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Geometric Analysis of the Ka'ba (Al-Sharifa)

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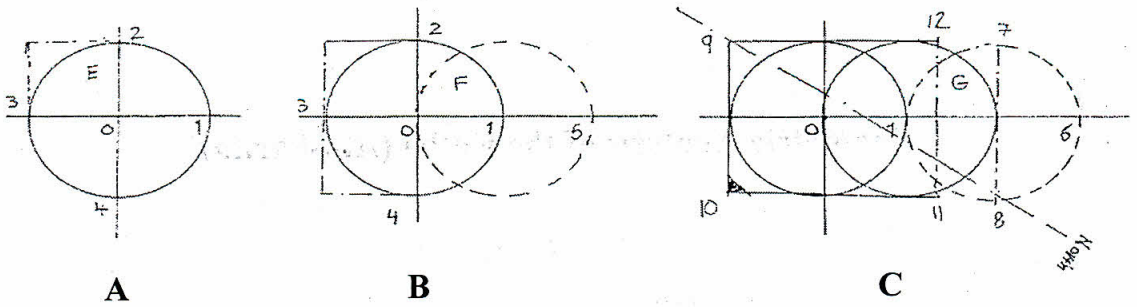
Abstract: As a result of my work since 1986 and many others such as Bolatov and Golombeck, in the subject of geometry in Muslim architecture, it appears that there is sufficient evidence to suggest the existence of strong geometric principles underlying most early Muslim Buildings producing an immense wealth of architectural forms, all within regular arrangements developed from basic geometric language such as squares and circles.

One of the new sites considered in my present Ph.D. research at Manchester Metropolitan University is the Ka'ba (Al-Sharifa), the first mosque in Islam in the sense of being the earliest building dedicated solely to the worship of the Creator. In this I was able to study the planning of the Ka'ba geometrically and in relation to its construction history in the following sequence.

- The Ka'ba before the Creation according to Muslim Tradition.
- The Ka'ba before Adam.
- The Ka'ba in the Time of Adam.
- The Ka'ba in the Period of Ibrahim.
- The Ka'ba in the Time of the Quraysh.
- The Ka'ba in the Period of Ibn Al-Zubayr.
- The Ka'ba in the Period of al-Hajjaj.

Most scholars refer to al -Azraqi on the overall dimensions of the original Ka'ba 32 X 22 X 31 X 20 cubits, and this was close enough for Creswell to conclude that the layout lends itself to a 2:3 proportion. Al-Azraqi also refers, under his section on The Original Dimensions of the Ka'ba, to an overlooked narration to the effect that Abu al Walid said, "Ibrahim Khalil Allah built the Ka'ba. He made it nine cubits high and thirty cubits long and twenty-two cubits wide, and it had no roof." Taking into consideration the fact that the Ka'ba today measures 25 cubits length-wise from the corner of the Black Stone to the northern corner and 25 cubits from the southern corner to the western corner, and measures 20 cubits width-wise from the corner of the Black Stone to the southern corner and 21 cubits from the northern corner to the western one within the *Hijr*, we notice that the oldest side in line with the Black Stone measures 20 cubits, while the most recent side by the *Hijr*, which the Quraysh built c. A. D. 600, measures 21 cubits. In this case let us assume the 2:3 proportion to be a reasonable assumption and the plan of 30X20X30X20 to be not beyond the bounds of imagination, and further let us take a generating unit circle of 20 cubits' diameter as the inner dimension as the present Hijr to be 20 cubits. This will be our circle E (Fig. A). From centre 0 the unit circle cuts the horizontal axis at 1 & 3 and with same radius 20 cubits, we draw a second circle from centre 1 cutting the horizontal axis at 0 & 5. From centre 5 again with same radius, we draw a third circle cutting the horizontal axis at 1 & 6 (Fig. B). Rectangle 9.10.11.12 (Fig. C) appears to reproduce the exact proportion of the Ka'ba, semicircle 7.8 (Fig. C) appears to reproduce the exact position of Hijr Ismail.

Using actual dimensions of the Ka'ba surveyed recently metrically and obtained via the Saudi embassy 1997 I was able to confirm the accuracy of my geometric analysis to within two decimal points.



Introduction

Ilm al-miqdar according to the Islamic faith is the science on which God based the creation of all things from the smallest particle to the furthest expanse of the universe in Sura: 54 Al-Qamar Verse: 49

﴿ ۞ إنا كل شيء خلقناه بقدر ۞ ﴾

Verily all things have we created in proportion and measure. (Yusuf Ali's Translation)

And in Sura: 25 Furqaan Verse: 2

﴿ ۞ تبارك الذى نزل الفرقان على عبده ليكون للعالمين نذيرا ۞ الذي له ملك السموات والأرض ولم يتخذ ولدا ولم يكن له شريك في الملك وخلق كل شيء فقدره تقديرا ۞ ﴾

He to Whom belongs the dominion of the heavens and the earth: no son has He begotten nor has he a partner in His dominion: it is He Who created all things and ordered them in due proportions.

The subject of proportion in Islamic architecture was rekindled by the work of the Russian scholar Bulatov in the early sixties and seventies during his thorough examination of early (Russian/Muslim) buildings and through his translation of early Muslim treatises written by Abual-wafa-al-Buzajani a Muslim scholar. Born in A.D. 940 in Bozjan a small town in Khurasan, who immigrated to Baghdad where from 959 to 998 A.D. he was to play a most important part in furthering Arab mathematics and astronomy.

Since the work of Bulatov there has been little progress or interest in this subject especially in Britain, until the arrival of El-said and Parmas book Geometric Concepts in Islamic Art. During that period another book was making an impression on Italian schools of architecture, that book was called The Geometry of Art and Life, by Ghyka Matila.

Between Ghyka's Geometry of Art and Life and Isam's new book on Islamic geometry, those who were from a Muslim background and studying art and architecture have at last found the torch which will light their future in the search for identity and a solid background to build on. Others encouraged to write about the subject were Keith Albarn who wrote the language of pattern in which Islamic examples were prominent, and Keith Critchlow who produced his well known book Islamic Pattern. In the United States of America another scholar was working on the same subject producing a book which later proved to be the most influential in the deeper meaning of Islamic patterns. The work was that of Ardalan,

The Sense of Unity, although deep and at times difficult to comprehend it revealed a more philosophical understanding to the work of Muslim craftsmen and artisans.

In Europe Echoshard a French scholar had been working on the subject for many years. Concentrating mainly on the geometry of the scalactites and producing magnificent geometric analyses. More recently Lisa Golombe particularly in her examination of Timured Architecture has been able to carry Bolatovs work further with very interesting conclusions. Her results were published in two volumes. Tumured Architecture of Iran and Turan.

Although Islam started in the 7th century A.D. Islamic culture and science did not take a foothold for two or three centuries thereafter. The pinnacle of Islamic civilisation was well established during the Abbasied Dynasty of the 9th century to the 12th century. Manuscripts and scientific data were compiled and translated. Research and studies of all aspects of knowledge were encouraged and generously rewarded. Libraries were founded, Mosques were transformed into study centres, an Islamic Cultural Revolution was in progress.

Islam as a faith penetrated into all aspects of human life. It regulated the economy, banking, tax, profits, inheritance, marriage, divorce and human relations. It regulated personal behaviour, food, drink, clothes and body cleanliness. The words of the Quran and Prophet Mohammed (PBUH) dominated the life of Muslims, individually and collectively, more than any other monotheistic religion ever did. Investigation of the influence of such phenomena on art and architecture is part of this research.

The heritage of this cultural revolution was unique not only in terms of its direct effect on architecture, but also in terms of its influence on people, their social life and their way of thinking. Architecture for example was not regarded as a pure science in itself. It was regarded as a craft, an art, a vocation that was taught through apprenticeships from one generation to another, even though it was based on many forms of science.

Mathematics was found to be the base of all Islamic sciences, in chemistry and medicine and in astronomy and astrology. A unique application of mathematics was the worship of God through appreciation of his creation. Proportions and mathematical relations in natural and man-made objects became manifestations of metaphysics. The concept of God's uniqueness was amalgamated in cosmic unity with man as a minuscule but integral part of that unity. Geometry in its divinity and application as we shall see in this research can be regarded as a form of worship.

Some of the Islamic design patterns are formed on the basis of mathematical theorems. As an example let us take the so called Pythagorean theorem that states that: in a right angle triangle, the square of the side facing the right angle equals to the sum of the square of the other two sides.

If four equal right angle triangles are drawn as shown in figure 1.1, we find that:

the area of each triangle = ab/2

and the area of the central square = $(a-b)^2$

The area of the square = The area of the four triangles + the area of the central square.

The purpose of my thesis, of which this paper is a part of, is to examine the planning methods used in early Muslim architecture (A.D. 692-1125) and to determine whether geometric systems predominated in their construction.

This work is about architecture and its design principles, and, although the subject matter is fixed in historic content, i.e. a particular period of Islamic art, its relevance to the present is intriguing. It is also about those who conceived these buildings and their aspirations to achieve, through the use of geometry *('Ilm Al-Miqdar)*, forms of harmony and proportion.

In the present study, geometry is viewed as a tool which enabled the architect to realise his vision, a system which helped him to transmit complex plans from paper to reality with extreme efficiency, maintaining their proportions, from an overall concept of inner space and volume to the smallest details. Mathematics is a means of translating geometry into another language. For example, any figure involving an octagon is full of irrational measurements which, as Vitruvius was aware,[1] cannot be expressed in round numbers. Vitruvius's solution to the problem was to set out the geometrical figure at full size on the ground and then to measure it.

If we take as an example the Dome of the Rock, which is an obvious octagon in shape, and then prove arithmetically that it is so, are we in fact checking the margin of error in the implementation of the octagon in built form, or are we translating the characteristics of the octagon into numerals? If the former is the case, the margin of error will always relates to many factors, such as the method of marking out on the ground (e.g. the use of cord pegs, shadow casting, or steel chains) or the quality of the labour involved, as well as the ground conditions or site restrictions.

Vitruvius admitted that architects were -and perhaps still are- very different from pure mathematicians.[2] If the architect used geometric principles in marking the ground to solve the problem, the resulting building should reproduce fairly closely the same geometric proportions derived from the diagram used.

The methodology of the present research is based on the following principles. Firstly, a brief examination is made of the historical sources relating to the use of geometry as a basis for generating and setting out of building plans. This includes studying available information on medieval treatises.

Secondly, by examining particular examples of geometric architectural constructions, it is shown that ancient methods, e.g. the use of the square and the circle, were used to establish complex geometric proportions and that these proportions were then used in transferring the exact layout to the full scale, which might be in built form or in decorative motifs of artifacts.

Thirdly, by analyzing plans of early Muslim architecture, i.e. of buildings constructed between A. D. 692 and 1125, use is made of the principal of 'squaring the circle' in reverse, that is to say, superimposing a geometric grid of squared circles on the plans of the buildings as they now stand, in order to establish if the main proportions of the building relate to the proportions of the geometric pattern. Towards the end of each analysis, conclusions are drawn and observations recorded, usually backed by historical evidence, especially that in support of extensions carried out on these buildings which appear to relate closely to the same geometric principal that generated the original plan.

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[1] Architecture, IX, Introduction (cited by J. Wilkinson, Levant, XIII, p. 160, no.11)

[2] Op.cit., I. 2. Pp. 12-16.

It is necessary to investigate the possible existence of such proportions by means of calculations,[3] using measurements derived from the building or the site itself. This I have tried to achieve with every building analyzed, where exact measurements have been published or where it has been possible to take such measurements personally.

The Early History of the Ka'ba According to Muslim Belief

The Ka'ba before the Creation According to Muslim Tradition

According to Ka'ba Al-Ahbar, the Ka'ba existed forty years before the creation of the heaven and the earth. Ibn 'Abbas said that God sent a gentle breeze over the surface of water so as to reveal a dome-shaped mound, now the site of the Ka'ba. God then moulded the earth beneath it, and surrounded it with mountains, the first of which was Abu-Qubais. Hisham Mujahid also said that God created the site of the house (Ka'ba) two thousand years before he created anything on earth and that its foundations reached below the seventh underworld.[4]

The Ka'ba before Adam

When Ali Ibn Al-Husayn, the great grandson of the prophet (PBUH) was asked who first began the rite of circumambulation of the Ka'ba[5] he replied, 'when God assembled the angels to announce that he was appointing a trusteeship on earth, the angels were perplexed, questioning this decision, and so they asked God, "Will you entrust the earth to someone other than us, who is iniquitous and who will spill blood and cause destruction? We worship you, praise you, and do not disobey you " God answered, "know that which you do not." The angels were full of remorse for what they had spoken, so in order to seek forgiveness they began to circumambulate the throne of God, weeping and praying.

The scale of the task won God's compassion. He allowed the angels to continue circumambulating around a much smaller house below his throne (Al-Bayt Al-Dirra) described as a house on four emerald columns all engulfed by a hallow ruby. God later on ordered the angels to construct a similar house on earth with the same proportions (miqdar) for earth inhabitants.[6]

The Ka'ba in the Time of Adam

According to Ibn 'Abbas, when Adam (PBUH) was sent down to earth, he asked God why he could no longer hear the angels chanting. God replied, "it is because of your sin, Adam. But in my name go and build a house around which you will circumambulate in my praise,

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[3] See E. Fernie, 1990, pp. 229-238.

4 Al-Azraqi, Akhbar Makkah p. 31-32. In the religions of many societies and markedly in Islam, there is a symmetry of division above and below the sphere of mankind, that is, there are as many heavens as underworlds.

5 One of the requirements of the haj known as Al-tawwaf.

6 Al-Azraqi, Akhbar Makkah p. 33.

as you have seen the angels do around my throne.' Adam journeyed across lands and sea until he reached Makkah where he began to erect the house of God with the assistance of the angel Jibril[7]

Wahb Ibn Munabbih also said, 'When God forgave Adam he ordered him to make his way towards Makkah. God consoled Adam by rewarding him with a canopy sent down from Heaven which he placed him in Makkah on the site of Ka'ba. The canopy was a ruby containing three golden torches shining with heavenly light. When Adam arrived at Makkah, the canopy was guarded by angels who stood in a circle around the Haram (the compound of the Ka'ba).

'After the death of Adam, the canopy was lifted back to heaven and Adam's children rebuilt the house using clay and stone, which survived until the great flood of Nuh (PBUH).[8] The traces of the Bayt (House) were completely erased and were not discovered until they were again revealed to Ibrahim.[9]

In another riwaya, Ibn 'Abbas said 'When Adam came down to earth, it was within the vicinity of the present Ka'ba (the sacred House). After years of solitude, he longed for the Bayt and as a sign of forgiveness, God permitted him to make his first pilgrimage to the Bayt at Makkah.'[10]

In another riwaya, Outada said, 'Adam and the Bayt were both lowered simultaneously. When Adam became sad and dejected, he prayed to God for compassion. As a sign of forgiveness, God revealed to Adam that he was lowering down a house around which Adam would circumambulate as he saw the angels to around the throne. "Hurry towards it", God Commanded.[11]

According to Abu Hurayra, 'Adam made his pilgrimage to Makkah and was welcomed by the angels who were saying, "Adam, we made this pilgrimage two thousand years before you." "What did you invoke?" Adam asked. "Praise be to God, thanks be to God, there is no God but Allah: and Allah is great, " replied the angels.[12]

The above narration's recounting the history of the Ka'ba may now be summarised as follows:-

A The angels in remorse circled God's throne seeking for forgiveness

B Owing to the scale of this task, God in his compassion placed for them a house below his throne engulfed by a ruby and supported on four emerald columns.

C God instructs the angels to erect a similar house on earth, to the same proportions, for earth's inhabitants, or beings.

D Adam was cast out of heaven, wandering in despair and dejection.

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7 Ibid, p. 37.

8 Ibid, p. 38.

9 Recorded in Qur'an Surat Al-Hajj (22) 26.

10 Ibid.

11 Ibid, p. 42.

12 Ibid.

E Then one day Adam received a sign of forgiveness. God consoled him with one of heavens canopies, which was to be placed for him in Makkah. It was fashioned out of a ruby containing three torches glowing with heavenly light. The canopy was erected on the foundations which had been established by the angels, replacing the previous construction which was for earth's inhabitants.

F Adam made his way to Makkah to visit the House where he was met by the angels who told him of the prior visit to the House.

G After Adam's death, the house was lifted up to heaven. His children after him rebuilt it out of mud and stone. The edifice survived until the Nuh.

The Ka'ba in the Period of Ibrahim

﴿وإذ بوأنا لإبراهيم مكان البيت﴾

It was revealed in the Quran that God had disclosed to Ibrahim the site of the original Ka'ba, Surat Al-Hajj (22), 26: *Behold! We gave the site, to Abraham, of the (Sacred) House*[13] Y. Ali comments on this verse, 'The site of Makkah was granted to Abraham (and his son Ismail) for a place of worship that was to be pure (without idols, the worship being paid to the One True God) and universal, without being reserved (like Solomon's Temple of Later times) to anyone People or Race.[14] Also, in Surat Al-Baqara (2:127), there is a reference to Ibrahim constructing the Ka'ba with his son Ismail:

﴿وإذ يرفع إبراهيم القواعد من البيت وإسماعيل ربنا تقبل منا إنك أنت السميع العليم﴾

And remember Abraham and Ismail raised the foundations of the house (with this prayer): "Our Lord! Accept (this service) from us: for Thou art the All-Hearing, the All-Knowing."

Ibrahim excavated his foundations, only to reveal the original solid foundations of Adam's house. He then raised a structure 9 cubits high, on a plan 32 cubits from the Black Stone corner to the Northern corner by the Hijr[15] and 22 cubits from the northern corner to the western corner-by the Hijr. He made its length from the western corner to the southern, or Yamani, corner 31 cubits and 20 cubits from the Black Stone to the Yamani corner. He also made its entrance at ground level without a door.[16]

When Ibrahim's walls reached a certain height, he searched for a stone to mark the start of the tawwaf. In a riwaya, it is the angel Jibril who brought to Ibrahim this special stone which is now referred to as the Black Stone which God had preserved for Ibrahim in Mount

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[13] English translations of Qur'anic verses are taken from Y. Ali's version.

[14] His footnote No. 2797.

[15] The semicircular enclosure often referred to as Hijr (the lap of Isma'il).

[16] Al-Azraqi, Akhbar Makkah, p. 60, 64.

Abu Qubais. According to many traditions, the stone originally shone so brightly that it illuminated the entire valley.[17]

We may conclude that, according to Muslim traditions, the Ka'ba in the time of Ibrahim was constructed to an almost rectangular plan of 32 x 22 x 31 x 20 cubits and to a height of 9 cubits without roof or door, and that one corner was marked to indicate the starting point of the circumambulation rite.[18] The Hijr was thus referred to at this very early stage when God arranged for Ibrahim and his family to migrate to Makkah. Ibrahim then asked the angel Jibril, 'Am I to place my family here?" (pointing at the place of the Hijr). 'Yes' replied Jibril, whereupon Ibrahim headed toward the place and asked his wife to build around it a shelter.[19]

The Ka'ba in the Time of the Quraysh, (A. D. 600)

As a result of the numerous fires and countless flood, the Ka'ba was completely rebuilt by the tribe of Quraysh in A.D. 600[20] During this period the Prophet Mohammed (PBUH) was about thirty-five years old and had not yet received the mantle of prophethood. Al-Azraqi records that a Christian (perhaps Coptic) builder/carpenter by the name of Baqum helped Quraysh rebuild the Ka'ba.[21] The carpenter was on his way to Abyssinia when his ship, carrying building materials, was wrecked on the shores of Al-Shuaibah the seaport of Makkah. Quraysh paid for the materials by raising funds among the local tribes. They were anxious that the money used to rebuild the Ka'ba should be acquired in a manner sufficiently pure for the purpose. This was in accordance with the scripture found buried under the Ka'ba, possibly in the time of Ibrahim.[22] During the reconstruction of the Ka'ba and due to lack of funds, the Quraysh agreed to stop short of the original foundations. They excavated new foundations and erected a new wall within the boundaries of the original temple. The remaining part was left in the Hijr. A curved wall was built beyond which people could circumambulate.[23] The result was a structure measuring 25 x 22 x 20 cubits and 18 cubits high, with a main door raised off the ground for security and flood protection.

With regard to the Hijr at this period, there is a little material on its relation with the main body of the Ka'ba. All we know at this stage is that the remaining unbuilt part of the Ka'ba is in the Hijr and that a curved wall was built to mark the limit of Ibrahim's original structure.

The Ka'ba in the Period of Ibn Al-Zubayr (A.D. 684)

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[17] Ibid. p. 65.

[18] See sketch plan in Vol. II. Pt. 1 of the present work.

[19] Al-Azraqi, Akhbar Makkah, p. 54.

[20] Ibid. p. 157-160.

[21] Ibid. p. 160.

[22] Matar, Tarikh, p. 65.

[23] Al-Azraqi, Akhbar Makkah, p. 163.

When 'Abd Allah Ibn Al-Zubayr procrastinated in supporting Yazid Ibn Mu'awiya, Ibn Al-Zubayr fearing reprisals hurriedly sought sanctuary in the safe refuge of the Haram (the compound of the Ka'ba) at Makkah. In Makkah Ibn Al-Zubayr rallied his allies and supporters and succeeded in re-establishing himself as the figure-head and authority over the community. He often spoke of Banu Umayya's shortcomings, pointing out Yazid's allegedly numerous vices and failings. One day Ibn Al- Zubayr became excessive in his denunciations and so hearing this Yazid vowed to bring him back in chains. Realising that what he had vowed in anger might cause discord among Muslims and might lead to the violation and a chance to concede with dignity and respect. To reinforce this sentiment, Yazid sent Ibn Al-Zubayr refused emphatically, so that Yazid had no option but to despatch his army, led at the start by Ibn Uqba who later died from a stomach illness during the journey.

As Ibn Uqba's successor, i.e. Ibn Numayr, reached Makkah, he encountered tough resistance from Ibn Al-Zubayr's supporters who were encamped in the grounds of the Haram where they put up tents and erected canopies to shelter from the heat of the sun and any catapulted stone. Ibn Numayr had mounted catapults on high ground overlooking the Ka'ba and each time the Ka'ba received a direct hit it weakened its structure and caused its covering (kiswa) to become tattered and to flap in the wind. At that time the compound was compact and crowded. One day one of Ibn Al-Zubayr's men were lighting a fire when a spark caught the edge of the Ka'ba's torn covering, setting it on fire.

Still maintaining his position on high ground, Ibn Numayr besieged the city, while the citizens of Makkah grew more and more concerned about the deteriorating state of the Ka'ba. Ibn Al-Zubayr decided to send an envoy in order to try and make Ibn Numayr see reason and to divert his attention with the news of Yazid's death. 'Go back to Damascus', the envoy suggested, and see what Yazid's successor may decide. Ibn Numayr was persuaded to return home, whereupon Ibn Al-Zubayr turned his attention to rebuilding the Ka'ba which by then was in a sorry state.

He called Makkah's leading citizens to deliberate on his plans for demolishing the Ka'ba and rebuilding it according to Ibrahim's original dimensions. Many refused, suggesting that he should do no more than repair it but in a famous reply, Ibn Al-Zubayr said, 'None of you would like to live in patched-up homes, yet all of you see no objection to patching up God's house.'

Ibn Al-Zubayr's conviction that the existing structure at this time was short of Ibrahim's original ground plan was based on a well-documented Hadith of the Prophet Mohammed (PBUH) in which he said to his wife Aisha,

'You people (meaning the Quraysh) have shortened the Ka'ba as your funds dried up, leaving part of it in the Hijr unbuilt. If it were not for your people's recent encounter with paganism, I would have demolished the Ka'ba reclaiming what you have left out, and would have built two doors at ground level: an eastern one and a western one for their exist... come with me., 'Aisha, and let me show you what they have left." He showed her a distance close on seven cubits.[24]

Ibn Al-Zubayr completed the demolition of the Ka'ba in the year A.D. 64. He excavated down to foundation level, only to confirm that Quraysh's building did not extend as far as

[24] Al-Azraqi, Akhbar Makkah, p. 206.

the four corners of the original footings.[25] He selected fifty men from among the nobles and wealthiest members of the community and commanded them to witness and proceed with the reconstruction of the Ka'ba according to its true plan. He soon observed, however, that if he was to maintain the Ka'ba's existing height of 18 cubits as established by the Quraysh, the building would appear too long and squat, so he decided to increase its height by another third, making it 27 cubits high.[26] He also brought its entrance down to ground level and devised the well-known waterspout (mizab).[27] Internally, Ibn Al-Zubayr replaced Quraysh's six pillars with three new ones and constructed a small opening through the ceiling to permit the entrance of daylight.

The Ka'ba in the Period of al-Hajjaj AD 692

In AD 691, with an army 5,000 strong al-Hajjai arrived at Makkah to take control, after long battles and these resulted in the death of Ibn Al-Zubayr in AD 692. Thereupon Makkah came under the rule of the Umayyads and al-Hajjai wrote to the Caliph Abd al-Malik Ibn Marwan, informing him of what Ibn Al-Zubayr had done to the Ka'ba without authority and seeking permission to demolish the Ka'ba once more and restore it to Quraysh's plan. The caliph wrote back 'Leave whatever Ibn Al-Zubayr did to increase the height, block up the doors at ground level, and demolish the section he added by the Hijr[28] Al-Hajjai did just that.

When al-Hajjai completed the alterations to the Ka'ba, a delegation from Makkah headed by al-Harith Ibn Abi Rabi's visited the Caliph, Abd al-Malik Ibn Marwan who asked Ibn Al-Zubayr never really heard Aisha narrate the Hadith regarding the Ka'ba being short, did he? What was it you heard from 'Aisha? asked the Caliph. Al-Harith answered:

> *I heard her say that the prophet (PBUH) told her that her people shortened the Ka'ba. She said that the prophet said, "if it were not for your people's recent encounter with paganism, I would have demolished the Ka'ba, reclaiming what you have left out, and would have built two doors at ground level; an eastern one and a western one for their exit..... Come with me, 'A'isha, and let me show you what they have left out.' He showed her a distance close on seven cubits.*
>
> The Caliph was remorseful and said, 'I wish I had left Ibn Al-Zubayr alone. Is there anything I can do now?" He was strongly advised not to correct the mistake, but to allow the Ka'ba to remain as it was and so it has remained unchanged to this day.[29]

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[25] Ibid.

[26] Ibid. p. 209

[27] Now made from Gold.

[28] Al-Azraqi, Akhbar Makkah, p. 210.

[29] Ibid. p. 20.

'Ka'ba does not Mean 'Cube'

It is very curious that in almost all Western historic references it is stated that the name Ka'ba is derived from the Arabic word for 'cube', yet in Classical Arabic, the word Ka'ba means a shape which protrudes or projects out of a plain or surface and, in addition, almost all objects referred to by this term are characteristically curved or spherical. For instance, the word ka'ba in Arabic means 'ankle'. Other examples of this descriptive term can be found in the poetry of the pre-Islamic period, e.g.:

قتيل كِعَاب لا قتيل حروب

not victims of battles, but victims of young breasts.

Again, in the Quran Surat al-Naba (78:33), there is a reference to Kawa'ib atraban, describing men's companions in heaven as 'maidens of young breasts and of equal age.' We have evidence that the Ka'ba was known by this name as far back as the Jahiliyya, thanks to the extensive research work of Al-Ansari in the 1970s, confirming the usage of the term Ka'ba referring to the actual Ka'ba in Makkah.[30]

Al-Azraqi's discussion on the subject of the term Ka'ba simply says that it is narrated that Ibn Abi Najih said that it was called the Ka'ba because it resembled the Ka'b (i.e. ankle) and that people used to build their homes in a round or circular shape (mudawwara) as a mark of respect for the Ka'ba.[31]

Was the Ka'ba Curved?

As discussed above under the heading Ka'ba does not mean 'Cube', the name itself seems to suggest a more rounded shape. According to Ibn Hajar al-Asqalani (d. 852/1449). 'The Ka'ba of Jahiliyya times was built using broken stones without mortar, and its walls were draped in a cloth with only two corners according to the following shape:[32]

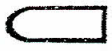


Fig. P.1

The Ka'ba in the Jahiliyya period was a structure highly respected by pagan Arabs, but it was also a building shared among several other cultures and beliefs. It was a place of worship for Persians, Jews and Indians.[33]

The question whether the Ka'ba was originally curved or not seems to hinge on understanding the true significance of the Hijr, as it is the only immediate structure closely associated with the history of the Ka'ba. We first encountered the Hijr as the sanctuary in the wilderness built for Hajar and her son Isma'il (PBUH). We next encounter the Hijr in

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[30] Al-Tarikh Al-Mufassal Li'l-Ka'ba (Jeddah, 1982), p. 11.

[31] Akhbar Makkah, p. 279f.

[32] Cited in Al-Ansari, Al-Tarikh Al-Mufassal Li'l-Ka'ba, p. 36.

[33] Al-Ansari, al-Tarikh Al-Mufassal, Li'l-Ka'ba, p. 41.

the pre-Islamic period in connection with the reconstruction work of the Quraysh. Although the Hijr was then left out of the building on account of inability to finance the whole structure, Hijr Isma'il, which was then called Al-Hatim, was a court of honour for the great men of Quraysh such as Abd al-Muttalib, the grandfather of the Prophet (PBUH). As the Ka'ba cast a constant shadow on the Hijr, the place had the benefit of a pool of cool air. It is narrated that when Isma'il complained against Makkah's heat, God promised that the Hijr should thereafter be cool as earth from heaven.[34]

After the rise of Islam, we encounter the Hijr as a holy place, the true significance of which was known only by Mohammed (PBUH). It is narrated in the Hadith that A'isha said:

> *I used to cherish entering the house to pray. The prophet (blessings be upon him) once took me by the hand and said, 'pray in the Hijr if you ever wish to enter the house, for it is a portion of the house although when your people shortened the Kaba they excluded it from the house.*[35]

Geometric Analysis

Most scholars cite Al-Azraqi on the overall dimensions of the original Ka'ba, i.e. 32 x 22 x 31 x 20 cubits, and this was close enough for Creswell to conclude that the layout lends itself to a 2:3 proportion.[36] Al-Azraqi also refers under his section on "The Original Dimensions of the Ka'ba,[37] to an overlooked narration to the effect that Abu Al-Walid said, Ibrahim Khalil Allah built the Ka'ba. He made it nine cubits high and thirty cubits long and twenty-two cubits wide, and it has no roof.' Taking into consideration the fact that the Ka'ba today measures 25 cubits lengthwise from the corner of the Black Stone to the northern corner, and 25 cubits from the southern corner to the western corner, and measures 20 cubits widthways from the corner of the Black Stone to the southern corner and 21 cubits from the northern corner to the western one within the Hijr[38], we notice that the oldest side in line with the Black Stone measures 20 cubits, while the most recent side by the Hijr, which the Quraysh built A.D. 600, measures 21 cubits. In this case let us assume the 2:3 proportion to be a reasonable assumption and the plan of 30 x 20 x 30 x 20 to be not beyond the bounds of imagination, and further let us take a generating unit circle of 20 cubits' diameter as the inner dimension of the present Hijr to be 20 cubits.[39] This will be our circle no. 1 (see Geometric Analysis, Ka'ba/A1). From centre 0 to the unit circle cuts the horizontal axis 6.2 and 8.2 and cuts the vertical axis at 7.2 and 5.2. From 6.2 and with the same radius of 20 cubits, we draw a second circle cutting the horizontal axis at 6 and 0 and cutting the vertical axis at 3.2 and 2.2. From 8.2 and again with the same radius, we draw a third circle cutting the horizontal axis at 0 and 8, and the vertical axis at 4.2 and 1.2.

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[34] Al-Azraqi, Akhbar Makkah, p. 312.

[35] Matar, Tarikh, p. 75.

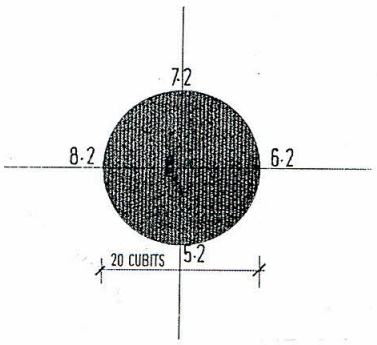
[36] Early Muslim Architecture, Vol. I pt 1: Umayyads 622-750 AD, p.1.

[37] Akhbar Makkah, p. 288.

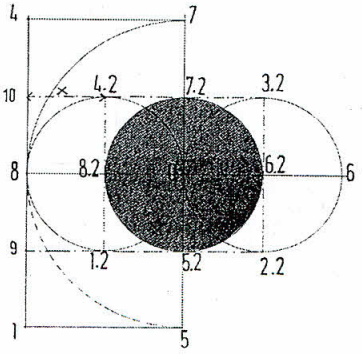
[38] Ibid. p. 289.

[39] Ibid. p. 320.

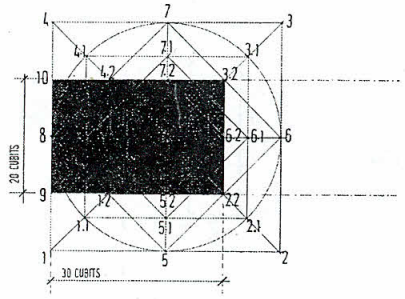
In (Geometric Analysis), Ka'ba/A.3 we see how we can arrive at a rectangle of 2:3 proportions. By connecting 3.2, 7.2 and 4.2: and 2.2, 8.2, and 1.2, if x = 10 cubits, the rectangle would measure 30 x 20 cubits, leaving at the end a semicircle from 6.2 resembling the position of the Hijr (see Geometric Analysis, Ka'ba/A4)



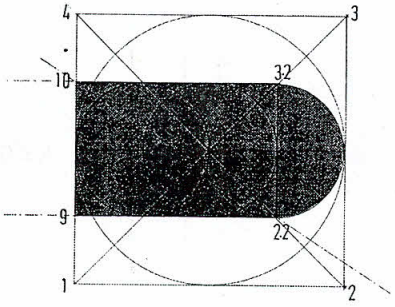
Ka'ba/A1



Ka'ba/A2



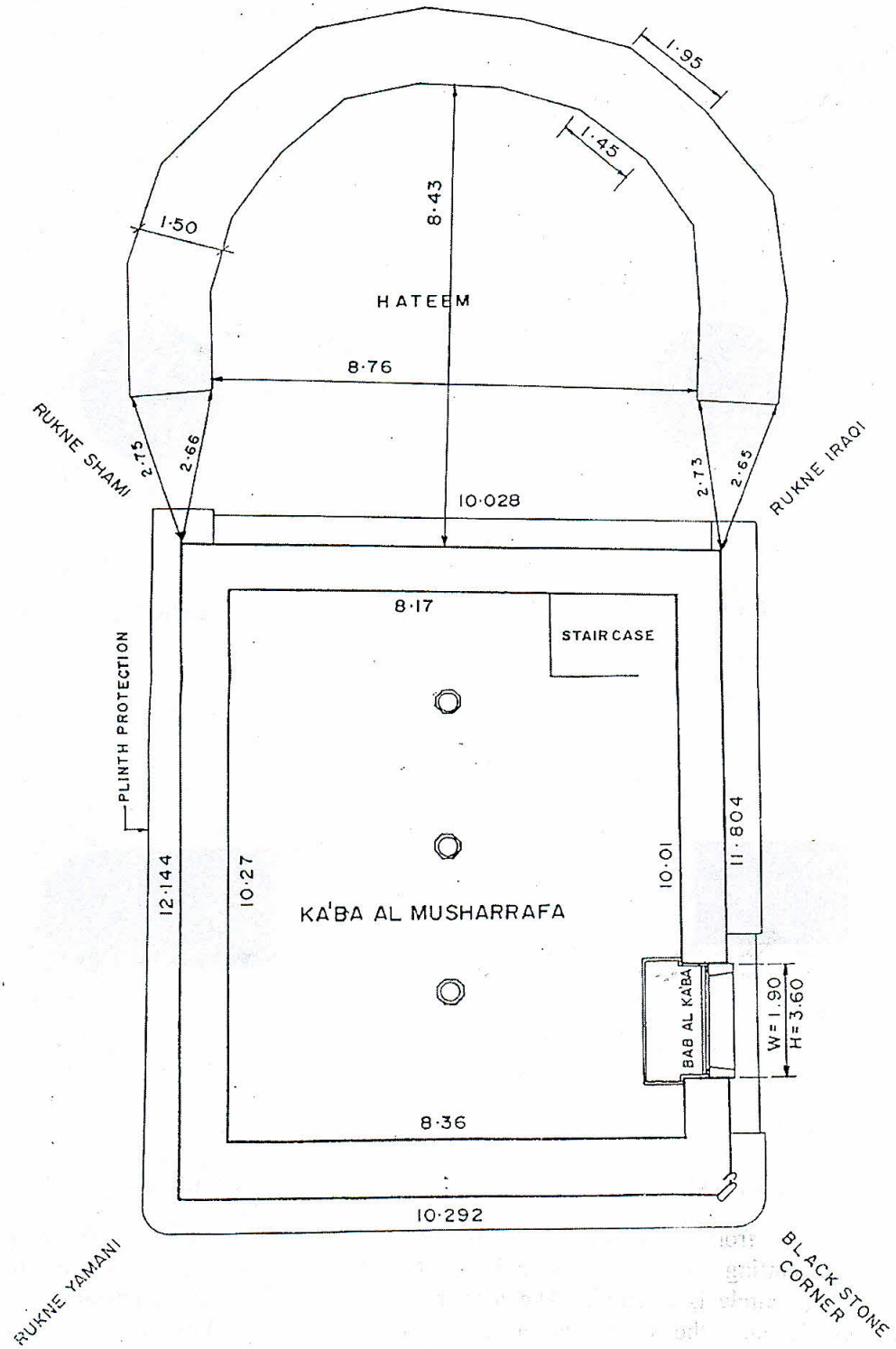
Ka'ba/A3



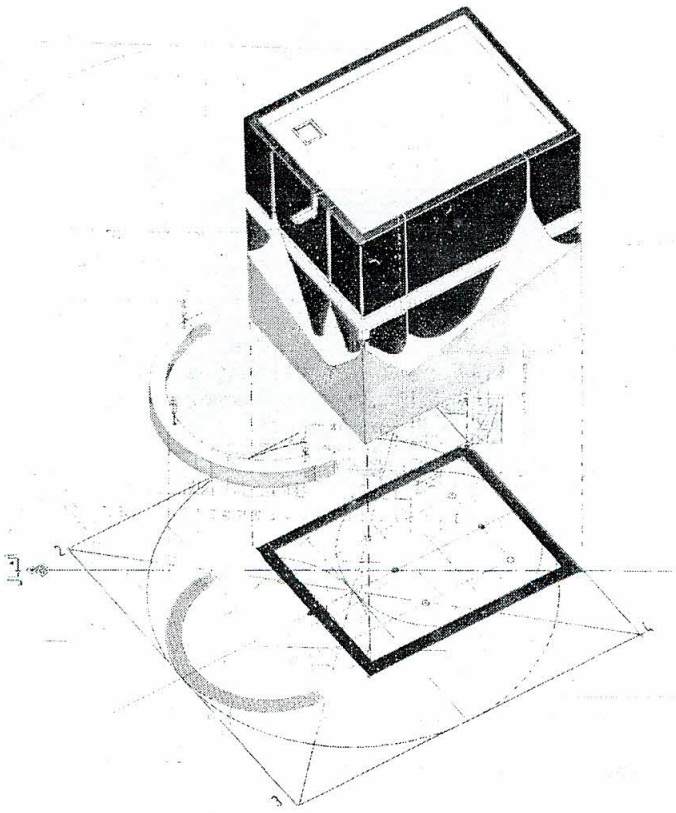
Ka'ba/A4

To take this further, from the centre of the middle circle 0 and with radius 0-6, we now draw a master circle cutting the horizontal axis at 6 and 8 (see Geometric Analysis, Ka'ba/A2). Then the master circle is squared. The master square 1, 2, 3, 4 has diagonals 1-3 and 2-4. The master circle cuts the diagonals at 1.1, 2.1, 3.1 and 4.1. When connected, these will form a square and if this square in turn is turned by 45 degrees it will make a square 5,6,7,8. This turned square cuts the main diagonals at 3.2, 4.2, 1.2 and 2.2, forming an inner square 3.2, 4.2, 1.2, 2.2 which, If turned by 45 degree will produce the square 7.1, 8.1, 5.1, 6.1 and so on.

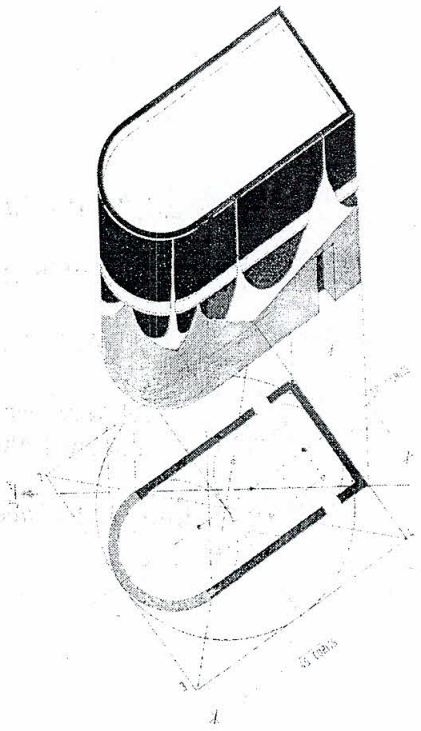
The rectangle 9, 2.2, 3.2, 10 reflects the 2:3 proportion assuming that the Hijr is part of the Ka'ba (see detailed analysis Ka'ba/A7).


1·95
1·45
1·50
8·43
HATEEM
8·76
RUKNE SHAMI
2·75
2·66
2·73
2·65
RUKNE IRAQI
10·028
8·17
STAIR CASE
PLINTH PROTECTION
12·144
10·27
KA'BA AL MUSHARRAFA
10·01
11·804
BAB AL KABA
W=1.90
H=3.60
8·36
10·292
RUKNE YAMANI
BLACK STONE CORNER

Ka'ba/A8



Ka'ba/A. 02



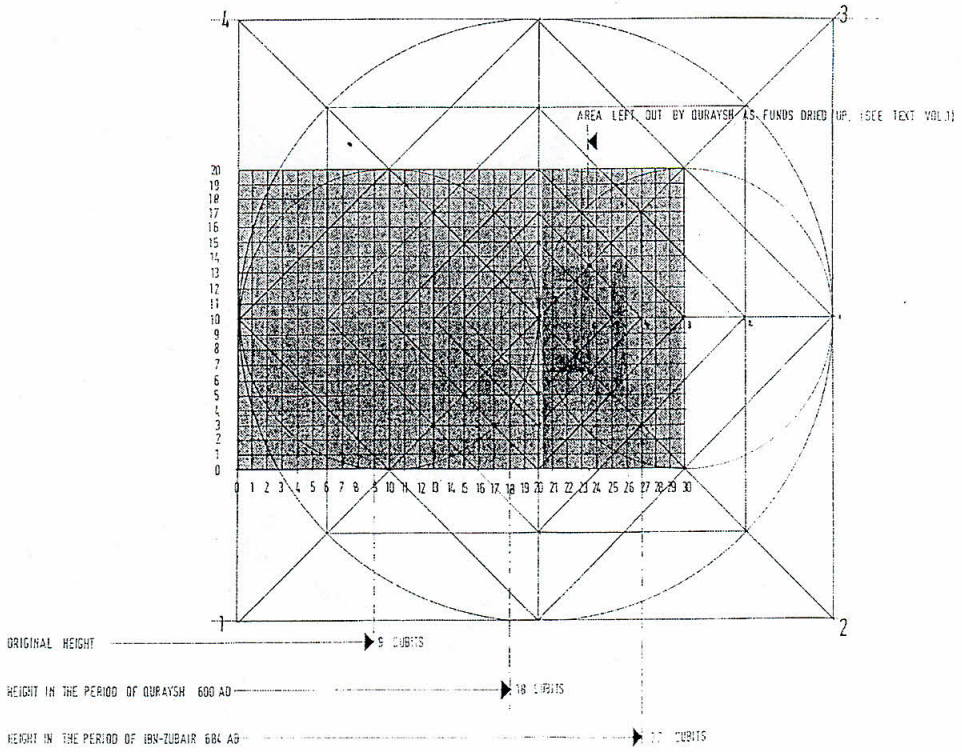
Geometric Analysis also in Vol II P.One.

How the Ka'ba may have appeared had Quraysh Completed the Structure.

Prior to Quraysh Reconstruction the Ka'ba was Curved.

See Vol.1 Ka'ba

Ka'ba/A. 03



Ka'ba/A7

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التحليل القياسي الهندسي للكعبة الشريفة

نجيب جدال

جامعة مانشستر

مانشستر, المملكة المتحدة

ملخص البحث : أظهر موضوع دراسة التحليل القياسي في هندسة العمارة الإسلامية أن هنـــاك دليـــلاً كافيـــاً لوجـــود أســـس هندســـية قوية ضمن بدايات المباني الإسلامية والذي نتج عنه ثراءً في الأشكال المعمارية ، وشكل لغة هندســـية ضمـــن اســـتخدام المربـــع والدائـــرة .

تناولت الدراسة الكعبة الشريفة أول مسجد في الإسلام من حيث أنها أول مبنى نذر لعبادة الخـــالق عـــز و جـــل. مـــن ذلـــك تمكنـــت مـــن دراسة تخطيط الكعبة هندسياً مع تتبع إنشائها زمنياً و ذلـــــك كالتـــالي :

الكعبة قبل الخلق تبعاً للمعتقد الإسلامي .

الكعبة قبل آدم عليه السلام.

الكعبة في عهد آدم عليه السلام.

ـــ الكعبة في عهد إبراهيم عليه السلام.

ـــ الكعبة في عهد قريش.

ـــ الكعبة في عهد عبد الله ابن الزبير رضي الله عنه.

ـــ الكعبة في عهد الحجاج رضي الله عنه.

أكثر الباحثين يعودون الى الأزرقى لمعرفة القياســـات العامـــة للكعبـــة ٢٣ X ٢٢ X ٣١ X ٢٠ ذراعـــاً ممـــا حـــذا ب Creswell إلى القول بأن مخطط الكعبة هو بنسبة ٢:٣. ويبني الأزرقى فرضيته في موضوع "المقاســـات الأصليـــة للكعبـــة" الى اعتمـــاد روايـــة أبـــو الوليـــد حيث قال أن "إبراهيم خليل الله بنى الكعبة وجعلها ٩ أذرعـــه ارتفاعـــاً و٣٠ ذراعـــاً طـــولاً و ٢٢ ذراعـــاً عرضـــاً وبـــدون ســـقف. وإذا أخذنا بحقيقة أن الكعبة تبلغ اليوم ٢٥ ذراعاً طولاً من ركن الحجر الأســـود الى الركـــن الشـــمالي و ٢٥ ذراعـــاً مـــن الركـــن الجنـــوبي الى الركن الغربي و ٢٠ ذراعاً عرضاً من ركن الحجر السود إلى الركـــن الى الركـــن الجنـــوبي و ٢١ ذراعـــاً مـــن الركـــن الشـــمالي الى الركـــن الغرب من داخل الحجر، نلاحظ أن أقدم ضلع محاذيا للحجر الأسود يبلغ ٢٠ ذراعاً، بينما أكـــثر الأبعـــاد حداثـــة محاذيـــاً للحجـــر و الـــذي بنته قريش سنة ٦٠٠ قبل الميلاد يبلغ ٢١ ذراعاً. في هذه الحالة لنفرض أن نســـبة٢:٣ هـــي نســـبة معقولـــة وأن الأبعـــاد ٣٠ X ٢٠ X ٣٠ X ٢٠ ليست خيالية . ولنفرض أيضا أن هناك دائرة داخلية قطرها ٢٠ ذراعـــاً علـــى حســـب أن الحجـــر يبلـــغ ٢٠ ذراعـــا للحجـــز(دائرة E شكل A. من المركز صفر وحدة الدائرة تقطع المحـــور الأفقـــي في ١ و ٣ وبنفـــس فتحـــة نصـــف القطـــر (٢٠ ذراعـــا) نرســـم دائرة ثانية من المركز ١ ليقطع المحور الأفقي في صفر و ٥ . من المركز ٥ نرسم دائرة مـــرة أخـــرى و بنفـــس طـــول نصـــف القطـــر نرســـم دائرة ثالثة لتقطع المحور الفقي في ١ و ٦ (شكلB) يظهر أن المستطيل ٩ ، ١٠ ، ١١ ، ١٢ شـــكل Cيشـــكل نفـــس نســـب الكعبـــة ، شبة الدائرة ٧ ، ٨ شكل C تحدد بالضبط مكان حجر إسماعيل. وباستخدام مقاسات فعلية للكعبـــة رفعـــت حديثـــاً وحصلـــت عليـــها مـــن السفارة السعودية عام ١٩٩٧م استطعت إثبات تحليلاتي الهندسية وذلك حـــــتى فـــاصلتين عشـــريتين.