THE MODEL FOR THE CONSTRUCTION OF FIRE-ALTAR

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Abstract : While describing altars of various kinds, *Baudhāyana* describes in detail bricks of various shapes to be used in erecting the altars. The shapes of bricks described there in correspond to geometrical figures of a right-angled triangle, an isosceles right-angled triangle a scalene triangle, a rectangle, a rhombus and a trapezium. But this is not all impelled by the desire to achieve accuracy. *Baudhāyana* proceeded to find out models for the constructions of those geometrical figures in the course of which one stumbled upon certain geometrical theorems, that on a right-angled triangle being a glowing examples in point. In the present paper our aim to the Model for the construction of Fire-Altar in the form of an Isosceles Triangle (*Praugaciti*), Rhombus (*Ubhayata Prauga*) and Chariot Wheel (*Rathacakra Citi*).

Keywords : Fire-Altar, Isosceles Triangle (*Praugaciti*), Rhombus (*Ubhayata Prauga*) and Chariot Wheel (*Rathacakra Citi*).

Introduction

During the period 600 B.C. to 300 B.C. or even earlier, knowledge was transmitted from father to son or from guru to disciples by committing to memory. In course of time need for setting out the instruction in a written form was slowly felt and consequently the several *Sulbasūtras* were written. In this way, the subsequent developments in mathematics are recorded in *Sulbasūtras*. The much older and traditional Indian mathematics developed for constructions and transformation of Vedic altars of various types and forms, which are recorded in *Sulbasūtras*. Some *Sulbasūtras* deal with the rules for the measurement and construction of the various sacrificial altars and consequently involve geometrical propositions and problems relating to different geometrical figures. In this paper, we developed some mathematical models of different proposition and problems which are given in the *Sulbasūtras* in the form of rules.

In the present paper our aim to the Model for the construction of Fire-Altar in the form of an Isosceles Triangle (*Praugaciti*), Rhombus (*Ubhayata Prauga*) and Chariot Wheel (*Rathacakra Citi*).

The Model For the construction of Fire-Altar in the form of an Isosceles Triangle (*Praugaciti*)

Baudhāyana has given a model for the construction of a fire altar in the form of an isosceles triangle, which is as follows :

yāvaragniḥ śārtniprādeśastāvatpraugaṃ kṛtvā tasyāparasyāḥ
karaṇyā dvādaśeneṣṭakāstadardhavyāsāḥ kārayet / (III. 162) /
tāsāmardhyāḥ pādyāśca / (III. 163) / (*Bśl*. 14.2)

"An isosceles triangle equal in area to the (seven fold) fire altar with two *aratnis* and (one) *prādesa* (that is, $7\frac{1}{2}$ sq. *puruṣa*) is laid. Bricks (called *bṛhati*) of length equal to one-twelfth of its western side and breadth equal to half (of the length) are to be made; then bricks which are half and quarter (of the *bṛhatis*)".

According to this rule, the fire altar should be $7\frac{1}{2}$ sq. *puruṣa Baudhāyana* (*Bśl*. 2.7) has shown that an isosceles triangle of $7\frac{1}{2}$ sq. *puruṣa* can be drawn from a square of double this area, that is, 15 sq. *puruṣa* by joining the mid point E of the eastern side AD with two western corner points B and C (Fig. 1). The base BC and each side EB, EC are given by

$$BC = \sqrt{15}\ \textit{puruṣa}$$
$$= 120\sqrt{15}\ \textit{angulas}$$
$$= 464.76 \text{ or } 464\frac{4}{3}\ \textit{angulas} \text{ approx.}$$

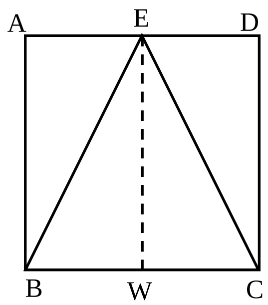

Fig. 1

and EB = EC
$$= \sqrt{\left(\sqrt{15}\right)^2 + \left(\frac{\sqrt{15}}{2}\right)^2}\ \textit{puruṣa}$$
$$= \frac{\sqrt{75}}{2}\ \textit{puruṣa}$$
$$= \frac{5}{2}\sqrt{3}\ \textit{puruṣa}$$
$$= 120 \times \frac{5}{2}\sqrt{3}\ \textit{angulas}$$
$$= 300\sqrt{3}\ \textit{angulas}$$
$$= 519.6 \text{ or } 519\frac{1}{2}\ \textit{angulas} \text{ approx.}$$

Dvārakānātha explains that a square with $464\frac{4}{3}$ *aṅg* is to be first drawn and then the required isosceles triangle is constructed.

The following are the models for four types of bricks which are prescribed for the construction of the fire altar (Fig. 2).

B_1 – a rectangular brick, *bṛhati*

$$\frac{BC}{12} \times \frac{BC}{24} \qquad \text{or } 10\sqrt{15} \times 5\sqrt{15} \text{ sq. } ang$$

B_2 – a triangular brick half of the *bṛhati*, diagonally intersected.

B_3 – a triangular quarter brick with long base, *dirghapādyā*

B_4 – a triangular quarter brick with short base and pointed like a spear, *sūlapādyā*.

According to *Bśl* 14.3 and 14.4 half bricks with their hypotenuse turned out side one to be placed on both sides and the rest of the fire–altar is to be covered with *bṛhati* and the number (of 200 bricks) is to be completed with half bricks.

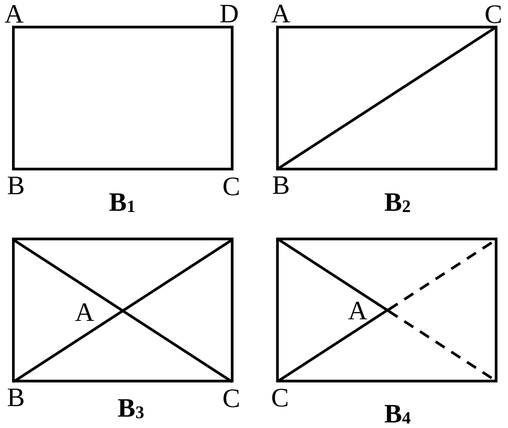

Fig. 2

Fire-Altar in the Form of a Rhombus (*Ubhayata Prauga*)

Baudhāyana has given a mode1 for the construction of a rhombus or double isosceles triangle having common base and the two vertices on the opposite side are given *Bśl* (2.8).

ABCD and BFGC are two equal squares, each of area $7\frac{1}{2}$ sq. *puruṣa*. EBWC is the desired rhombus of $7\frac{1}{2}$ sq. *puruṣa* of which E and W are the mid points of AD and FG respectively. (Fig. 3)

$$BC = 120\sqrt{\frac{15}{2}} \; ang$$
$$= 328.56 \; ang$$

$$BE = EC = BW = WC = 300\sqrt{\frac{3}{2}} \; ang = 367.5 \; ang$$

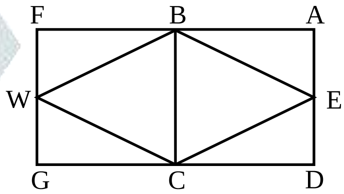

Fig. 3

Dvārakānātha gives the value of BC as *Trini satānyastāvimsatis cāngulaya ardhavimsāsca tilāh* (56 *aṅg* = 19.04 *tila*) *tiryanmāni*.

Each side of the rhombus is given as *evam krterdhādhikasaptas* as *tisatatrayamangulayah karanyo bhavanti*.

Four types of bricks are made in the same way as those for the isosceles fire-altars. B_1 the rectangular brick, *bṛhati*, is $\frac{BC}{9} \times \frac{BC}{18}$; bricks; B_2 (*ardhyā*), B_3 (*dirghapādyā*) and B_4 (*sulapādyā*) are made by diagonal intersections of the *bṛhati* as before.

The entire area $7\frac{1}{2}$ sq. *puruṣa* of rhombus EBWC is divided into 144 rectangles where an equal number of *bṛhati* bricks can be placed and into 36 half rectangles along the sides where an equal number of *ardhyās* can be placed. Thus we get 180 bricks. The deficit is met by replacing 10 B_1s in the 6th vertical row on either side of the central line EW by 20 B_2S. With the above substitution, the total number of B_1s is 124 and that of B_2S 76.

Fire-Altar in the Form of a Chariot Wheel (*Rathacakra Citi*)

There are two types of fire-altars in the form of a chariot wheel:

(i) A square piece with four circular segments attached one on each side so as to give the whole structure a circular shape and

(ii) A circular wheel provided with spokes.

Both types of fire-altars are used for sacrificial purposes.

The method of constructing a circle equivalent to that of a square area (in this case $7\frac{1}{2}$ sq. *puruṣa*) has been given by *Baudhāyana* in his rule (*Bśl*. 2.9). Fig. 4 represents the required circle of area $7\frac{1}{2}$ sq. *puruṣa* within which is drawn the largest possible square ABCD. The space bounded by each side of the square and the area of the circle is called *pradhi* (segment), there are four such segments.

Let the side of the square AB or AD = a be a chord and the radius of the circle OA be r.

Therefore, area of the circle = πr^2

or, $\frac{15}{2}$ sq. *puruṣa* = πr^2

or, $\frac{15}{2} \times 120 \times 120$ sq. *aṅg* = πr^2

$$\therefore \quad r = 120\sqrt{\frac{15}{2\pi}} \; ang$$
$$= 185.45 \; ang \text{ or } 185 \; ang \; 15 \; tilas$$

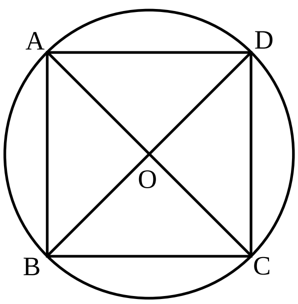

Fig. 4

Again,

$$a^2 = r^2 + r^2$$
$$= 2r^2$$
$$= \frac{2\times15\times120\times120}{2\pi}$$
$$\therefore a = \sqrt{\frac{15\times120\times120}{\pi}}$$
$$= 262.27$$ *aṅg* or 262 *aṅg* 9 *tilas*.

In the above calculation π has-been taken to be 3.14. *Dvārakānātha* gives the value of r as 185 *aṅg* 14 *tilas* (*ṃadhye sankum nihatya pancāsi tisatāngulena caturdasatilayuktena parimandala bhramayet*). His value of a is 262 *aṅg* 7 *tilas* (*tasya madhye viskambhārdhadvikaranyā* $(r\sqrt{2})$ *saptatilādhikayā dvisastisatadvayāngulayā samacaturasram kuryāt*). It appears that in giving these values *Dvārakānātha* used the more approximate correct value of π.

The square bricks are then made with each side equal to the twelfth part of AD, which, according to *Dvārakānātha's* value of the side inscribed square is 21 *aṅg* 29 *tilas*.

Conclusion

We therefore conclude that the Ancient Indian Mathematicians had mathematical ability in the field of geometry which is used in the constructions of various and altars. This show that there models for the constructions of fires and altars involve mathematics specially geometrical propositions and problems relating to rectilinear figures, their combinations and transformations, squaring the circle and circling the square as well as arithmetical and algebraic solutions of problems arising out at such measurements and constructions. It can not be denied that the *Bakhshāli* Manuscript exhibition the cap stone of the advance of the science of mathematics from the vedic age to the pre-medieval period in which it was composed.

References

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