

# On the symmetry of the central dome of the Taj Mahal

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*The Taj Mahal attracts millions of visitors annually. It is renowned for its perfection, symmetry and attention to detail; its beauty and magnificence appeal to almost all viewers. It does, however, possess some slight imperfections that escape most observers. Revisiting both, the appreciations and criticisms, this study analyses possible flaws in the symmetry of the external central dome and discusses the reasons for the flaws.*

**Keywords:** Mughal monuments, symmetry in architecture, Taj Mahal.

AMONG the millions who see the Taj Mahal, praise is almost universal. Rabindranath Tagore said that the Taj Mahal rises above the banks of the river like a solitary tear suspended on the cheek of time. Even art historians have been effusive in their praise. Percy Brown<sup>1</sup> described it as ‘the “perfect moment” in the evolution of architecture during the Mughal period’. Ebba Koch<sup>2</sup> writes: ‘I felt overwhelmed by its perfection, splendour, and sheer size. Eventually I realized that as a scholar I was not alone in my awe of the famous building’. She goes on to analyse the building according to the eight principles of Shahjahani architecture among which she includes geometric planning, symmetry and attention to detail. She claims that ‘there is perfect symmetrical planning with emphasis on bilateral symmetry (*qarina*) along a central axis on which are placed the main features’<sup>2</sup>.

In comparison, written criticisms are few. We found only four. In chronological order, the critics are Hermann Keyserling<sup>3</sup>, Aldous Huxley<sup>4</sup>, Sarat Chandra<sup>5</sup> and Wayne Begley<sup>6</sup>. Mostly criticisms are not of the building but they dispute the standard explanation of Shah Jahan’s motives for having the monument built.

Count Keyserling, a German philosopher, was unable to fathom the building’s meaning. ‘As far as the ordinary architectural possibilities go, it lacks all expressive value.... The Taj Mahal is not even necessarily a funeral monument: it might just as well, or just as badly, be a pleasure resort.... The dead queen is by no means the soul of the Taj Mahal. It has no soul, no meaning which could be deduced from anywhere’<sup>3</sup>. Yet he is clearly in awe: ‘A massive marble structure without weight, as if composed of ether; perfectly rational and yet purely decorative; without ascertainable content, and yet full of significance

in the highest degree: the Taj Mahal is not only one of the greatest works of art, it is perhaps the greatest of all pieces of artifice which the creative spirit of man has ever achieved’<sup>3</sup>.

Aldous Huxley was unique in pointing out the building’s architectural flaws. ‘Architecturally, the worst features of the Taj are its minarets. . . There was no need to make them feebly taper, there was no need to pick out the component blocks of which they are built with edgings of black, and above all there was no need to surround the shaft of the minarets with thick clumsy balconies placed, moreover, at just the wrong intervals of distance from one another and from the ground’. He also criticised the *pietra dura* decorations and the bas reliefs of the flowers which adorn the gateway<sup>4</sup>. Begley<sup>6</sup> dismissed Huxley’s views as frivolous.

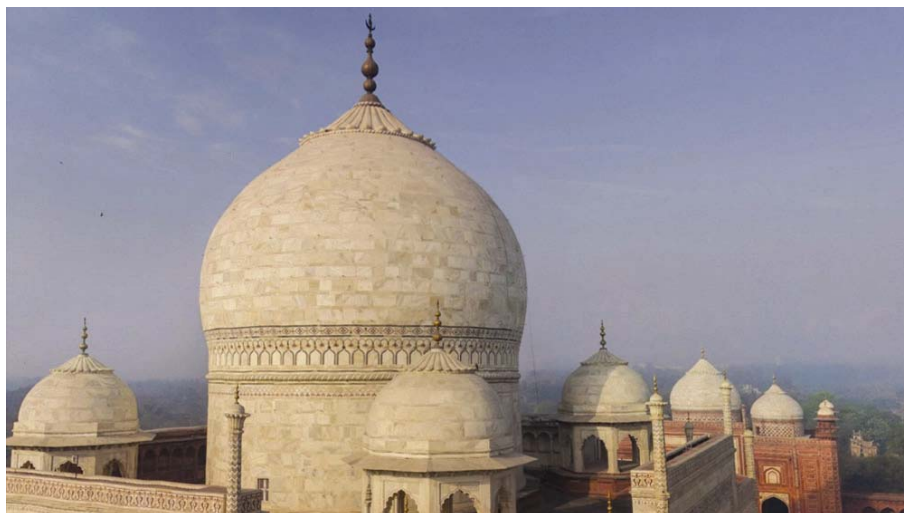
Sarat Chandra Chattopadhyay<sup>5</sup> heroine in *Shesh Prashna* expresses doubts about popular explanations. ‘After pointing out some of the flaws in the myth of Shah Jahan’s marital devotion, [she] concludes that the Emperor would probably have built a monument like the Taj even if Mumtaz Mahal had *not* died, that he would have found some other excuse to build it, perhaps “in the name of religion” or perhaps as a “memorial to conquest” ’<sup>6</sup>.

Wayne Begley provided a novel, and so far the only symbolic interpretation of the Taj – less as a monument to marital love and more as an imagined ‘Throne of God’. Both Keyserling and Huxley were unaware of this symbolism. Even Begley admits that ‘the Taj possesses the charismatic power to awe almost all its viewers (a few cynics excepted), to instil a sense of greatness, a sense of transcendent majesty’<sup>6</sup>.

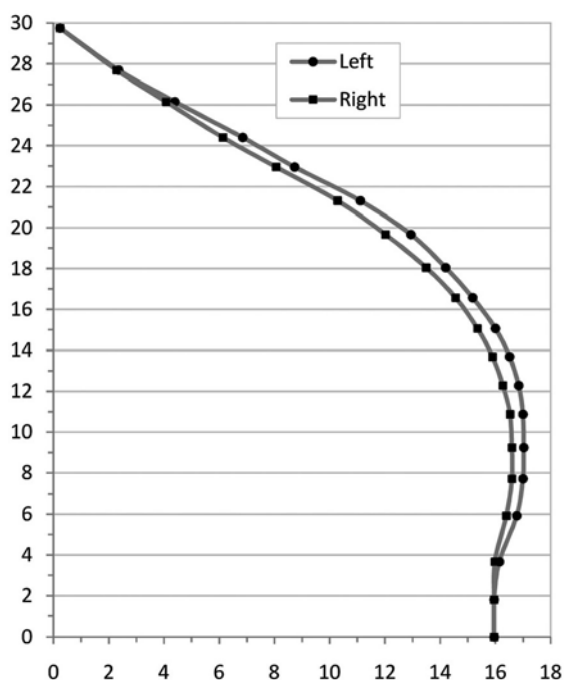
We count ourselves among Taj’s admirers and neither the reasons for its construction, nor its symbolism concern us. We think it is a building that looks far better during an actual visit than in any depiction. Even repeated visits do not lessen the feeling of gladness that it induces in viewers.

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**Figure 1.** Photograph of the central dome of the Taj Mahal showing the supporting drum.



**Figure 2.** Measurements of the central dome of the Taj. The radius of outer dome (m) is plotted against various height (m) from the top of drum.

The Taj is renowned for its bilateral symmetry. The central structure, however, seems to us to have two imperfections. The first is relatively minor: in some of the photographs, the finial over the central dome is tilted from the vertical axis by about 3° (angle as measured at the bottom of the dome; smaller if measured at ground level). The finial is not original<sup>7</sup>. The tilt could have occurred when the bronze replica was installed in the early 19th century, or during a subsequent restoration.

**Table 1.** Offset (m) as a percent of the local outer diameter (m) of the central dome

Height (m)	Diameter	Offset	% Offset
29.75	0.48	0	0
27.70	4.64	0.08	1.66
26.16	8.45	0.32	3.83
24.41	12.97	0.72	5.52
22.96	16.79	0.67	3.99
21.31	21.40	0.82	3.85
19.67	24.95	0.92	3.67
18.05	27.69	0.71	2.56
16.57	29.74	0.62	2.07
15.07	31.35	0.65	2.06
13.70	32.41	0.62	1.92
12.28	33.12	0.58	1.74
10.88	33.53	0.47	1.40
9.24	33.62	0.42	1.26
7.72	33.60	0.40	1.19
5.93	33.18	0.38	1.14
3.66	32.13	0.16	0.50
1.79	31.91	0	0
0	31.91	0	0

The other anomaly is that the central dome of the monument is not perfectly symmetrical. There are at least three ways to corroborate this fact: low-tech, mid-tech and high-tech.

(1) The easiest way to establish this fact is to print a photograph of the Taj, preferably one that shows part or all of the drum (as in Figure 1) and carefully cut along the boundary. When one folds the picture along the central axis one will find that the two edges do not coincide. Therefore, the central dome is asymmetric.

(2) The second way to establish this fact quantitatively is to take several horizontal slices of the dome and measure the two sides across the central axis. Figure 2 plots the radii of the two sides of the outer dome (shown in

Figure 1) for various heights measured from the top of the drum. The non-coincidence of the two edges becomes clearly apparent. Table 1 shows the offset as a function of local diameter of the dome at different heights from the drum. The dome at its widest is 33.62 m, 9.24 m above the top of the drum. The offset here is 0.42 m or 1.26%. The maximum horizontal offset is seen at 24.4 m above the drum, where it is close to 5.5%.

(3) The third and most precise way to establish this fact would be to undertake precise measurements using LiDAR scanning. LiDAR is a technology that measures distance by illuminating the target with a laser and analysing the reflected light. The sensor can be calibrated to a high degree of precision; therefore it would be possible to create an accurate three-dimensional (3D) model of the Taj dome. LiDAR sensors can be mounted on aerial or terrestrial platforms<sup>8</sup> but the size, shape, position and architecture of the Taj dome can pose challenges for measurements. In order to scan the whole dome, sensors will have to image the dome from multiple locations to cover 360°. The position and height of the platform to place the scanner will have to be carefully chosen in order to capture data from multiple locations that then will have to be merged seamlessly.

While we have chosen one particular photograph to illustrate the pronounced asymmetry, this was also discernible to us in photographs taken from many different angles.

Being the first to report an observation comes with the obligation to discuss conjectures. Three possible conjectures present themselves. One, that it was an intentional error. Second, the deformation did not exist at beginning but became accentuated over time, and third, it was a construction error that has existed from the beginning:

(1) Islam holds that only Allah is perfect. We have heard stories that for this reason, Islamic master carpet weavers deliberately introduce a slight error in their carpets that is detectable only by a trained eye. This is unlikely to be the case for the Taj's central dome. There are other small imperfections in the building (not visible from ground level), that seem intentional. For example, Figure 1 shows that the base of the *chattris* is left in red sandstone and not covered with marble.

(2) It is also becoming apparent that the northern and the southern ends of the platform on which the Taj sits are differentially sinking over time, with the northern end towards the river having sunk 35 mm more than the southern end<sup>9</sup>. It seems highly unlikely to us that this slight sinking would have caused the rigid dome to become more asymmetric over time.

(3) The third conjecture, and to us the most plausible one, is that it was imperfect from the beginning. It is an outer dome constructed after the inner dome was finished and therefore perhaps the builders did not have the benefit of a central plumb line. Error could also have crept in as Koch informs us that the Shahjahani linear *gaz* had a

range of 80–82 cm. Field studies conducted with her colleagues have shown that 'it was not an exact unit, but a relative, proportionally used one, the length of which could vary slightly, even within one and the same building complex. For the Taj complex, the average *gaz* is 80.55 cm'<sup>2</sup>.

Would Shah Jahan have been aware of this imperfection? In the absence of direct written evidence, we can only speculate on the basis of counterfactuals. We can find factoids which will support either theory – that he must have known and that he did not know. Let us first consider those facts which might lend support to the did-not-know theory. It is recorded that his eyesight had deteriorated. Muhammad Amin Qazwini, the court historian mentions that Shah Jahan even wore spectacles as constant weeping had deteriorated his eyesight<sup>10</sup>. Given the propensity of Mughal Emperors to order the re-construction of buildings they did not like (cf. the first structure at Sikandra was demolished upon Jahangir's orders), we think his first instinct would have been to have the dome re-built. Numerous references in the Persian histories attest to Shah Jahan's direct involvement in his architectural projects, approving the plans and ordering alterations on the spot<sup>11</sup>. The last argument in favour of the did-not-know theory is that he agreed to be buried in the building, ruining the monument's symmetry.

What factoids support the theory that he might have known? First, there are accounts that after moving his capital to Delhi, he rarely came to visit the Taj. Second, there is the widespread myth that one or a few of the key architects had their hands or fingers chopped. If there is any truth to this myth and punishments were meted out, they were more likely to be for an error than for preventing the construction of a similar monument. However, this is contraindicated by the fact that the same architects helped him build later his capital in Delhi.

It seems incredibly unlikely to us that for someone with his aesthetic sense, he would not have known. More likely, he chose to overlook it. It is quite possible that the artisans may have convinced him that there was no way to guarantee that a second attempt would lead to an improvement given the 'tools' available to them and the complexity of the dome's shape. The Jama Masjid in Delhi, possibly designed by the same architect/s, also has a central bulbous dome (where the widest part of the dome is larger in diameter than the drum it sits on and tapers smoothly into a point thereby creating a more complex curve). Our measurements on the photograph of the Jama Masjid dome reveal similar asymmetry. In the dome of Humayun's tomb, however, the diameter of widest part is same as the drum and thereafter curves inward and tapers to a point. This dome shows more perfect symmetry.

Historians are divided as to whether Shahjahan wanted to be buried alongside Mumtaz Mahal. His funeral was arranged by his daughter Jahanara. Times had changed.

He had lost control. He was under house arrest for 8 years before his death. Moreover, there was already a precedent for asymmetric placement of a couple's graves in Itmad-ud-daulah's tomb.

Lest we be accused of looking a gift horse in the mouth, is it more beautiful because it has this imperfection? Let us recall what the Count said: 'Let us transpose ever so slightly the proportions, or change its dimensions by an iota, or place the Taj Mahal, as it is, into another region which is subject to different conditions of air, damp and light: it would be the Taj Mahal no longer'<sup>3</sup>. Many other modern buildings appear geometrically perfect but do not have the same effect on the viewer as the Taj. Let us ask the question in another way: Would it have been *less* beautiful had the dome been *more* symmetric? We doubt it. It is imperative to determine whether the asymmetry poses any risk to the structural integrity of the monument.

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