IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

BODHAYAN: FATHER OF GEOMETRY

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Abstract:

अंतिम प्रभा का है हमारा विक्रमी संवत यहाँए
है किन्तु औरों का उदय इतना पुराना भी कहाँ ?
ईसाए मुहम्मद आदि का जग में न था तब भी पताए
कब की हमारी सभ्यता हैए कौन सकता है बताद्द.मैथिलिशरण गुप्त

These lines of poetry by Rashtrakavi Maithilisharan Gupta remind us of our glorious past and inspire that we, who have become accustomed to look at other countries in the matter today, are nothing but forgetting our past. An important pillar of this past was Rishi Bodhayana.

Baudhayana was the ancient mathematician of India and the author of Shulba Sutra and Shrauta Sutra. Euclid's geometry is taught all over the world, considering it to be authentic in the subject of geometry. But it should be remembered that even before Euclid, the great Greek geometry, many geometry scientists in India had discovered important laws of geometry, among those geometry, the name of Bodhayana is paramount, in India Geometry or Geometry was called Shulva Shastra.

Keywards - Shulba Sutra, Shrauta Sutra, Rhombus, Sage Baudhayan, Yagya, pi, Hypotenuse.

I. INTRODUCTION

Geometry of Euclid is taught all over the world, considering it to be authentic in the subject of geometry. But it should be remembered that even before the great Greek geologist Euclid, many geometry scientists in India had discovered important laws of geometry, among those geometry the name of Bodhayana is paramount. Geometry or Geometry in India at that time was called Shulva Shastra.

The sutras of Baudhayana are in Vedic Sanskrit and are related to religion, daily rituals, mathematics etc. They related to the Taittiriya branch of the Krishna Yajurveda. These are probably the oldest texts in the Sutra texts. They were probably composed in the 8th-7th century BC. Most notably, Bodhayana's Shulbasutras contain many results and theorems of early mathematics and geometry, including an approximate value of the square root of 2, and a statement of the Pythagorean theorem.

LIFE STORY OF BODHAYANA: It is not possible to write a biography of Bodhayana as nothing is known about him except that he was the author of one of the earliest Sulbasutras. We don't know his dates exactly, even can estimate his life span, which is why we have given the same estimated birth year as death year. Born in 800 BC, Bodhayana composed more than two hundred religious texts. He gave many important principles of mathematics. It is told by a verse that in a rectangle the square of the hypotenuse is equal to the sum of the squares of the base and the perpendicular. This verse, described in his work Vriti Granth, is known as Bodhayana Theorem. The theorem was elaborated by the Greek scholar Pythagoras. Later on its basis Aryabhatta made discoveries in the field of space science.

The famous grammarian of Sanskrit, Panini, in his treatise Ashtadhyayi, has described Bodhayana as a guru. Bodhayana was a great scholar of philosophy, religion, mathematics and language. He wrote more than two hundred treatises. Among them, Vedavruti, Vedanta, Ratna Manjush, Dharmasutra and Grihasutra are prominent.

He certainly must have been a man of much learning, but was probably not interested in mathematics for himself, only interested in using it for religious purposes. There is no doubt he wrote the Sulbasutra to provide rules for religious rites and it would seem almost certain that Bodhayana himself would have been a Vedic priest. The mathematics given in the Sulbasutras is meant to enable the precise construction of the altars required for the sacrifice. It is clear from the writings that Bodhayana must have been a priest as well as a skilled craftsman. He must have been proficient with life-useful use of mathematics, which he described as a craftsman who himself constructed sacrificial altars of the highest quality.

WORK OF BODHAYANA:

1.Square root of 2

Bodhayana verse number i.61-2 (explained in Apastamba i.6) describes the method of finding the length of a diagonal given the lengths of the sides of a square. In other words, it describes the method of finding the square root of 2. The verse related to this solution is as follows:-

समस्य द्विकर्णि प्रमाणं तृतीयेन वर्धयेत।
तच् चतुर्थेनात्मचतुस्त्रिंशोनेन सविशेषः ।।

Meaning: To get the value of the diagonal of a square, by adding one-third to the side, then adding one-fourth of it, then subtracting thirty-fourth of it, what is obtained is approximately the value of the diagonal.

2. Constructing a circle of area equal to the area of the square

चतुरस्रं मण्डलं चिकीर्षन्न् अक्षयार्धं मध्यात्प्राचीमभ्यापातयेत् ।
यदतिशिष्यते तस्य सह तृतीयेन मण्डलं परिलिखेत् ।। (I-58)[1]

Draw half its diagonal about the center towards the East-West line; then describe a circle together with a third part of that which lies outside the square. That is, if the side of the square is 2a, then the radius of the circle r = [a+1/3(√2a – a)] = [1+1/3(√2 – 1)] a

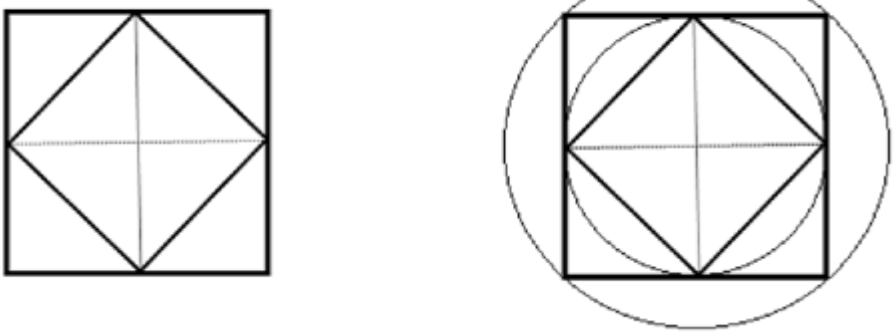
3. Constructing a Square of Area Equal to the Area of the Circle

मण्डलं चतुरस्रं चिकीर्षन्विष्कम्भमष्टौ भागान्कृत्वा भागमेकोनत्रिंशधा।
विभाज्याष्टाविंशतिभागानुद्धरेत् भागस्य च षष्ठमष्टमभागोनम् ॥)I-59))[2]

If you wish to turn a circle into a square, divide the diameter into eight parts and one of these parts into twenty-nine parts: of these twenty-nine parts remove twenty-eight and moreover the sixth part (of the one part left) less the eighth part (of the sixth part).

4. **Circling a square**

Bodhayana was able to draw a circle roughly equal to the area of a square and vice versa. These processes are described in their sources (I-58 and I-59). Possibly in his quest to build circular altars, he constructed two circles enclosing the two squares shown below.



Now, as in the area of squares, he realized that the inner circle should be exactly half of the larger circle in area. He knew that the area of a circle is proportional to the square of its radius and the above construction proves to be the same. By the same logic, as the circumference of two squares, the circumference of the outer circle must also be 22 times the circumference of the inner circle. This proves the known fact that the perimeter of a circle is proportional to its radius. This led to an important perusal made by Bodhayan. that the areas and perimeters of many regular polygons, including the squares above, can be related to each other as in the case of circles.

5. Bodhayana theorem

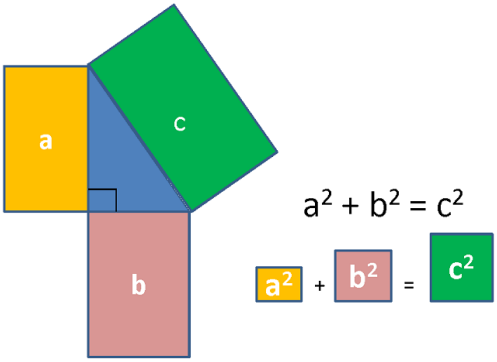
Bodhayana listed the Pythagorean theorem in his book Bodhayana Sulbasutra.

दीर्घचातुरास्रास्याक्ष्नाया रज्जुः पार्च्वमानी तिर्यङ्मानीच च यत्पृथग्भूते कुरुतस्तदुभयं करोति ॥

For example Bodhayana used a rope in the above verse/verse, which can be translated as: The areas produced by the length and breadth of a rectangle separately are equal to the areas produced by the diagonal together. The described diagonals and sides are those of a rectangle, and the areas are those of the squares whose sides are those of these line segments. Since the diagonal of a rectangle is the hypotenuse of a right triangle formed by two adjacent sides, this statement appears to be equivalent to the Pythagorean theorem.Various arguments and explanations have been given for this.While some have assumed that the sides relate to the sides of a rectangle, others say that the reference may be to a square.There is no proof to suggest that Baudhayana's formula is limited to right-angled isosceles triangles so that it can be linked to other geometric figures as well. So it is logical to assume that the sides he mentioned can be sides of a rectangle. Bodhayana seems to have simplified the learning process by encapsulating the mathematical result in a simple verse in a layman's language. As we see, it becomes clear that this is probably the most innovative way to understand and visualize the Pythagorean theorem (and geometry in general).

Comparing his findings with Pythagoras' theorem:

In mathematics, the Pythagorean theorem is a relation between the three sides of a right-angled triangle. According to this theorem area of square at hypotenuse is equal to sum of areas of square at other two sides.If c is the length hypotenuse of the right angled triangle with a and b being the other two then



The question may well be asked why the theorem is attributed to Pythagoras and not Bodhayana. Bodhayana used area calculations and not geometry to prove his calculations. He came up with geometric proof using isosceles triangles.

6.Value of π

Bodhayana is considered among one of the first to discover the value of 'pi'. There is a mention of this in his Sulbha sutras. According to his premise, the approximate value of pi is 3.3.Several values of π occur in Bodhayana's Sulbasutra, since, when giving different constructions, Bodhayana used different approximations for constructing circular shapes.

Some of the major theorems propounded by Bodhayan are-

1.Diagonals of a rectangle cut each other at their middle point.

2. Diagonals of a rhombus cut each other at ninety degree

3.The area of a square formed by joining the mid-points of the sides of a square is half the area of the original square.

4.A rhombus is formed by joining the mid-points of the sides of a rectangle whose area is half the area of the original rectangle.

It is clear from the above description that Bodhayana had studied the properties and areas of rectangle, square, right angled triangle, rhombus. The Yaj was probably due to the importance of the 'Yagya Bhumika' being made for the Yagya at that time.

CONCLUSION: Bhodhayana's place in the field of mathematics will remain immortal for ages. Bhodhayana's important contribution was to take science out of superstitions and give new thinking, new vision. He is the first mathematician in the world to discover famous theorem which gives the relation between sides of right angle triangle, but the credit is given to Pythagoras, which is wrong.

.With time people's thinking has changed and here along with the interest of the people of the world has also started to know and understand Indian culture. Perhaps it is the result of this that the attention of the people towards the great works of ancient sages and mathematicians. The biggest example of this is the theorem of Pythagoras, which is now known as the Bodhayana-Pythagoras theorem. The aim of the Indians from the very beginning has been "Vasudhaiva-Kutumbakam". Everything discovered by them was dedicated to the welfare of the people. We forgot our great tradition and got lost in the depths of ignorance. Today there is a need to re-research on the beliefs established by our sages so that their discovery can be planned in the direction of public welfare**.**

We have all heard our parents and grandparents talk of the Vedas. Still, there is no denying that modern science and technology owes its origins to our ancient Indian mathematicians, scholars etc. Many modern discoveries would not have been possible but for the legacy of our forefathers who made major contributions to the fields of science and technology. Be it fields of medicine, astronomy, engineering, mathematics, the list of Indian geniuses who laid the foundations of many an invention is endless

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