Elements of Taj Mahal.	Consistency of the data of fractality for each scale of a specific element.
L. plan	0.09
Elevation	0.08
Ornament	0.13
Section	0.04
Structure plan	0.23

Table (7) Consistency of the data of fractality for each scale of a specific elements of Taj Mahal.



Elements of Taj Mahal.	Consistency of multi-scaled data fractal analysis between the different elements	level
Between L. plan & elevation	0.99	high
Between L. plan & section	0.72	high
Between L. plan & ornament	0.95	high
Between L. plan & structure plan	0.22	low
Between elevation & section	0.71	high
Between elevation & ornament	0.96	high
Between elevation & structure plan	0.22	low
Between section & ornament	0.88	high
Between section & structure plan	0.84	high
Between ornament & structure plan	0.49	middle

Table (8) Consistency of multi-scaled data fractal analysis between the different elements of Taj Mahal.

The graphic-analytical calculation of the fractal dimension of the ornamental motif (Table 4) was introduced. This pattern is located in the dome space of Taj Mahal (Fig. 6).

The fractal dimension of key ornamental motif at different scales also shows high consistency of fractal analysis data (Diagram 4).

The structure plan is always a key element in any architectural monument. This is how the fractal analysis can be introduced (Table 5). The results of the fractal dimension of the plan at different scales are shown as a broken line (Diagram 5). That refers to the low consistency of fractal analysis data.

Entire data of fractal dimensions of the above mentioned elements is put into a single graph (figure 6). The results of the calculation of the consistency of data of fractality of each element of Taj Mahal at different scales are presented in Table 7. The consistency of multi-scaled data of the fractal analysis between different elements is presented in the tabular form (8).

To conclude, the study confirms the hypothesis in general the high coherence between the different spatial characteristics of the complex of Taj Mahal. Thus, the consistency of the fractal dimension of the landscape plan, elevations, sections, and the ornament is high and meets the criteria of high fractal ($1 < DF < 2$), as seen from the tables (1,2,3,4,5) and from the diagram (6).

It is also stated that the architectural characteristics of the structure plan coincide with the architectural characteristics of the section of Taj Mahal, but the architectural characteristics of the structure plan does not coincide with the architectural characteristics of the landscape plan, elevation and ornament (Table 8), (diagram 6).

The explanation of this is that the structure plan of the building performs only the constructional function and is not visually an identifiable element. In comparison, the elevation as a visual element is closely associated with the environment (landscape plan); it is captured by the viewer with entire environment and therefore has a high degree of fractal dimensions and approvals.

The results of the study prove the presence of high artistic experience of architects in creating a harmonious architectural ensemble. The fractal analysis of Taj Mahal substantiates the existence of common principles of organization of complex composition, which were based on deep knowledge, experience and architectural tradition. The revealed high level of fractality can be considered as a one possible explanation for the organic connection of all elements of the complex and the surrounding area.

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