INDIAN MATHEMATICS RELATED TO ARCHITECTURE AND OTHER AREAS WITH SPECIAL REFERENCE TO KERALA

Thesis Submitted to the
COCHIN UNIVERSITY OF SCIENCE AND TECHNOLOGY
for the degree of
DOCTOR OF PHILOSOPHY
Under the Faculty of Science

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SEPTEMBER 1998

CERTIFICATE

Certified that the thesis entitled **"INDIAN MATHEMATICS RELATED TO ARCHITECTURE AND OTHER AREAS WITH SPECIAL REFERENCE TO KERALA"** is a bonafide record of work done by **Sri. P. Ramakrishnan** under my guidance in the Department of Mathematics, Cochin University of Science and Technology, and that no part of it has been included anywhere previously for the award of any degree.

Kochi - 682 022
September 25, 1998.

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DECLARATION

This thesis contains no material which has been accepted for the award of any Degree or Diploma in any University and to the best of my knowledge and belief, it contains no material previously published by any other person, except where due references are made in the text of the thesis.

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ACKNOWLEDGEMENT

I am most grateful and deeply indebted to **Prof. T. Thrivikraman,** Head of the Department of Mathematics, Cochin University of Science and Technology, for his patient supervision and valuable guidance throughout my research. Timely suggestions and encouragement of Prof. A. Krishnamoorthy, Department of Mathematics, are greatly acknowledged with heartfelt gratitude

I also place on record my thanks to my colleagues in Cochin University and in the Cochin College, Kochi - 2, for their cooperation in carrying out my research.

Finally, I wish to thank Mrs. Kochuthresia for her good typing.

Kochi - 682 022
September 25, 1998.

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CONTENTS

INTRODUCTION

Indian Mathematics in its broad sense is as old as at least Indus Valley Civilization which is also true in the case of Indian Architecture (Vāstuvidya). The earliest texts on Indian Mathematics are the Sulba (or Śulva) Sutras (800-500 B.C.) which are compilations of mathematical principles that have developed in India during ancient times.

Several geometrical principles are either explicitly mentioned or implied in the construction of altars, platforms, sacrificial halls and other things with a measuring rod and thread or rope[(11)] (rajju). Since rope was used for measuring length and breadth, in course of time, geometry was called Rajju śāstra in the early period of Indian Mathematics (gaṇita)[(17)]. The development of geometry may just as well have been stimulated by the practical needs of construction and surveying and this explains the relation between geometry or mathematics and architecture in ancient India.

The period extending from the 5^{th} century A.D. to 17^{th} century was one of general prosperity for scientific development in India. Āryabhata I (b. A.D.476) was the first among the top ranking mathematicians of ancient India, as he had not only introduced many new theories and formulae but also anticipated discoveries of modern times. He has also laid the foundation of different branches of mathematics. Varāhamihira (A.D.505), Bṛahmagupta (A.D.628), Sridhara (A.D.750), Mahāvīra, Srīpati and Bhāskara (b. A.D.1114) are some of the scholars of this period who made notable contributions to the twin disciplines of Mathematics and Astronomy.

It was an evolutionary period of Indian architecture and the historical evolution of architectural theory is traceable mainly from manuscripts and published treatises, from critical essays and commentaries, and from the surviving buildings of every epoch. According to P.K. Ācārya there are about 300 texts on architecture in India in different languages. Varāhamihira's Bṛhatsamhita of 6^{th} century A.D. gives an authoritative treatment on building temples and houses, in two separate chapters. Īsānagurudēvapaddhati, Kāmikāgama, Samarāngaṇasūtradhāra, Mayamata, and Mānasāra are some of the compilations on Indian architecture (Vāstuvidya). All these works are comprehensive and masterly compilations in highly technical Sānskrit. Even though, Mayamata and Mānasāra were treated as reference texts all over India, some variations in details were adopted in regional texts because of the geographical and climatic differences of different regions.

In Kerala the Mahōdayapuram(2) period (9^{th} century A.D. to 12^{th} century) marked an all pervasive transformation in the political, social and cultural fields and the earliest known structural temples in Kerala rose in the first quarter of the 9^{th} century (A.D.823). Even though the temples were constructed according to vāstu principles that was prevalent in India, a unique style of architecture was evolved in Kerala and attained perfection during the late medieval and early modern periods (14^{th} century A.D. to 17^{th} century). Stella Kramrisch(38) calls them purely Kerala shapes with their high sloping roofs and angular silhouettes, in temples, mosques, palaces and churches. There had been an effusion of mathematical, astronomical and architectural investigations during this period. As a result of this, a large number of treatises were formulated in these disciplines. We concentrate our investigations on Indian mathematics related to architecture to this period only, with special reference to Kerala.

Vēṇvarōha and other works of Saṇgamagrama Mādhava (Gōlavid) (1340-1425), Dṛggaṇita of Parameśwara (1360-1455), Tantrasaṇgraha of Nīlakaṇṭha Sōmayāji (1443-1545), Yuktibhāṣa or Gaṇitanyāyasaṇgraha of Jyēṣṭadēva (appr.1500-1610) etc, are some of the contributions of mathematicians and astronomers of Kerala during this period. Yuktibhāṣa (Rationale in Malayalam language) which is composed in Malayalam language deals with several branches under mathematics and astronomy and even cites examples from traditional architecture of Kerala for the verification of some of the mathematical results(66).

Further, several treatises on architecture were formulated during this period. Tantrasamuccaya of Cēnnās Nārāyanan Namboothirippad (A.D.1428), Śilparatna of Śrīkumāra (16^{th} century), Vāstuvidya (Anm.), Manuṣyālayacandrika of Thirumangalath Neelakanṭhan (16^{th} century) etc, are some of the wellknown architectural texts of Kerala. These are compilations of vastu principles composed in Sanskrit verses. The first two texts deals with temple architecture and the other two explains the details of domestic architecture of Kerala. Here we mainly consider the two texts Tantrasamuccaya and Manuṣyālayacandrika. There are many versions of Manuṣyālayacandrika and most of them contain about 245 verses arranged in seven chapters. But the one which was published by the Kochi Malayalabhāṣa Pariṣkaraṇa Committee in 1125 M.E[56] contains only 173 verses without any chapterwise classification. This may be considered as the earliest of all the commentaries on Manuṣyālayacandrika.

One of the contributions of Indian mathematics to architecture is the method of representation of numbers. In vāstu texts, the system of representation of numbers is a combination of Sānskrit names for numbers and the word numerals (Bhūtasaṇkhyā system) with place value. The Sānskrit names for the first nine numbers are ēka, dvi, tri, catur, pañca, ṣaṭ, sapta, aṣṭa and nava respectively. In word numeral system, numbers are expressed by means of words as in the place value notation which was developed and perfected in India in the early centuries of Christian era. In this system the numerals are expressed by names of things, beings or concepts which are very familiar to the people and therefore the system is also known as the bhūta saṇkhyā system. Thus the words, ākāśa, bāṇa and nanda represent the numbers zero, five and nine respectively. The katapayādi system is also employed for representing numbers in traditional architecture of Kerala. The terms used for fraction are 'bhāga' and 'aṁśa' meaning part or portion. The words padam, arddha, and pādōnam are used for denoting 1/4, 1/2 and 3/4 respectively. The fractions are frequently employed in defining the proportionate measures of the elements of the building.

The ratio and trairāśika or Rule of Three (proportion) play an important role in traditional architecture. The different parts of a building are proportionate to each other and hence, if the measure of any one of the elements is known, the measures of other elements can easily be arrived at by proportion. The celebrated ratio known as 'the golden ratio', belongs to the 'arddhādhikam' ratios in traditional architecture. In a 'golden rectangle', the ratio of length to its width is approximately equal to 1.618:1 or simply 1.618. This is the limiting value of the fraction F_{n+1}/F_n, where F_n denotes the n^{th} term of a Fibonacci series[(4)]. The inclination of the roof (amippu) is defined in terms of the ratio of rise to the run by considering an elemental right angled triangle of base of unit length. It is implied that when the sides of a right triangle are increased proportionately, the ratio of height to base remains the same.

Geometrical principles are implicitly made use of in determining the cardinal directions and forming the square vāstumaṇḍala on a site. The vāstupuruṣamaṇḍala, the intellectual foundation of a building, is derived graphically with respect to two perpendicular axes named Brahmasūtra and Yamasūtra intersecting at the centre of the vāstumaṇḍala. The grid system and the vīthi systems are geometrical methods of determining the exact position of the gṛhavēdika (foundation). The geometrical constructions of a triangle, rectangle, circle, hexagon and an octagon whose perimeters are the same as that of a given square have contributed many major results to mathematics. It is significant to note that in these geometrical constructions (or conversions) the perimeter is kept as a constant instead of their area. This is due to the fact that the perimeter is considered as the prime dimension of a vāstu which defines the yōni, the vital air (prāṇa) of a building. This is one of the difference of Kerala architecture from that of other parts of India. Further, an independent method is derived for finding the length of diagonal, approximately, of a square without using the Pythagoras theorem. Several approximations are obtained by implication for π, an irrational number which is the ratio of the circumference of a circle to its diameter. Another contribution is the implication of the value of another irrational number $\sqrt{2}$. The idea of limit is implied in the construction of the image of linga (śivalinga). Apart from these, various practical methods are formulated for determining accurate dimensions of different types of rafters by the traditional architects of Kerala (perumtaccans). The principles of vāstuśāstra were made available to the common man through these local 'thaccans' and therefore vāstuśāstra was often known by the name "thaccuśāstram" in Kerala.

The chapterwise content of the thesis is given below

Chapter I, deals with the domestic architecture of Kerala. The selection of site, geometrical determination of the cardinal directions, formation of square maṇḍala, the grid system and the vīthi systems for fixing the gṛhavēdika, the concept of marma, Vāstupuruṣamaṇḍala, units of measurement, the concept of yōni, different types of 'śālas' and vertical elements of a building are explained with appropriate figures.

In chapter II, an outline of the temple architecture of Kerala is given. The characteristics of different types of temples, construction of the garbhagṛha, classification of temples depending on their plan-shape, tala (storey) and perimeter, pañcaprākāras, vertical components of a temple, nātyamaṇḍapam (kūthampalam) etc, are explained briefly.

Chapter III, gives various approximations to the irrational number π implied by the architectural texts. The value of π (approximate) assumed in the construction of vṛttaprāsāda and in "Thaccusāstram Bhāṣa" is 3.1416 which is the 'āsanna' value of π given by Āryabhata I (b. A.D.476). Another value implied in 'Tantrasamuccaya' is 3.125 approximately, in the construction of gajapṛṣṭha shape. Some other values adopted for π are 3.2 and 22/7.

Chapter IV explaines the existance of 'golden ratio' in traditional architecture of Kerala. The method of construction of nātyamaṇdapa and its length to width ratio, arddhādhikam ratios and 'golden ratio', construction of golden rectangle and its properties, relation between the terms of the Fibonacci series and golden rectangle, application in the idol construction etc, are given in this chapter.

Chapter V explains the Rule of three (trairāśika) and its applications. Trairāśika and inverse trairāśika (vyasta trairāśika) are given in detail. Theorems on similarity of right triangles and their applications in determining the inclination of the collarpin (vala) in roof construction are explained with figures. Application of trairāśika in determining the heights of the ridge from the level of the wallplate (uttaram) and the corresponding lengths of rafters for different aviccil (pitch), determination of the length of the side of an octagon, the lengths of rafters using Ettāmpramāṇam (8^{th}-Postulate) and Nālāmpramāṇam (4^{th}-Postulate), various proportions of ridgeheight to semiwidth etc. are also included in this chapter.

Chapter VI explains geometrical construction of various plan shapes adopted in the traditional architecture and deductions of mathematical values which are used or implied in them. The architectural values assigned to the shapes of a square, circle, vṛttāyatam (elongated circle), gajapṛṣṭha (apsidal) and the methods of construction are given in detail. The practical method of determining the approximate length of the diagonal of a square without using Pythagoras theorem and a very close approximation to $\sqrt{2}$ are explained. Further, the methods of construction of a triangle, rectangle, hexagon, octagon and circle each of which having the same perimeter of a given square and the method of inscribing an octagon in a given square are included in this chapter. The method of construction of 'Srīcakram', geometrical method of determination of lengths of different types of rafters and the demarcation of lamba and vitāna (vertical line and horizontal line) on them are also explained in this chapter.

A translation of 'Manuṣyālayacandrika' in English language is given at the end of this work as an appendix.

Chapter I

RESIDENTIAL ARCHITECTURE

1.1. INTRODUCTION

Residential or Domestic architecture forms an important branch of Vāstuvidya. It is produced for the social unit: the individual, family and their dependents, human and animal. It provides shelter and security for the basic requirements of life and Vāstuvidya is the ancient Indian knowledge of planning, designing, building and maintaining artefacts to meet man's physical and metaphysical needs.

The word vastu is derived from the Sanskrit root (वस्) 'vas' which means 'to dwell'. In general, it covers the earth suitable for human habitation (Bhūmi), the buildings for different activities (Harmya), the movable artefacts required for human use and conveyance (Sayana and Yāna). The principal vāstu is ofcourse the Bhūmi, others have been included as they rest upon the Bhūmi and are also used for resting upon.

There are several texts on Vāstusāstra which deal with the residential architecture of Kerala. 'Vāstuvidya' and 'Manuṣyālayacandrika' are still used as reference texts on residential architecture. Though they are compilations of vāstu principles which were prevalent before 15th century A.D., they define a unique style of architecture which is harmoniously blending with the geographical and climatic conditions of Kerala.

1.2. SELECTION OF SITE

For the construction of a building which is a residence for man or god, the first and foremost requirement was considered to be the selection of site. The characteristics of an ideal site is given in Manuṣyālayacandrika(56). The site must be suitable for the living conditions of human beings, animals and plants. The presence of fruit-bearing trees, flowering plants and medicinal herbs, gentle birds and animals, fertile soil, underground spring and congenial climate were considered good omens in the selection of the best site.

Sites of irregular shapes, like triangular, elongated, segmental and circular were to be avoided for construction of houses and rectangular shapes were preferred. In the case of scattered settlements (Ekabhōgagrāma) as in Kerala, the location and extent of the site was often not so rigidly restricted. But there were restrictions in constructing houses in agricultural fields, mountain slopes, and very close to hermitage, temple, river and sea. Mounds and depression may require extensive levelling and may cause water logging or drainage problems. A gentle slope towards north or east was recommended in Vāstu texts. Before the construction work is to be started, the soil is to be examined by taste, colour, touch, and smell, by the trees standing thereon, by the situation of the underground spring, by birds and animals that frequent there and by the test of germination of seeds in the soil. Manuṣyālayacandrika(54) prescribes simple experiments to ascertain the qualities of the soil like fertility, humidity and compactness. The imperviousness of the substrata could be tested by pouring water in a pit of 1 Hasta (72 cm) square and 1 Hasta depth and watching the fall in the water level. An intelligent 'Sthapati' (traditional architect) can detect the hollow ground made by termites or rodents by gently "tapping" the ground by foot and listening the sound. Thus the site is selected accordingly and the ground is levelled and cleansed properly. Then the next step in the process of construction of building is the determination of the cardinal directions for the correct orientation of buildings and roads in the site. 'Tantrasamuccaya' and 'Manuṣyālayacandrika' provide geometrical methods based on solar path and shadows.

1.3. SOLAR PATH AND SHADOW METHOD

This is a geometrical method based on the solarpath(56). In this method a pole (sanku) of height ½ Hasta (36 cm) is fixed vertically on a properly levelled ground. With the foot of the pole as centre and radius equal to 1 Hasta a circle is drawn on the ground. The points where the shadows of the tip of the pole touch the circle in the forenoon and afternoon are noted. The line joining these two points gives the approximate East-West direction. To get the correct E-W direction at a place the following procedure is adopted.

The shadow of the tip of the pole does not fall at the same point on the forenoon of the subsequent day due to the northerly and southerly declination of the Sun (Uttarāyanam and Dakṣināyanam). This point will be to the south or to the north of the shadow point in West, noted on the first day, according as the Sun is in Uttarayana or Daksinayana. In either case the arc-length between these points is trisected. The point of trisection nearer to the first day's shadow point is joined with the shadow point on the East side to get the correct W-E direction as shown in Fig.1(a).

DIKNIRANAYAM (SANKUSTHAPANA METHOD)

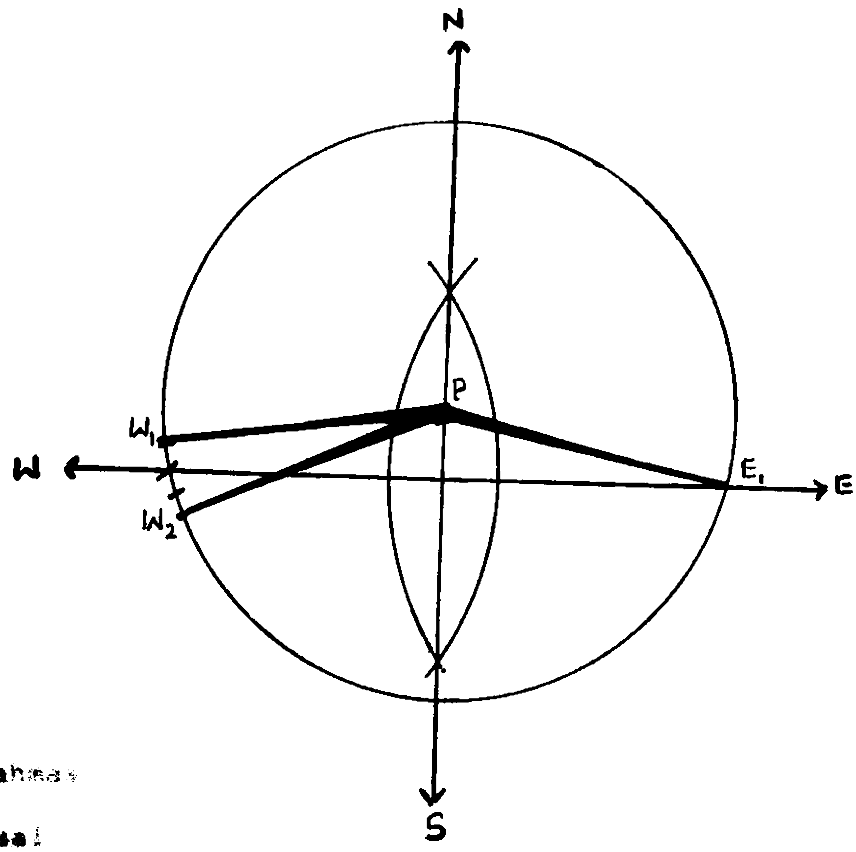


Fig.1(a)

W_1 : Tip of the shadow of the Sanku on first day

W_2 : Tip of the shadow of the Sanku on second day$_2$

P : Peg

E_1 : Evening shadow point on first day

PE_1 : Radius of the circle

EW : East-West line

SN : South-North line

The argument behind this correction is that the displacement of the points on West side is due to the movement of the sun Southward or Northward during the twenty-four hours that have elapsed between the two markings in the forenoon. The actual correction that is necessary is for the displacement between the markings of the forenoon and afternoon, ie, for about 8 hours. The forenoon marking therefore is shifted by one-third of the total displacement for one whole day and that is connected with the point for the afternoon.

1.4. FORMATION OF THE SQUARE MANDALA

The line in the W-E direction is known as the Brahmasūtra. To determine the S-N direction, consider two equal intersecting circles with their centres on the Brahmasūtra. The line joining the points of intersection of the circles will give the S-N direction. This line is called the Yamasūtra and the point of intersection of the Brahmasūtra and Yamasūtra is named as the Brahmanābhi (origin).

With respect to these axes the boundaries of the site were demarcated to form a square of required dimensions. The diagonals of the square are known as 'Karṇasūtras'.

It is to be noted that the requisites for selection of site for a domestic building are different from the requisites for other buildings since the functions of a human residence are entirely different from the functions of a temple or such other buildings.

1.5. LOCATION OF A DOMESTIC BUILDING

If the size of the site is small (ie, between 16H x 16H and 32H x 32H), the entire site is taken as the house-plot (gṛhamaṇḍala)[58]. If the site is of large size then it is divided into four quarters (quadrants) by the Brahmasūtra and Yamasūtra. The N-E quadrant named as manuṣyakhaṇḍa and the S-W quadrant called as dēvakhaṇḍa are taken for gṛhamaṇḍala. If the size of the Khaṇḍas are still large, these two khandas are again subdivided into 4 upakhaṇḍas and the S.W upakhaṇḍa of the manuṣyakhaṇḍa and the N.E upakhaṇḍa of the dēvakhaṇḍa are taken as gṛhamaṇḍala.

1.6.1. DETERMINATION OF GṚHAVĒDIKA USING GRID SYSTEM

In the grid system (or Padavinyāsam), the square maṇḍala is divided into a grid of cells (Padās). Manuṣyālayacandrika prescribes Aṣṭavarga (8 x 8), Navavarga (9 x 9) and Daśavarga (10 x 10) types of grid systems for the planning and design of houses, maṇḍapas etc and Navavarga is considered to be more acceptable than others. The maṇdala determined by 9 x 9 grid system is called the Paramaśāyika maṇḍala. It is defined by 10 lines each in the W-E direction and S-N direction producing 81 cells (Padâs) in the square maṇḍala. In the centre, the region of 9 cells is called the pada of Brahma where all kinds of constructions are to be avoided. Surrounding this region is the region covered by two envelopes of square cells which is defined as the space for constructing the Sālas (homes). The outermost envelope of square cells defines positions of subsidiary constructions like cattleshed, well, tank, kitchen etc.

With respect to the Brahmapada, four side spaces and four corner spaces are available for building Sālas (homes). The width of the spaces is the measure of 2 cells (Padās) and the length is the measure of 2, 3, or 4 cells depending on the vāstu divisions of 8 x 8, 9 x 9 or 10 x 10 grid systems respectively. The corner spaces are square spaces with side of the measure of two cells. In the case of 9 x 9 grid system, the total ground coverage is restricted to 40 out of 81 cells or a little less than 50 percent of the gṛhamaṇḍala and this is acceptable according to the modern building code also.

The outermost cells form a permanent open space around the building, having a width equal to 1/9th of the site-width[57].

1.6.2. VĪTHI SYSTEMS

In vīthi system, the site is divided into 9 vīthis or concentric square envelopes around the Bṛahmanābhi, which is the point of intersection of Brahmasūtra and Yamasūtra. The innermost vithi is known as the Brahmavīthi. The other envelopes around the Brahmavīthi are named as Vināyakavīthi, Agnivīthi, Jalavīthi, Sarpavīthi, Yamavīthi, Kubēravīthi, Dēvavīthi and Piśācavīthi in order. The width of the vīthi depends on the length of the aṇkaṇa or tālam, the height of owner of the house. Suitable multiples of this length is taken as the width of the vīthi and the region comprising the Brahmavīthi and Ganēśavīthi is considered to be the appropriate space for the gṛhavēdika. If the site is too small then the gṛhavēdika is determined by combining the Brahmavīthi, Ganēśavithi, Agnivithi and Jalavīthi. In any case the outermost envelope, the piśācavīthi is to be avoided for construction of main building.

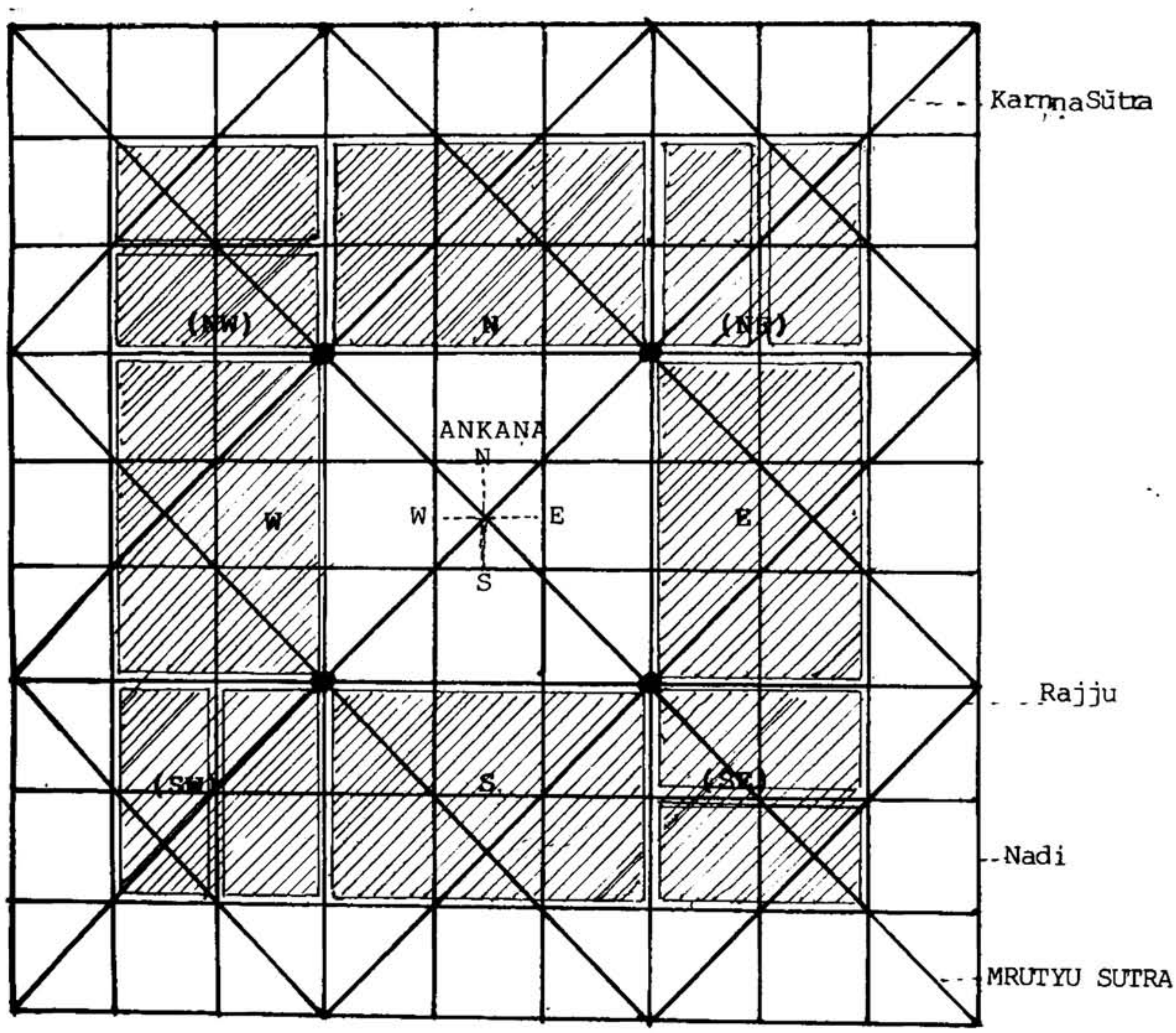
There is another method of dividing the site into four vīthis, namely, Brahmavīthi, Devavīthi, Manuṣyavīthi and Piśācavīthi. The region comprising of Dēvavīthi and Manuṣyavīthi forms the buildable area of the building. This method is used where the site is small.

Both the grid system and Vīthi system broadly give the same floor area coverage leaving the inside courtyard and the outermost peripheral envelope.

1.7. THE CONCEPT OF MARMA

The set of orthogonal lines dividing the Vāstumaṇḍala into grids are known as nādis (padasūtras) and the diagonals of the square maṇḍala are known as Rajju. The lines parallel to these Rajjus (Karṇa Sūtras) and passing through the corners of 3 cells, or 6 cells are also known as Rajjus. The nodal points of the nāḍis and diagonals (Rajjus) are called 'marma'(57). Out of these 100 murmas, there are 4 important murmas called 'Mahāmarmas' [Fig.1(b)]. At the points where two nāḍis and two Rajjus intersect constructions such as wall, pillar etc, are to be avoided. The rule stipulates that constructions can be done on either side of the nodal points leaving half the width of the sūtra on either side. Manuṣyālayacandrika defines the width of the sūtra as 1/12, 1/8 and 1/16 of the dimension of a pada (cell) when the Vāstumaṇḍala was divided into 81 padas, 100 padas and

SALAS AND MAHAMARMAS



Navavarga (9 x 9 pada) System

Fig.1(b)

Mahamarma
Marma
Nadisandhi
Marmantam
Rajju sandhi
Rajju Nadi Sandhi

E : East Sala
S : South Sala
W : West Sala
N : North Sala
NE, SE, SW, NW : Corner Sala

64 padas respectively.

These marmas or nodal points are important because they define the exact position of the building in the Vāstumaṇḍala. The Mahāmarmas may be used as the referral points for further constructions, rectifications and repairs of the building in future. Hence the intersections (vēdha) of any element of the building with these points are to be avoided.

1.8. THE CONCEPT OF VĀSTUPURUṢA

The vāstumaṇḍala is divided into 81, 100 or 64 cells. Then 45 regions (padas), one at the centre, 12 in the surrounding two envelopes and 32 in the outermost envelope, are determined and 8 positions outside the grid are also defined. These 53 positions (padas) are called by the names of 53 deities. Now a two dimensional figure of a man is superimposed on this square maṇḍala in such a way that he lies along the Karṇasūtra with his head in the N-E corner and legs in the S-W corner. Thus the square Vāstumaṇḍala becomes the Vāstupuruṣamaṇḍala which is symmetric about the Karṇasūtra and the size of the Vāstupuruṣa varies according to the size of the Vāstumaṇḍala. But the relative positions of the spaces in a Vāstumaṇḍala will not be changing and this property enables to bring a standardisation in the positioning of different spaces in a building. Hence the Vāstupuruṣamaṇḍala is the metaphysical plan of a building, a temple or a site plan of a house which completely defines exact positions of specific spaces in a building and is closely related to Vāstumaṇḍala based on grid system (Padavinyāsam).

1.9.1. UNITS OF MEASUREMENTS

Measurement is an important factor for any architectural construction. A system of measurement developed from a basic unit is called a scale. At different stages of construction the necessity of small and large measures will occur and the scale is to be selected in such a way that it suits the requirements. The early linear measurements indicate that the units of linear measurements used were mainly derived from the parts of the human body. The finger, the palm or hand-breadth, the foot and the cubit were the principal measures. The anthropometric module of one vyāma (span) is divided by 8 to give a pada. Angula was considered as the smallest practical linear measure in ancient India. Eight angulas define a pada.

sys

hum

1.9.2. UNITS IN MANUṢYĀLAYACANDRIKA

Manuṣyālayacandrika defines 3 types of angulas based on the measure of 8 yavas, width of 8 Navara grain and length of 4 Navara grain. Each type is again classified into 3 categories of Uttama (good), Madhyama (medium) and Adhama (bad) depending on the number of seeds. The smallest unit of measurement is called Paramānu (smallest atom) which is defined as the size of the minute aerosol particles seen in a dark chamber when the sun's rays creep into it. The units which are the multiples of this unit are given below(13).

8 Paramanu	:	1 Trasarenu or Ratha dhuli		
8 Trasarenu	:	1 Romagra		
8 Romagra	:	1 Liksha		
8 Liksha	:	1 Tila (Yuka):(0.47 mm)		
8 Tila (Yuka)	:	1 Yava	:	3.75 mm
8 Yava	:	1 Angula	:	30 mm
8 Angula	:	1 Pada	:	240 mm
3 Pada	:	1 Hasta (Kol)	:	720 mm
8 Pada	:	1 Vyama	:	1920 mm

Thus it is possible to unify the two dimensional system, one based on grain size and the other based on human size.

The measure of 24 angula (72 cm) is the standard Hasta which is known as Kiṣku, Aratni, Bhuja, or Kōl. By successively increasing the length of Kiṣku by 1 angula each upto 31 angula there will be 8 types of Kol (cubit) and each is used for specific purposes. Thus the 9 types angulas give rise to 72 types of Kols. The measure of 4 Kols is defined as a daṇdu and 8 daṇdu produces a Rajju which is 1/100th of a Yōjana. The octal system is used in defining the units in traditional architecture which may be used in computers easily.

In traditional architecture of Kerala incorporates different scales to serve measurement at different levels of uses. The perimeters of quadrangle (courtyard), well, tank, houses etc, are measured in Kol. Door, seat (pīdam) etc, are measured in Angula and Ornaments are measured in Yava where as clothes are measured using Vitasti (Muẓham). Weapons and other small quantities are measured using by breadth of fingers and Muṣti. The perimeters of the village, town, city etc, are determined by daṇdu.

1.10.1. THE CONCEPT OF YŌNI

Yōni is an architectural device which defines a proper orientation and dimension of the vāstu. For buildings (for domestic or temple) yōni is considered to be the vital air (prāṇa). With respect to the Brahmapada, a gṛhavāstu can take eight positions - four in the cardinal directions and four in the corner directions. These positions and directions are considered to be the birth places of the vāstu on earth and denoted by the names Dhwaja, Dhūma, Simha, Kukkura, Vṛṣabha, Khara, Gaja and Vāyasa in eight directions from the East direction onwards in cyclic order.

In Vāstuśāstra, the orientation of the building is defined from its prime dimension. Regarding the prime dimension there are differences of opinion. 'Bṛhatsaṁhita', recommends the area, Rājavallabha accepts the height, Mānasāra prescribes the width, Tantrasamuccaya and Manuṣyālayacandrika adopts the perimeter as the prime dimension of the vāstu. The method of finding the yōni is given in Manuṣyālayacandrika[54] (chapter 3, verse 30) as "Iṣṭātāna vitāna māna nicaye trignēṣtabhir bhājite śēṣō yōni" ie, multiply the perimeter by 3 and divide it by 8. Then the remainders will represent the 8 yonis. Thus if P is the perimeter then $3P=8q+r$ where q is the quotient and r is the remainder, which varies from 1 to 8 (0). When r=1, the yoni is known as Dhwaja and it defines the orientation of the building on the East side of the Brahmapada (or Ankaṇa). If r=2, it represents Dhūmayoni in S-E direction. Similarly, all the other six yonis are defined. Since the vāstu varies from large to small, the basic units of prime dimensions also vary with the size of the vāstu. For the computation of yōni perimeters are expressed in different units. The perimeter of a building is expressed in Hasta or Kol whereas the perimeter of a door is given in angula and the measure of details are presented in Yava.

In the case of gṛhavāstu, the least perimeter of Dhwajayōni is 3 Kol which is equal to 9 padas. (8 angula = 1 pada and 1 angula = 3 cm). Similarly the least perimeters of other yōnis are 10, 11, 12, 13, 14, 15 and 16 padas respectively and the subsequent perimeters are got by incrementing 8 padas to each category of perimeters. Thus the yōni system classifies the perimeters into eight categories and each of these eight sequences of numbers form an Arithmetic Progression with first term as the least perimeter and the common difference 8 pada in the case of buildings. This system of numbers may be represented on an Archimedian Spiral of an initial radius 3 Kol (cf. Fig.1(c)).

ARCHIMEDIAN SPIRAL OR YONI SPIRAL

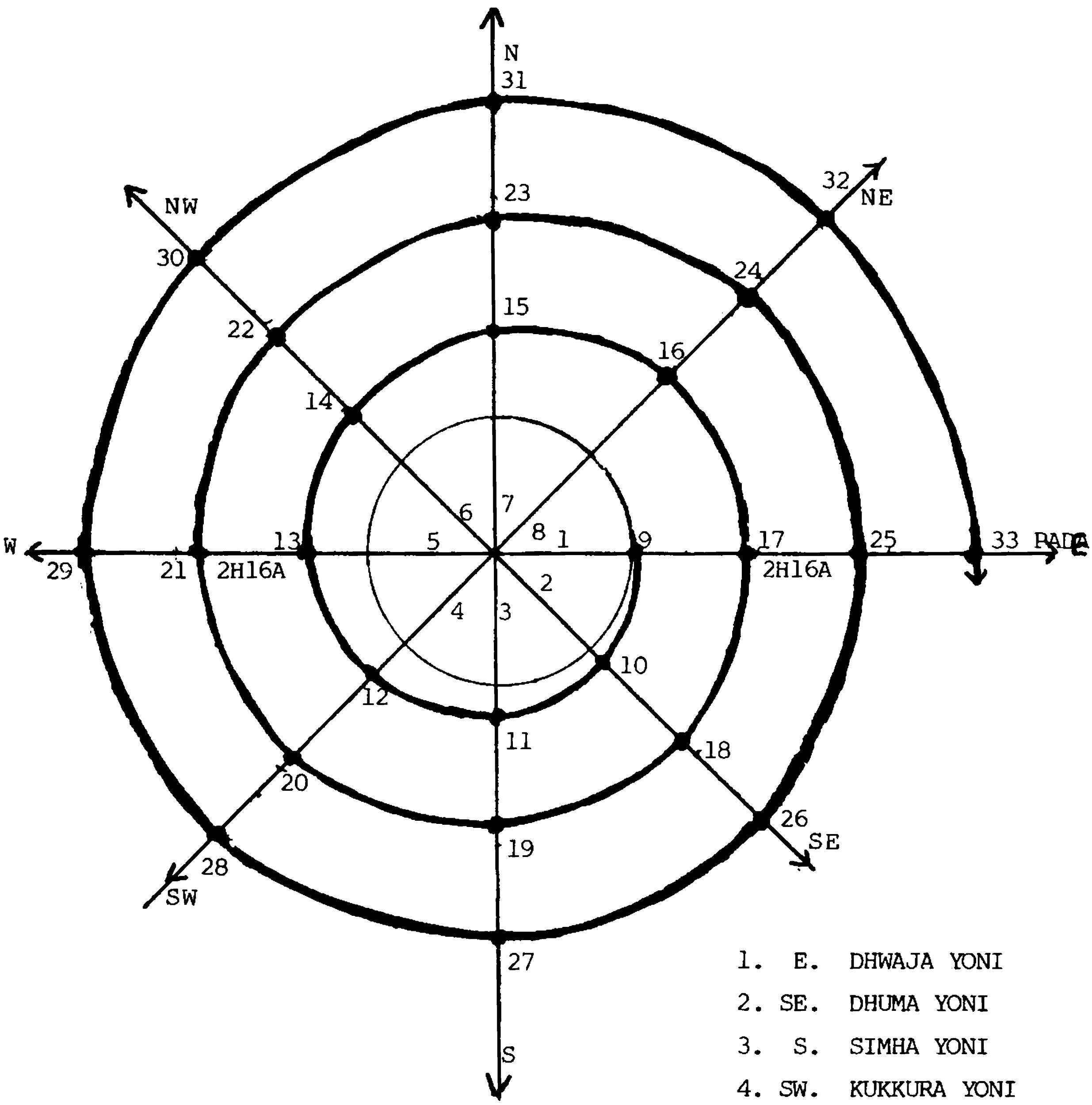


Fig.1(c)

1. E. DHWAJA YONI
2. SE. DHUMA YONI
3. S. SIMHA YONI
4. SW. KUKKURA YONI
5. W. VRSABHA YONI
6. NW. KHARA YONI
7. N. GAJA YONI
8(O)NE. VAYASA YONI

1.10.2. MODULAR COORDINATION IN TRADITIONAL ARCHITECTURE

Originally, the yōni concept was formulated for determining the orientation of the gṛhavāstu and to standardise the construction of buildings. But later yōni was attached to all artefacts, fixed or movable. The standardisation in the building construction was attained by selecting a small basic unit of size or module in the horizontal direction. In the traditional architecture, the basic module adopted was the minimum thickness of the wall which was about 1 pada (8 angulas). This module has a greater significance in Kerala than in other parts of the land because here the prime dimension is accepted as the perimeter which should be a multiple of pada so that when it was divided by 8, leaves integral remainder. Further it is stipulated that for any building the prime dimension could be taken as the perimeter measured along inside, centreline or outside the walls(54). It was considered auspicious that both the inside and outside perimeters yield the same yōni number. This is possible only if the wall thickness is 8 angulas (1 pada) or multiples of it. It is to be noted that in ancient times the size of the brick was 8x4x2 angula(58). This module may be derived from the height or span of a man as a reference measure which is equal to one Vyama (= 8 pada). Hence 1 pada is the most appropriate basic size to be considered as a module. For vāstus of smaller sizes, modules of preferred subunits are accepted. Thus it is evident that the modern idea of modular coordination was not a novel concept to the traditional architecture of Kerala.

1.11. METHOD OF FINDING PERIMETER AND LENGTH

Methods of finding the perimeter when the appropriate length is given and the length when the perimeter is given are explained in Manuṣyālayacandrika[54] (chapter 4, verse 2-4). According to this method, if P is the perimeter (in kol and angula), l kol is the chosen length, y the yōni number then

$$P = (8\,l + y)/3$$

$$\text{and} \quad l = (3\,P - y)/8$$

Another formula for P is given (Manuṣyālayacandrika)[54] as $P = 2\,l + \frac{2\,l}{3} + \frac{y}{3}$, which can be reduced to the first one.

For determining the yōni corresponding to a perimeter of a building, the perimeter is to be expressed in Padas (1 Hasta = 3 Pada). In texts on traditional architecture, tables of perimeters of buildings belonging to each yōni are given in Hasta (kol) and angula units. Here the angulas are in multiples of 8 (ie. 8 angula or 16 angula). Even though there are 8 classes of perimeters representing the eight yonis, four of them are not accepted for houses. They are the perimeters representing the corner yōnis or the perimeters of even number of padas. Sometimes the yōnis are represented by the numbers 1 to 8. For buildings, only the prime dimensions yielding odd yōni numbers were preferred. Further, even these perimeters were restricted by astrological canons (Āyādiṣaḍvarga) as uttama, madhyama, or adhama. Thus the words, "yōni: prāṇa ēvadhâm-nâm", about yōni becomes true since it defines the orientation, the basic module of the prime dimension and dimensions of all other elements of a building.

1.12.1. PROPORTIONS IN TRADITIONAL ARCHITECTURE

In traditional architecture proportion plays an important role in the construction of buildings from the foundation to the last plate. The qualities like horizontalness, verticalness and stability of an object are produced by the proportion. The buildable area (gṛhavēdika) is determined in proportion to the area of the plot and it is so stipulated that the ratio of the built area to the area of the plot must be less or equal to half. For domestic buildings, rectangular shapes are accepted and the dimensions of width and length are computed from the prime dimension (perimeter). Manuṣyālayacandrika prescribes three methods for finding the width, namely, padayōni, iṣtadīrga, and guṇāṁśa method.

1.12.2. GUṆĀṀŚA METHOD

In gunāmśa method the semiperimeter of the building is divided into 8 to 32 equal parts and in each case the width is fixed as the measure of 4 parts and the measure of the remaining parts becomes the length of the building. Here, the ratios of width to length are divided into four categories. When the length is an integral multiple of width, the ratio is known as Samatata. If a quarter of the width is added to this length, then it is known as padādhika, and when the length is increased by half the width, the ratio is known as ardhādhika. If the length is diminished by a quarter of the width (except in the 1st case) in the samatata, it is called pādōna. Evidently, the ratio 1:1 of width to length belongs to the samatata category.

WIDTH-LENGTH RATIOS

Perimeter = 24 units

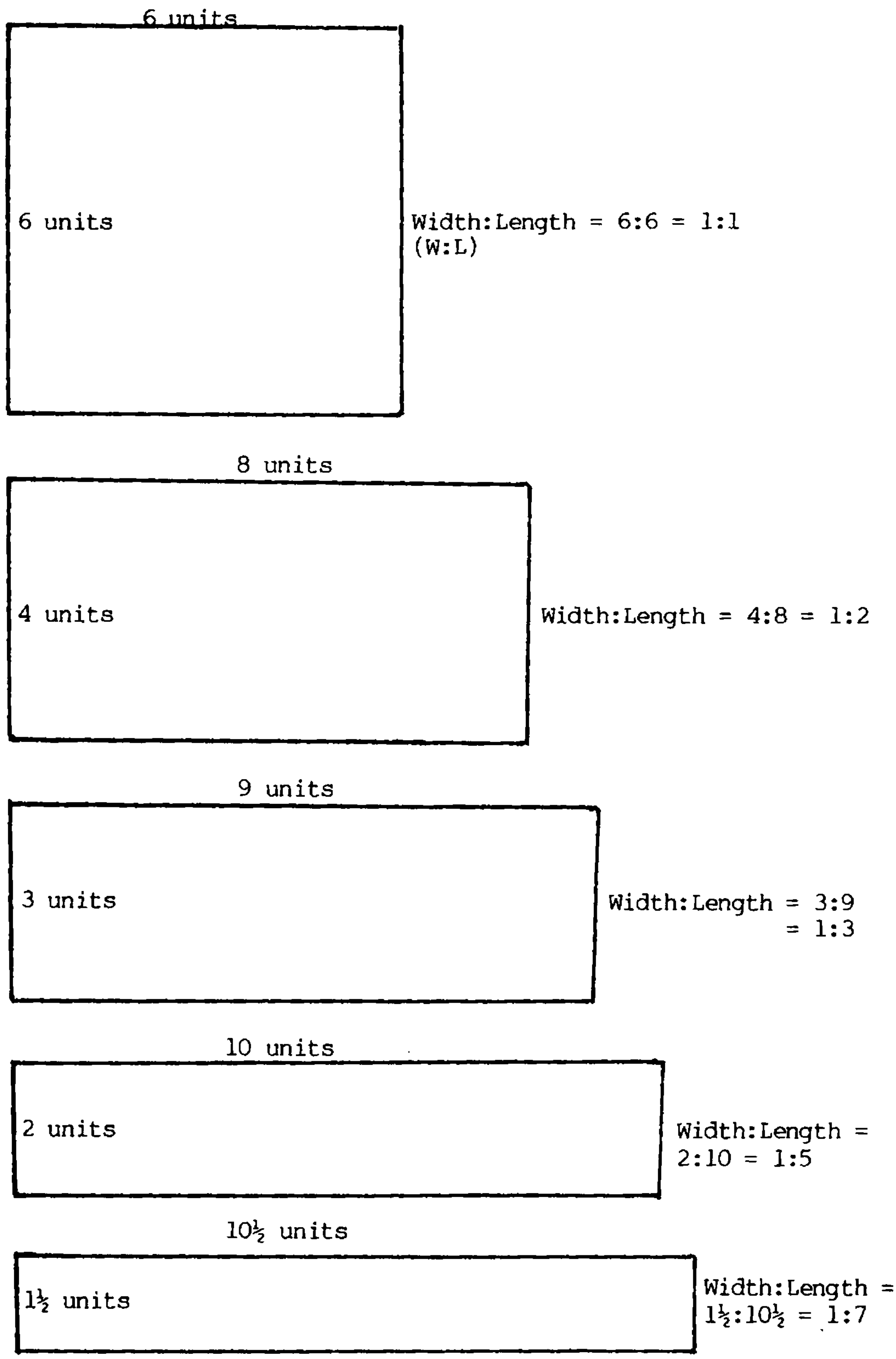


Fig.1(d)

It may be noted that the ratios of width to length of a rectangle varies from 1:1 to 1:7, the efficiency of space enclosure decreases so that further ratios of width to length are deleted, Fig.1(d). The four categories of ratios are given below.

Samatata	Pādādhika	Arddhādhika	Pādōna
1:1	1:1.25	1:1.5	1:1.75
1:2	1:2.25	1:2.5	1:2.75
1:3	1:3.25	1:3.5	1:3.75
1:4	1:4.25	1:4.5	1:4.75
1:5	1:5.25	1:5.5	1:5.75
1:6	1:6.25	1:6.5	1:6.75
1:7			

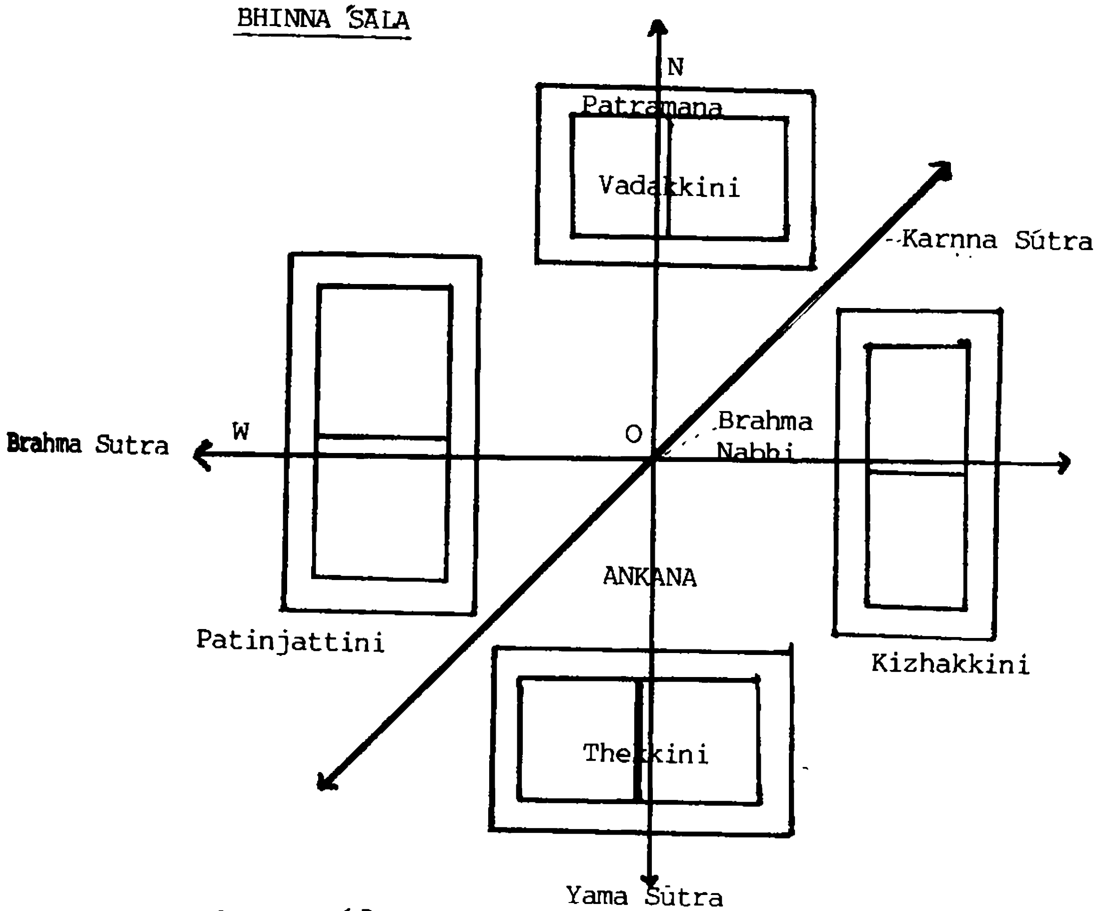
It is stipulated, without any evident reason, that the ratios of pādōna are not acceptable for any building.

1.13. TYPES OF ŚĀLAS

Manuṣyālayacandrika describes nine types of central courtyard houses. Basically they are divided into two types - separated sālas (Bhinna sālas) and non-separated

BHINNA AND ABHINNA ŚĀLAS

BHINNA ŚĀLA



ABHINNA ŚĀLA

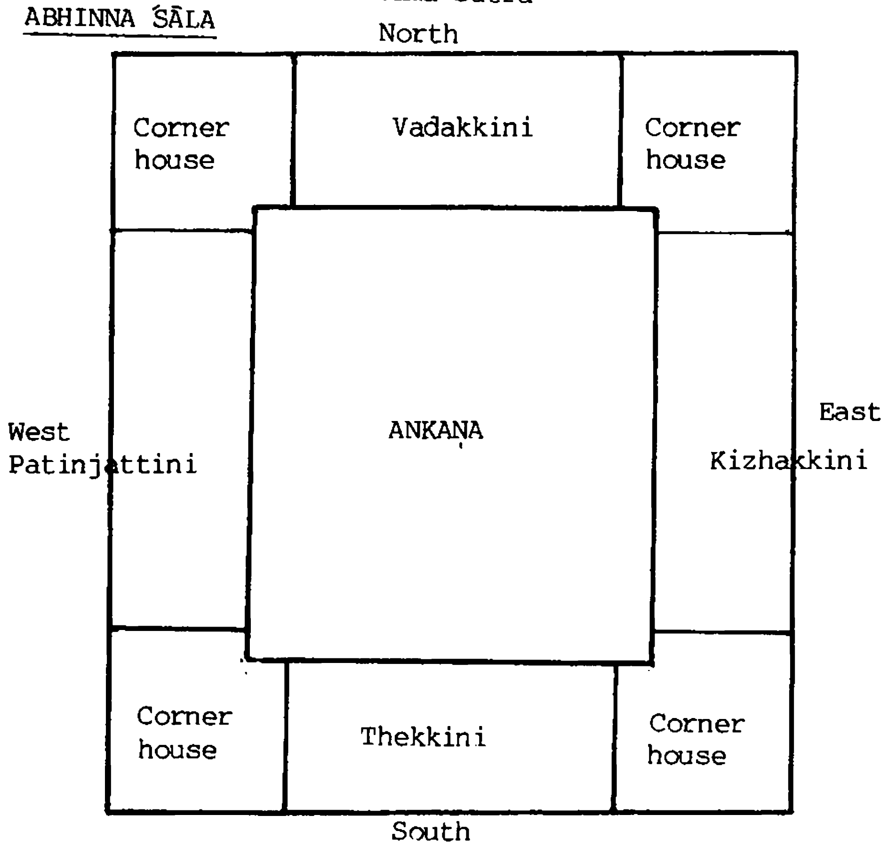


Fig.1(e)

sālas (Abhinna sālas) [Fig.1(e)]. If the four side-houses (diksālas) stand separated around the courtyard (or aṅkaṇa) satisfying the conditions such as yōni, gati, width etc, prescribed for each of them, it is called a 'Bhinnasāla'. When the four side houses (diksālas) are structurally combined as one unit together with the corner houses (vidiksālas) is called Abhinnasāla. Depending on the methods of joining the roof frames, interconnecting the sidehouses and corner-houses using passages (aliṇdas), and computation of yoni etc, the Abhinna sālas are again classified into 8 types so that there are 9 types of catussālas in total.

In Kerala the catussāla is known as Nālukettu, generally built for the elite group, which is a combination of four side houses along the four sides of the centralyard, or nadumuttam. This form is extended horizontally to Ettukettu, Patinārukettu etc, by adjoining suitable number of courtyards or vertically by constructing suitable number of storeys (tala) exactly as that of the ground plan. Depending on the needs, one may build any one of the 4 salas (Ēakasāla), a combination of two (dvisāla) or a complex of three (Trisāla) according to the rules stipulated in the Våstusāstras. The common type of sāla (house) accepted in Kerala is the Ēkasala which consists of a core unit containing three rooms connected to a front passage (Alinda). This may be extended horizontally by adding corridors on four sides and vertically by constructing upper storey.

1.14. VERTICAL ELEMENTS OF THE BUILDING

The height of the building from the ground level upto the level of wallplate (Uttaram) is termed Pādamāna, which is taken equal to or proportional to the width. The height of the foundation (adhiṣtāna) is a fraction of the pādamāna and the thickness of the wall is also proportional to the pādamāna. Deleting the height of the adhiṣtāna from the pādamāna gives the height of the pillar. The wall is topped with the wallplate (Uttara) which is considered to be the most important (Uttamānga) component of a building. The uttara (wallplate) is placed over the pōtika at the upper end of pillar. There are three types of uttaras namely, Khaṇḍōttara, Pathrōttara, and Rūpōttara (the definitions are given in the glossary) depending on the thickness of the uttara in relation to its width.

The roof frame consists of ridge (mōntāyam), rafters and the uttaram (wallplate) or the ārūḍam. The rafters are held in position by collar and collar pins. (Bandam and Vala). The rafters are seated on an additional annular wooden member (cittuttaram). The individual elements of the building are fabricated independently and joined together in position by using wooden wedges. The individual members can be dismantled by removing the wedges without damage to them and may be reassembled. The pitch of the roof is taken as 45°. The Perumthaccans of Kerala were responsible for the high degree of perfection achieved in construction of traditional buildings.

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Chapter II

TEMPLE ARCHITECTURE

2.1. HISTORICAL BACKGROUND

The history of architecture is concerned more with religious building than with any other type because in most civilizations the universal and escalated appeal of religion made the church or temple the most expressive, the most permanent and the most influential building in any community. In India temple was considered the residence of the deity and it is the most significant and typical monument of Indian architecture. The earlier shrines were simple enclosures or plain structures like platform with or without a roof. The elaborations of the temple structure followed the firm establishment of image-worship and the accompanying development of the ritual, which took time to crystallise.

In Kerala the earliest temples so far discovered date from the eighth century A.D. The Kulasekhara period (800-1102 A.D.) marked the rapid establishment of temple complexes and Kerala's peculiar temple architecture owe much resemblance to Nālukettu and Ettukettu of the traditional houses [2]. It attained perfection during the late medieval and early modern periods. Several vāstu texts were formulated during this period and 'Tantrasamuccaya' of Cēnnās Nārāyanan Namboothirippad explains the complete details of temple construction and the methods of offerings to seven deities in 2896 Sanskrit verses comprised in 12 chapters. The first step in the construction of temple is the selection of appropriate site.

2.2. SELECTION OF SITE FOR A TEMPLE

The sites for temples are described in Tantrasamuccaya elaborately. They are defined on the hill tops, on the banks of rivers and seas, along lakes, near the holy waters, grooves of trees and such other locations which will provide mental happiness and peace. The sites of types of Supadma, Bhadra, and Poorna are auspicious for temples whereas the type of 'Dhūmra' is inauspicious for the purpose. The sites for temples in villages or cities may be located at the centre or at different positions according to the nature and power of the deity.

After selection of appropriate site, the soil is to be tested for its compactness as in the case of domestic buildings and sanctification of the site should precede temple construction in accordance with the stipulations given in the texts. The cardinal directions are to be determined accordingly.

2.3. GEOMETRICAL METHOD OF DETERMINING THE CARDINAL DIRECTIONS

For the determination of the cardinal directions, a simple geometrical method is given in Tantrasamuccaya. Here also, consider a wooden peg (śaṇku) of length half hasta. It is fixed vertically on a properly levelled ground. Draw three concentric circles with radii ½, 1 and 1½ hasta respectively and with centre at the foot of the śaṇku. The points at which the shadow of the tip of the śaṇku just touches the circles are marked on the circles. Then, with these points as centres draw three circles having radii equal to ½ hasta. The two lines through the points of intersection of the circles will meet at a point and the line joining this point and the foot of the śaṇku will determine the North-South direction. The perpendicular line will represent the East-West direction as given in Fig.2(a).

ŚANKU-SHADOW METHOD (AS GIVEN IN TANTRASAMUCCAYA)

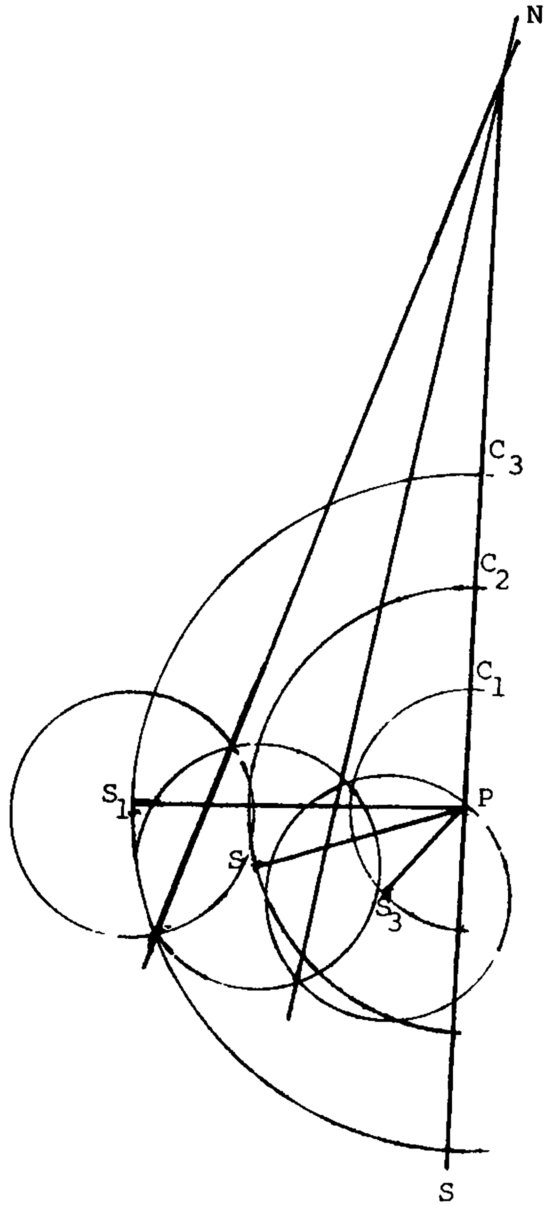

Fig.2(a)

P	:	Śanku of height 12 angula
C_1	:	Circle with radius 12 angula
C_2	:	Circle with radius 24 angula
C_3	:	Circle with radius 36 angula
S_1, S_2, S_3	:	Tips of the shadows on the circles (Centres of equal circles)
S-N	:	South-North direction

2.4. CLASSIFICATION OF TEMPLES

Temples are classified from different viewpoints such as their size, number of storeys they possess and their regular shape in design. According to their size they are broadly treated under two heads, known as Alpaprāsāda and Mahāprāsāda. Mahāprāsādas are again classified as Jati, Chandas, Vikalpa and Ābhāsa(15). Depending on the number of storeys they are named as Ēkatala, Dvitala, Tritala etc, and on the basis of their shape and design they are classified as Caturaśra (square), Caturaśradīrga (rectangular), Vṛtta (circular), Hastipṛṣṭha (apsidal), Vṛttāyata (elliptical), Ṣadkōne (hexagonal), and Aṣṭāśra (octagonal). In Kerala, most of the temples are of the Alpaprāsāda class and those under the Mahāprāsāda class are very few in number. Based on the regional styles, temples may be classified mainly into three types Nāgara, Vēsara and Drāviḍa(15). This differentiation is made from the point of view of shapes and their combination. Nāgara is purely square throughout from the basement to the finial; but with regard to Drāviḍa and Vēsara, the shapes may be both pure and mixed. The shape of the Drāvida shrine may be either purely octagonal or octagonal mixed with square and the shape of vēsara temple may be either wholly circular or combined with square.

2.5. ALPAPRĀSĀDA

In Kerala most of the temples belong to Alpaprāsāda class. This class varies from a beam (uttara) length of 2 hasta 18 angula to a beam length of 15 hasta 10 angula and correspondingly the perimeter varies from 11 hasta to 61 hasta 16 angula. Their widths are grouped into 3 hasta type, 4 hasta type etc, each width differing from the other in the measure of 8 angulas. Temples which come under the type of 3 hasta (comprising the widths 2 hasta 18 angula, 3 hasta 2 angula and 3 hasta 10 angula) will have pillars measuring 2 hasta for their height and for that of 4 hasta type, the height will be 2 hasta 4 angulas. The height is to be increased by 4 angulas for each type of temples in the increasing order upto a maximum of 4 hastas.

The total height of a temple from the lowest member (pāduka) of its basement to the finial (stūpika) is prescribed in the following 4 ways. The height is proportional to the breadth (or width) and is defined as $1\frac{3}{7}$ B, $1\frac{1}{2}$ B, $1\frac{3}{4}$ B or 2 B where B represents the breadth.

2.6.1. GARBHAGṚHA

The garbhagṛha occupies the central portion of a temple complex containing other accessory structures such as Agrasāla (halls), Nātyamaṇḍapam (Kūthampalam), Upadēvalayas etc. Garhbagṛha is of square shape even if the prâsāda is of circular, octogonal or of other shapes. The width (breadth) of the garbhagṛha is determined in proportion to the width of the prāsāda.

In tantrasamuccaya, the nine proportions are given as 2/3, 3/5, 4/7, 5/9, 6/11, 7/13, 8/15, 1/2 and 5/8 of the breadth of the prāsāda.

2.6.2. THE THICKNESS OF THE WALLS

The thickness of the wall of the garbhagṛha is one-eighth of the width of the garbhagṛha and the thickness of the wall of prāsāda is defined as one-eighth of the width of the prâsāda. The passage between the two walls is the Nādi (Etanāzhi). If the structure is too small, the two walls are combined into one thick wall.

2.6.3. THE DISPOSITION OF GARBHAGṚHA

In the case of Alpaprāsāda divide the length and breadth of the prāsāda each into 5 equal parts forming 25 padas. Then the central pada will form the disposition of the pīṭha or pedestal of the seat of the deity (Mūrthi). The immediate eight quarters that surrounded the central pada will form the garbhagṛha. The sixteen quarters that surrounded beyond the garbhagṛha will provide disposition for the thickness of the ghanabhitti or thick wall.

In another method(15), divide the length and breadth of the prasada into nine parts each forming 81 padas. The innermost pada provides for the pītha, the eight padas surrounding will constitute the garbhagṛha. The surrounding 16 padas will constitute the division for the inner wall, the wall of garbhagṛha. The outermost padas will provide for the wall of prāsāda. The space between the two walls is known as the Nādi (Etanāzhi).

2.7. VERTICAL COMPONENTS OF A PRASĀDA

In general, there are six main parts of a temple, namely, Adhiṣtāna (basement), Pāda (pillar), Prastara (entablature), Gala (neck), 'Sikhara (roof), and Stūpika (finial). The Kerala temples in their simplest form have only the four essential parts instead of six of the simple vimāna (temple). The Prastara and Gala (grīva) below the 'Sikhara are avoided. These parts bear fixed and relative proportion to one another.

The Adhiṣtāna (base) is the lowest portion of a building. It is the strongest, firmest and the most solidly built, and carries the weight of the remaining parts of the structure above. Adhiṣtāna is classified into different types on the basis of difference in dimensions of its mouldings or the presence or absence of one or other of its mouldings. The various mouldings of the adhistana are Pāduka, Jagati, Kumuda, Gala, Antari, Kampa, Pattika or Patta, Prati and Vājana. There are four types of adhistanas explained in Tantrasamuccaya[15] as given below.

Height of the Adhiṣṭāna is divided into							
(a) 24 parts		(b) 21 parts		(c) 12 parts (Pratikrama)		(d) 12 parts (Pādabandha)	
Pāduka	- 3	Pāduka	- 3	-		-	
Jagati	- 8	Jagati	- 7	Jagati	- 4	Jagati	- 4
Kumuda	- 7	Kumuda	- 6	Kumuda	- 4	Kumuda	- 4
Gala	- $1\frac{4}{5}$	Kumuda Paṭi	- 1	Kumuda Paṭi	- 1	Kumuda Paṭi	- 1
Kampa	- $1\frac{1}{5}$	Gala with Pāda	- 2	Gala	- 1	Gala	- $1\frac{1}{2}$
Gala	- $1\frac{4}{5}$	Gala Paṭi	- $\frac{1}{2}$	Vājana	- 1	Vājana with Paṭi	- $1\frac{1}{2}$
Pati	- $1\frac{1}{5}$	Paṭi with Vājana	- $1\frac{1}{2}$	Paṭi	- 1		
Total	- 24	Total	- 21	Total	- 12	Total	- 12

The garbhagṛha is constructed on the adhiṣṭāna.

Among the structural divisions of a temple, the columns come above the Prati and below the Uttara (Wallplate). The pillars are spaced at equal intervels apart so that the weight supported is equally distributed among them. Columns differ in their shapes and architectural ornamentations. Geometrical shapes like square, octagonal, sixteen-faced and circular are used in the construction of pillars. Pillars of mixed shapes are constructed depending on the type of prasada.

The sikhara corresponds to the roof of the temple or garbhagrha. In small temples, the garbhagrha and the prasada will be the same and the garbhagrha will have corbelled roof. The inner side of the garbhagrha being made into an octagon by putting up corbels at the corners from above half the height of the door and gradually clossing the gap with stones, or bricks according to the 'Kadalikakarana' process[16]. The height of the ceiling from the level of door will be half the width of the garbhagrha.

To construct the roof of the temple, the rafters are to be so placed that their lower end must rest on the uttarapattika, while their upper extremity must be secured on a kūta of suitable shape and dimensions. Then the rafters should be covered all around with wooden planks or metal-sheets. Tiles are used for covering the pyramidal roof of wooden planks.

The śikhara is surmounted by a finial (Stūpika). It bears distinct proportion to the height of the temple

VERTICAL COMPONENTS OF A SRIKOVIL

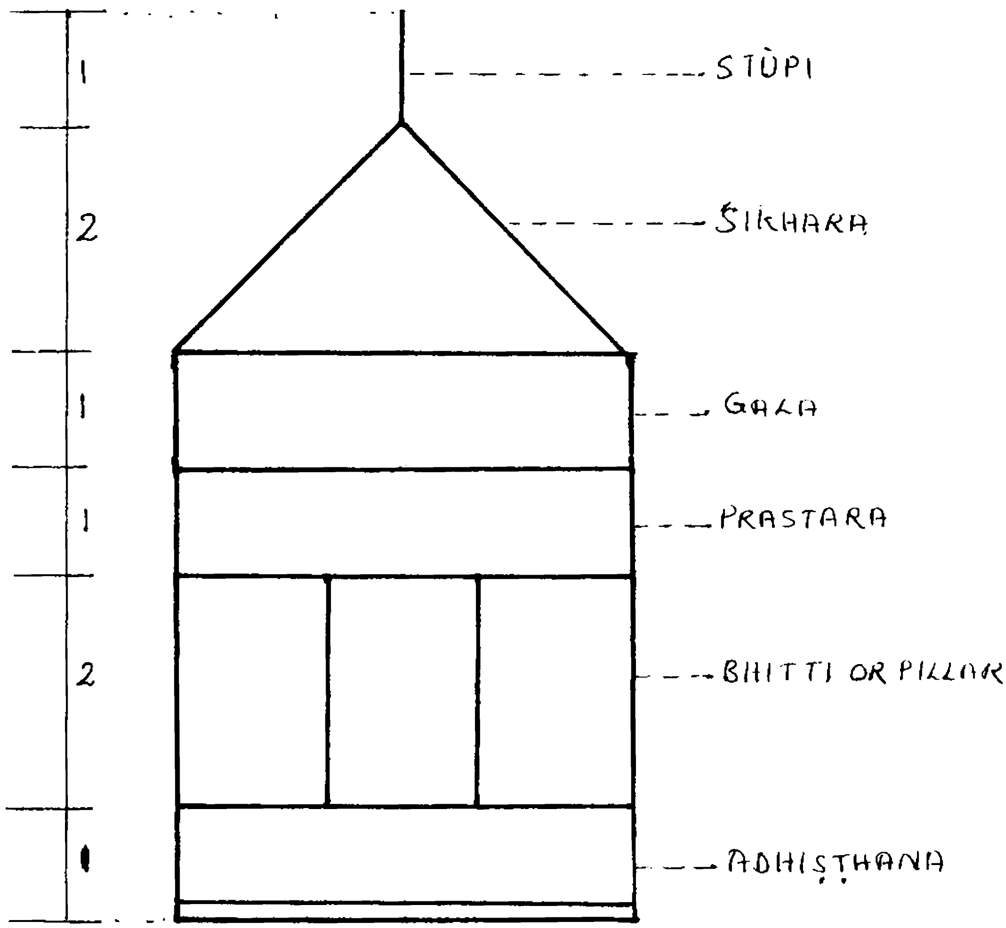

Fig.2(b)

and in general, its height will be equal to that of the height of the basement (adhiṣtāna). It consists of 4 parts, namely, Padma (full-blown lotus), Kumbha (pot), Nāla (lotus stalk) and Kuḍamāla (lotus-bud).

2.8. VERTICAL PROPORTIONS

Tantrasamuccaya prescribes the simplest and most commonly accepted proportions. The height of the temple is determined in any one of the ways as prescribed earlier. Divide this height into 8 parts. Then the height of adhiṣtâna, pillar (or wall), prastara, gala, śikhara and finial will be given by 1 part, 2 parts, 1 part, 1 part, 2 parts and 1 part respectively. Thus each element of the temple will be in the ratios 1:2:1:1:2:1 of the height of the temple (Fig.2(b)). But the height of the temple depends on the width of the temple and hence each vertical component of the temple is proportional to its width.

2.9. DISPOSITION OF THE DOORS

The main door of the sanctum sanctorum, is placed in front of the image (deity). Divide the thickness of the wall into 12 parts and mark line separating 7 parts inside and 5 parts outside this line. The door should be so placed that the middle of the door must coinside with the above line. There are other three doors known as 'false doors' or 'ghanadvāras' on the other three sides. They possess all the ornamental details of the main door along with the decorations of Tōranas on their upper side.

In front of the entrance is a flight of stone-steps (sōpāna) flanked by stone side-slabs or balustrades, which contain rich relief sculptures, the banister or coping being shaped in the form of an elephant trunk issuing from a vyālimouth.

2.10. PAÑCAPRĀKĀRAS

These are the bounding limits of five regions surrounding the prāsāda or Srīkovil. These limits are defined in proportion to the width (breadth) of the prāsāda and the outer-width of the prāsāda is known as daṇḍu. The Pañcaprākāras, Antarmaṇḍala, Antahāra, Madhyahāra, Bāhyahāra and Maryāda are determined at ½, 1 or 1½, 2, 4, and 7 daṇḍu from the external side of the prāsāda accordingly, Fig.2(c). The Antarmaṇḍala and Maryāda are of square shape while the other three are

PANCAPRAKARAS

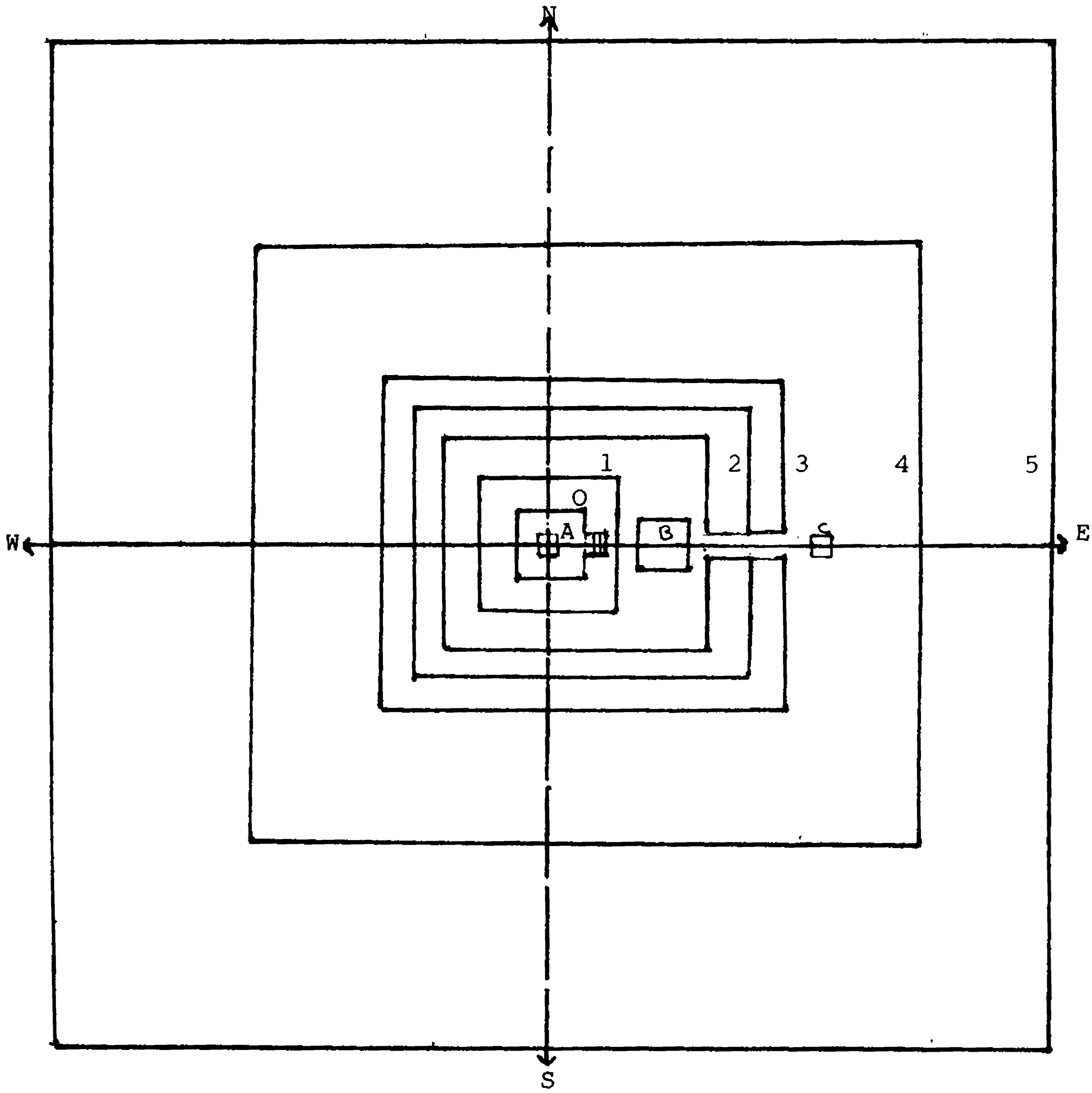

Fig.2(c)

A. Pitham
B. Namaskaramandapam
C. Balikallu
O. Prasada (Srikovil)
1. Antarmandalam
2. Antahara
3. Madhyahara
4. Bahyahara
5. Maryada

of rectangular shape with front side elongation (Mukhāyāmam).

The innermost boundary line denotes the positions of aṣtadikpālakas. The namaskāramaṇḍapa is located within the region of Antahāra. The open court is surrounded by a Nālampalam (or Cuttampalam) in which the front hall (Valiyampalam) is used for special sacrificial activities. The Madhyahāra represents the position of dīpamāla (Vilakkumaṭam), the trellis construction carrying rows of lamps in nine or eleven rows. The position of the Balikallu (altar stone) is in the region of Bāhyahāra. The dhwajastamba is also located in this region. The maryāda is to be constructed accordingly with gōpuras on four sides.

2.11. NĀTYAMAṆḌAPAM

In large temple complexes Nātyamaṇḍapam is included for the performance of dance (Nātyam), Kūthu, Kathakali etc. In Kerala Nātyamaṇḍapam is known as Kūthampalam, Fig.2(d). Their shapes are of square, rectangular, circle, elliptical and triangular. The square or rectangular shapes are preferred in Kerala. It is to be noted that the foundation of the incompleted

NATYAMANDAPAM (KUTHAMPALAM)

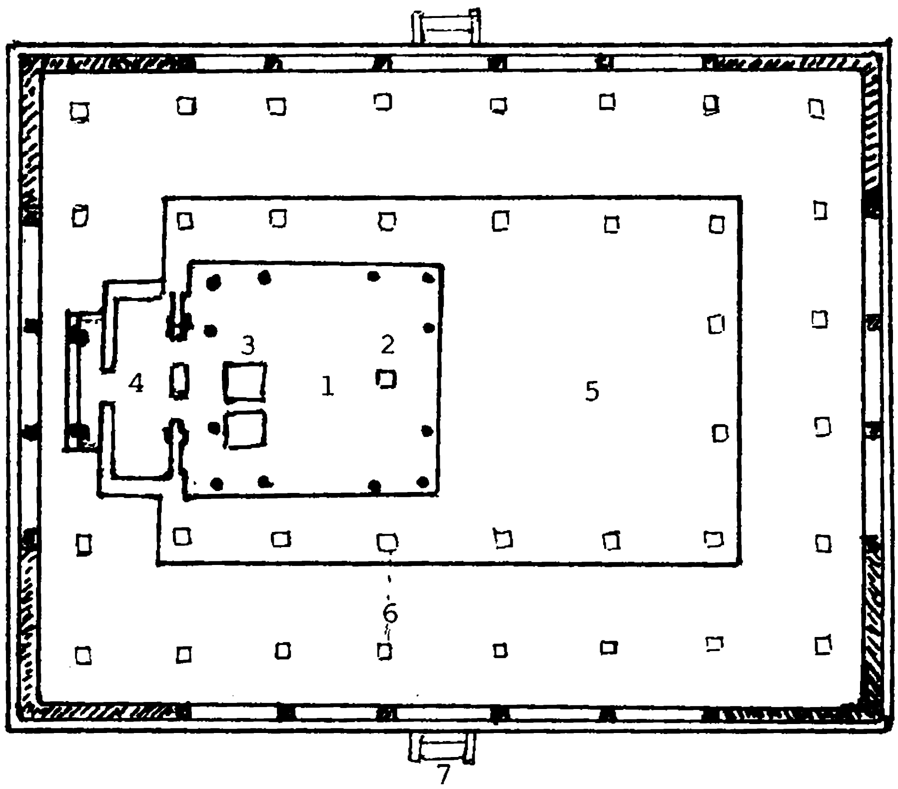

Fig.2(d)

1. Rangam
2. Nilavilakku
3. Mizhavu
4. Aniyara (Makeup room)
5. Hall (sabha)
6. Pillars
7. Entrance

Kūthampalam in Chengannur temple is of elliptical shape.

2.12. TĀLAMĀNA

This is a proportionate scale based on tāla which is used in sculpture. The appropriate height of an idol (bimba) is divided into 10, 9, 8 etc, equal parts. Then each part is known as a tāla. When one tāla is divided into 12 parts, each part is known as angula. The measure of 2 angula is a 'kala' or 'gōlaka'. Depending on the number of divisions, the bimbas (images) are named Daśatāla, Navatāla, Aṣtatāla etc. In Navatāla system the length of the face of the idol is fixed as one tāla.

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Chapter III

THE CONCEPT OF π – VARIOUS APPROXIMATIONS

3.1. INTRODUCTION

The ratio of the circumference of a circle to its diameter, has fascinated mathematicians through the centuries and the realisation that this ratio remains the same for all circles is a great event in the history of mathematics. It was William Jones (1706) who first used the notation π (Pi), a Greek letter, for representing the ratio of the circumference of a circle to its diameter and gained popularity by the adoption of the symbol by one of the greatest mathematicians Leonard Euler (1707-83)[12]. In 1761 Lambert proved that π is irrational and C.L.F. Lindemann, a German mathematician, in 1882, established that π is a transcendental number which cannot be expressed as a root of an algebraic equation with rational coefficients.

Various approximations to π are implied or explicitly stated in texts on Vāstusāstra, Sulbasūtras and in most of the mathematical works of Indian mathematicians ranging from Āryabhata I to Rāmānujan. Nīlakaṇṭha even stressed the irrationality of π in his

'Bhāṣyā' on Āryabhatīya and Mādhava[75] expressed π as an infinite series. Many approximations to π are implied in texts on traditional architecture of Kerala such as 'Tantrasamuccaya' of Cēnnas Narayanan Namboothirippad, 'Thaccusāstram Bhāṣa' (Gadyam) (author unknown), 'Kuzhikkātu Pacca'[47] of Mahēswaran Bhattathirippad etc, in the construction of temples and altars. In this chapter we deal with the approximate values of π which are given in the available architectural texts.

3.2. VALUE OF π IN THE CONSTRUCTION OF VṚTTAPRĀSĀDA

A method of construction of Vṛttaprāsāda is explained in Tantrasamuccaya[15]. Since the prāsāda (Srīkovil) is having a circular plan-shape, a circle of the desired circumference is to be constructed. The method is described in the verse given below:

swābhīṣtamānē daśayuktasaptaśatāmśitē
viswalasacchatāmśa:
yastēna mānena paribramayya vṛttātmakam
vēśma samātanōtu.
(Tantrasamuccaya, patalam 2, slōka 65)

This means that divide the desired perimeter of the circle into 710 parts and then draw a circle with radius equal to the measure of 113 parts. This will be the circle whose circumference is equal to the perimeter of the Vṛttaprāsāda.

Let C be the circumference of the circle. Then according to the above verse, the radius of the circle is $\frac{C}{710} \times 113$ and therefore its diameter is $\frac{C}{710} \times 226$.

$$\text{But} \quad \pi d = C$$

$$\therefore \pi = \frac{C}{d}$$

$$= C \div \frac{226C}{710}$$

$$= \frac{710}{226}$$

$$= \frac{355}{113}$$

$$= 3.1415929, \text{ approximately}$$

or $\pi = 3.1416$, correct to four places of decimals. This approximate value of π is implied in Āryabhatīya of Āryabhata I (A.D.499) as given below:

Caturadhikam śatamaṣṭaguṇām
dvādaṣṭhistatha sahasrāṇām
ayutadvaya viṣkambhasyā-
sannō vṛttapariṇāha:
(Āryabhatīyam, Gaṇitapādam, slōka 10)

The rule reads "The circumference of a circle of diameter 20000 is close (asanna) to 62832". This implies the fine approximation

¶ = 62832/20000

= 3.1416

Thus the value of ¶ assumed in the construction of Vṛttaprāsāda is more accurate than the Āryabhatīan value.

3.3. VALUE OF ¶ IMPLIED IN THE CONSTRUCTION OF GAJAPṚṢṬHA SHAPE

Another value of ¶ is implied in the construction of Gajapṛṣṭha (apsidal) type of temples. The plan shape is a combination of a square and a semicircle. The measurements of the sides of the Gajapṛṣṭha shape are given in the verse below:

swābhīṣṭē pariṇāhamānanicayē dhāmnaśca tuṣṣaṣṭibhā-

gōnēƒṣtadaśadhā kṛtēƒrṇṇavamitairamśai: pṛṭhakkalpayēd

pārśwadvandva samāyati mukhatatim ca, dvyamśa sūtrabhramāt

prāya: sāmghrirasāmśanāhamapi pṛṣṭham hasti pṛṣṭhātmana:

(Tantrasamuccayam, patalam 2, slōka 67)

The rule states that the desired perimeter of the gajapṛṣṭhaprāsāda is to be divided into 64 equal divisions and delete one division from it. The remaining length is further divided into 18 equal parts. Then the front and the two sides are to be constructed with the measure of 4 parts each. The fourth side (rear side) is completed by drawing a semicircle with the fourth side of the square as diameter. Then the perimeter of the semicircle will be approximately (prāya:) equal to the measure of $6\frac{1}{4}$ parts.

Let the perimeter of the prāsāda be 64 units. When it is divided into 64 divisions the length of each division will be 1 unit. After deleting one division, the remaining length of 63 divisions is again divided into 18 equal parts. Then the length of each part will be $3\frac{1}{2}$ units. According to the above rule the length of front and lateral sides of the prāsāda are of 4 parts each. The rear side (pṛṣṭha bhāga) is in the shape of a semicircle whose diameter is equal to the length of the side, 4 parts. Therefore its radius will be of 2 parts which is equal to 7 units and hence the perimeter of the semicircle is 7¶. But it is given that the perimeter of the semicircular portion is approximately (prāya:) equal to $6\frac{1}{4}$ parts which is equal to 21.875 units approximately.

∴ Perimeter of the semicircle = 21.875 units, approximately

ie, 7¶ = 21.875 units, approximately

∴ ¶ = $\frac{21.875}{7}$, approximately.

= 3.125, approximately.

But the desired perimeter of the prāsāda is taken as 64 units. The length of the front and lateral sides equal to 42 units. Therefore the remaining perimeter is 22 units. Hence the perimeter of the semicircle lies between 21.875 units and 22 units. Thus the value of ¶ lies between 3.125 and 22/7. Further, the above rule gives an important idea regarding the nature of the number represented by ¶. The radius of the semicircle is stated to be 2 parts or 7 units whereas the semiperimeter 7¶ is defined as approximate (praya:). This implies that the value of ¶ is only approximate or it is not a rational number.

The above value of ¶ have been found implied in the Mānava Sulba Sūtra where the value of ¶ is approximated to 25/8 or $3\frac{1}{8}$. This value ¶ = 3.125, approximately, also implied in the data found in ancient Babylonian tablet[22]. Chih of China is said to have used it in third century A.D. This value of ¶ is used in traditional architecture of Kerala for practical purposes.

3.4. VALUE OF ¶ IN THE CONSTRUCTION OF A CIRCLE WITH PERIMETER EQUAL TO THAT OF A SQUARE

According to the rule of construction (construction and rule is given in chapter VI) of circle given in 'Tantrasamuccaya', the radius of the circle is defined as $\frac{a}{2} + \frac{a}{8}$, where a is the side of the square.

$$\therefore \text{ the perimeter of the circle } = 2\pi\left(\frac{a}{2} + \frac{a}{8}\right) = \frac{5\pi a}{4}$$

If this perimeter is equal to the perimeter of the square then

$$\frac{5\pi a}{4} = 4 \times a$$

$$\therefore 5\pi = 16$$

$$\pi = \frac{16}{5} = 3.2$$

This value is greater than the other values of ¶ given in the above two cases. This approximation may be seen in some of the earlier works on mathematics. Bhaskara I[22] (early 7th century A.D.) has given the approximation,

$$\sin\theta = \frac{4\theta(180-\theta)}{40500-\theta(180-\theta)}$$

Where is in degrees. For the radian measure of the argument, we shall have

$$\sin\phi = \frac{16\,\phi(\pi-\phi)}{5\pi^2-4\,\phi(\pi-\phi)}$$

For very small angles, we have

$$\sin\phi = (16/5\pi)\phi$$

When ϕ tends to zero and using that the limit of $\sin\phi/\phi$ is unity, we get the approximation of

$$\pi = 16/5 = 3.2$$

This value of π is found implied in the Mānava Sulba Sūtra and in the medieval Tamil work Kanakkadikaram of Kāri (after 12th century A.D.).

Another method is explained in 'Tantrasamuccaya' and Kuzhikkàttu Pacca and according to this method the radius of the circle is determined as

$$r = \frac{(1+\sqrt{2})a}{4},$$

where a is the length of the side of the square. (The rule and method of construction is explained in chapter VI).

Then the perimeter of the circle (circumference) will be

$$2¶\frac{(1 + \sqrt{2})a}{4} = \frac{¶(1 + \sqrt{2})a}{2}$$

When a = 4, the circumference of the circle is equal to $2¶(1 + \sqrt{2})$ and that of the square will be 16.

If they are equal then,

$$2¶(1 + \sqrt{2}) = 16$$

$$\therefore ¶ = \frac{16}{2(1 + \sqrt{2})} = \frac{8}{1 + \sqrt{2}}$$

$$= 3.314, \text{ approximately.}$$

This implied value of ¶ differ much from the approximate value of ¶.

3.5. APPROXIMATION TO ¶ IN 'THACCUSĀSTRAM BHĀṢA'

'Thaccusāstram Bhāṣa' (gadyam)[5] is a book on traditional architecture of Kerala, whose content is similar to that of the 'Silparatna'. It deals with the calculations and dimensions related to the temple construction. A method of construction of a circle is given at the end of the book. It is explained in the lines given below:

'Vṛttaprāsādattinte cuttinekkondu ezhupattionnu kūriṭṭal atilorukūru kondu pattu kūriṭṭatil mūnnu kūru ezhupattionniṭṭatileppatinonnum kūtakkūṭiya nīḷamulloru kaiyurikondu vīcumpōl vṛṭtattinṭe sūkṣmam varum'[(5)].

The rule states "The perimeter of the Vṛttaprāsāda (circular srīkovil) is divided into 71 divisions. The length of one division is again subdivided into 10 parts. Add the length of 3 parts to the length of 11 divisions. The required circle is got by drawing the circle with the above length as radius.

Let the perimeter of the Vṛttaprāsāda be 71 units. Then by the above rule the radius of the circle is equal to $11+\frac{3}{10} = 11.3$ units. $\therefore$ the perimeter (circumference) of the circle = 22.6¶. But it is assumed to be 71 units.

$$\therefore 22.6\,¶ = 71$$

$$¶ = \frac{71}{22.6}$$

= 3.1415929, approximately

= 3.1416, correct to 4 places decimals

This is the same value of ¶ implied in Āryabhatīya and Tantrasamuccaya.

3.6. APPROXIMATION TO ¶ IN FINDING THE RADIUS OF A CIRCLE

A method of finding the radius of a circle whose circumference is known is given in 'Bālārāmam', a book on traditional architecture of Kerala[34]. The method is given below:

'Kūpaparivṛtālarddham
arddhakē vimśati dvayam
saptāmśakam prabhūrikku
nīlamkolluka buddhimān'.

(Bālārāmam, Vṛttaprāmāṇām, page 39)

ie, the radius of the circle will be the length of 7 divisions when the semiperimeter is divided into 22 divisions.

If C is the circumference and r represents the radius then

$$r = \frac{C}{2 \times 22} \times 7 \qquad \text{---------(1)}$$

But the circumference of the circle = 2¶r

$$C = 2\P r$$

$$\therefore \frac{C}{2\P} = r \qquad \text{---------(2)}$$

From (1) and (2) we have,

$$\frac{7C}{2 \times 22} = \frac{C}{2\P}$$

$$\therefore \frac{7}{22} = \frac{1}{\P}$$

Thus the value of ¶ assumed in this rule is $\frac{22}{7}$.

Chapter IV

THE GOLDEN RATIO IN TRADITIONAL ARCHITECTURE

4.1. INTRODUCTION

The Golden Ratio (or Golden section) which is known as 'Kanakamuri' in traditional architecture is an important concept in both ancient and modern artistic and architectural design. It is the geometrical proportion in which a line AB is divided into two parts by an interior point P in such a way that AB/AP = AP/PB [cf Fig.4(a)].

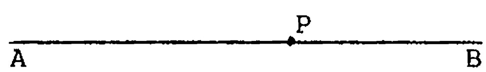

Fig.4(a)

A rectangle whose length is in this ratio to its breadth is called a golden rectangle. In this chapter we illustrate the existence of golden ratio in traditional architecture, relation between golden ratio and arddhādhika, and its application in the constructions of Nātyamaṇḍapa (Kūthampalam) and idols of deities (bimbas).

4.2. THE CONCEPT 'GOLDEN RATIO'

Dividing a segment into two parts in mean and extreme proportion, so that the smaller part is to the larger part as the larger is to the entire segment, yields the socalled Golden section and the ratio $\frac{\sqrt{5}+1}{2}$ = 1.618 (approximately) designated as ϕ, is known as the golden number. The ratio $\frac{\sqrt{5}-1}{2}$ = 0.618, approximately, is the reciprocal of ϕ. This number has many fascinating qualities and the ancient Greeks considered the regular pentagon which includes a number of 'golden ratio' relationships, as a holy symbol. In a regular pentagon PQRST there is a golden ratio relationship between any diagonal and any side of it, namely,

$$PR:PQ = 1.618.....$$

Further, all the diagonals intersect each other in golden ratio such that, [cf Fig.4(b)],

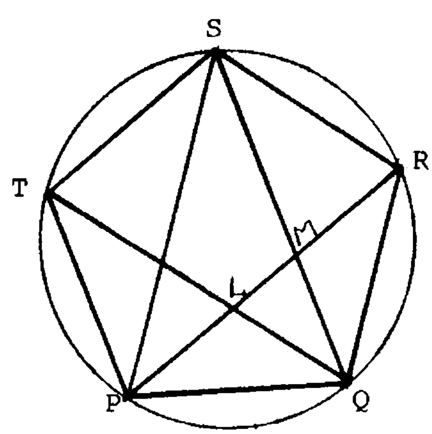

Fig.4(b)

$\frac{PR}{LR} = \phi$, $\frac{LR}{MR} = \phi$, $\frac{MR}{LM} = \phi$, when ϕ = 1.618, approximately.

In a regular decagon (10 sided polygon) the ratio of a side to the radius of the circumcircle is also ϕ.

4.3. GOLDEN RECTANGLE AND ITS PROPERTY

A rectangle in which the ratio of the length to width is equal to 1.618 approximately, is called a golden rectangle [cf Fig.4(c)]. This number ϕ produces a set of nesting rectangles.

PQRS is a rectangle such that $\frac{PQ}{QR} = \phi$, and PTUS is a square such that $\frac{QR}{TQ} = \phi$.

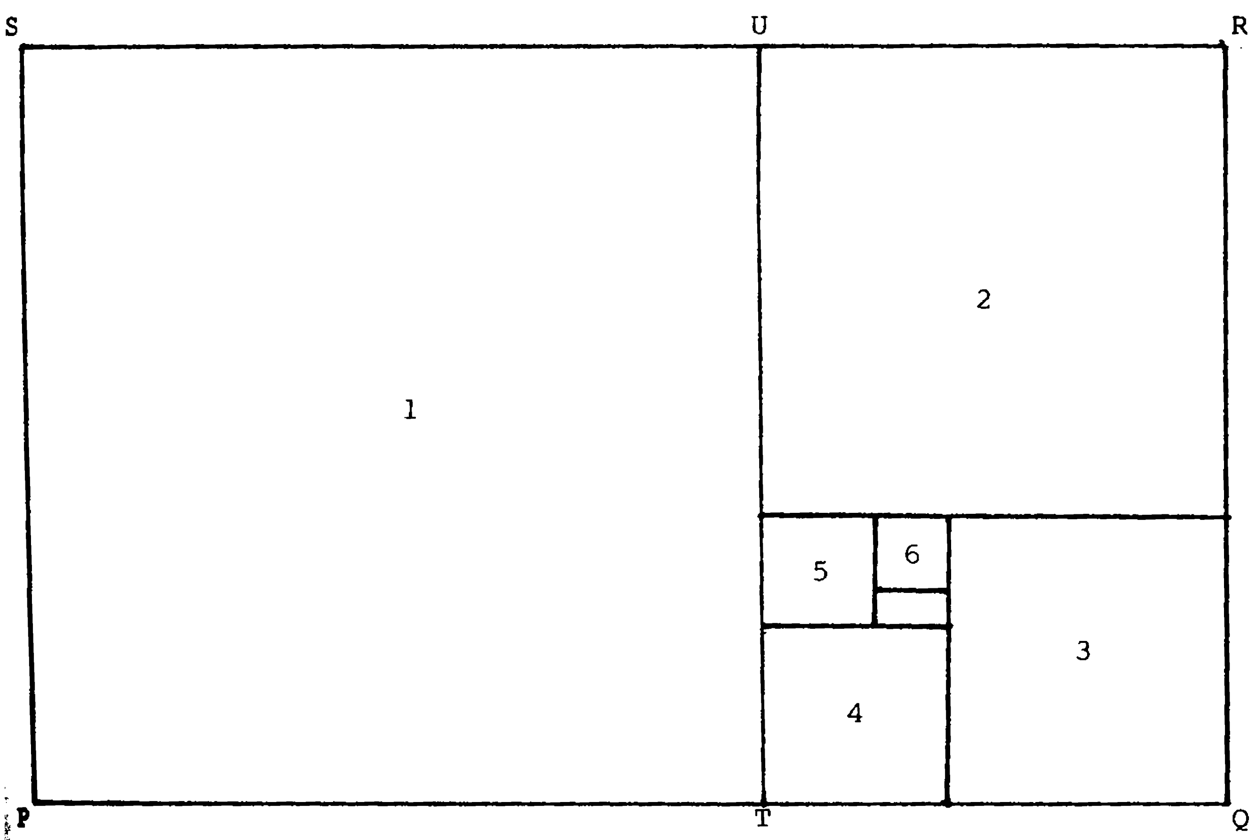

Fig.4(c)

This is a representation of the so called 'golden rectangle'. If the largest square in a golden rectangle is cut away, the figure remaining will also be a golden rectangle. Such rectangles are characterised by a length to width ratio of $(1 + \sqrt{5})/2$, the golden ratio[4]. It is believed that the ancient Egyptians may have used this ratio in the construction of Pyramids. This ratio recurs often in number theory; for example

$$\lim_{n \to \infty} \frac{Fn_{+1}}{Fn} = \frac{1 + \sqrt{5}}{2}$$

$$= 1.618 \text{ approximately,}$$

where Fn is the n^{th} Fibinacci number[4]. This is an irrational number which is the solution of the equation

$$x^2 - x - 1 = 0.$$

Solving the above equation we have,

$$x = \frac{1 \pm \sqrt{5}}{2}$$

The golden rectangle whose sides are in the ratio $1:\phi$ has the following property that the ratio of the length of the smaller side to the greater side is equal to the ratio of the length of the greater side to the sum of the lengths of the two sides(49)

ie, $\frac{1}{\phi} = \frac{\phi}{\phi + 1}$, or ϕ is the mean proportion between 1 and $\phi + 1$.

ie, $1 + \phi = \phi^2$

ie, $\phi^2 - \phi - 1 = 0$

If we divide the golden rectangle into two parts such that one of the smaller resulting rectangles is a square then it follows that the proportion of the second rectangle is $1:\phi$ itself [cf Fig.4(d)].

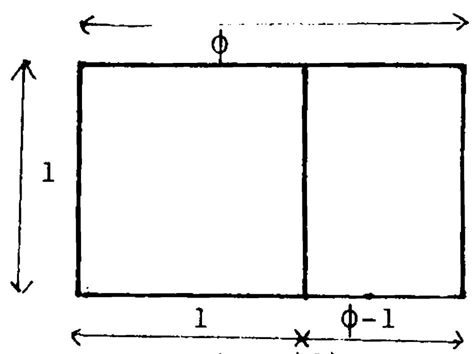

Fig.4(d)

The proportion is $\frac{\phi - 1}{1}$ and multiplying by ϕ we get $\frac{\phi^2 - \phi}{\phi}$. But $\phi^2 - \phi = 1$.

$\therefore \frac{\phi^2 - \phi}{\phi} = \frac{1}{\phi}$ which is the same as the original proportion.

4.4. GOLDEN RECTANGLES AND FIBONACCI NUMBERS

A sequence of numbers each of which, after the second, is the sum of the two preceding numbers is known as Fibonacci numbers. The sequence 1, 1, 2, 3, 5, 8, 13, ... is a Fibonacci sequence of numbers. This sequence was discovered by Leonardo Fibonacci, also known as Leonardo of Pisa (1170-1250). The formula for generating the sequence is

$x_n = x_{n-1} + x_{n-2}$, where x_n is the n^{th} term of the sequence, $n > 2$.

Another formula for generating the Fibonacci numbers is attributed to Lucas[4]. It is given as

$$x_n = \frac{1}{\sqrt{5}}\left[\left(\frac{1+\sqrt{5}}{2}\right)^n - \left(\frac{1-\sqrt{5}}{2}\right)^n\right]$$

Further, the sequence of numbers[49],

1, 1.618, 2.618, 4.236, 6.854, 11.090, ...

(correct to three places of decimals only) have the property that if we add the first two terms together (1 + 1.618) we get the third, 2.618. In the same way the sum of the second and third 1.618 + 2.618 gives the fourth, 4.236; and so on. Thus each successive term is the sum of the preceding two. Therefore it is a Fibonacci sequence of numbers. In the above sequence the ratio of any term to its preceding term is 1.618 which is the golden ratio.

The Fibonacci numbers can be used to make a golden rectangle. Consider a unit square representing the first term of Fibonacci sequence. Then add a second square. Add a third square to fit the longest side. Again add a fourth square with its side as the longest side of the above square. If we continue the process we will eventually get a golden rectangle [cf Fig.4(e)].

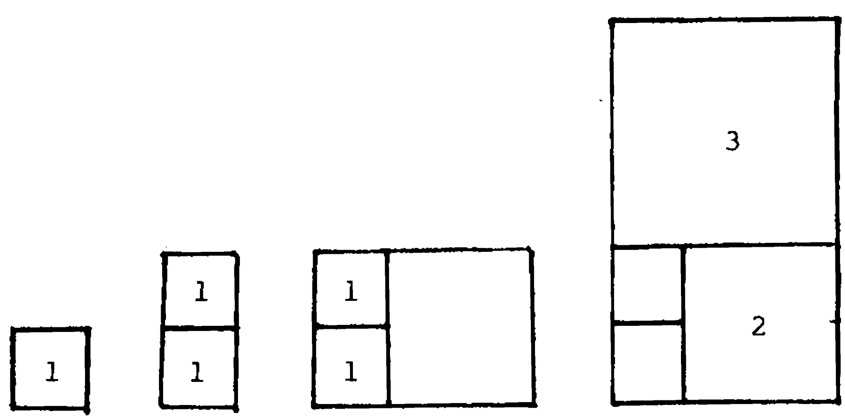

Fig.4(e)

Thus the Fibonacci numbers and the golden rectangle are closely related.

4.5. GOLDEN RATIO AND ARDDHĀDHIKA

In Vāstusāstras, four types of width to length ratios are defined in determining the width of the house in guṇāmśa method. They are Samatata, Pādādhika, Arddhādhika, and Pādōna (explained in Chapter I). They define four categories of ratios of width to length in rectangular buildings. The arddhādhika ratios are[58] 1:1.5, 1:2.5, 1:3.5, 1:4.5, 1:5.5, 1:6.5. It is to be noted that the ratios from 1:1.5 upto 1:1.75 are also considered as arddhādhika. According to Manuṣyālayacandrika[54], pādādhika ratios are most suitable for domestic buildings and arddhādhika ratios are accepted for buildings, idols, nātyamaṇḍapa etc, which have aesthetic values. Thus the golden ratio belongs to the arddhādhika ratios in traditional architecture. The existence of golden ratio in traditional architecture may be understood from the construction of Kūthampalam of Kerala.

4.6. GOLDEN RATIO AND NĀTYAMAṆḌAPAM (KUTHAMPALAM)

'Tantrasamuccaya' (Śilpabhagam)[16] of Kanippayyur Damodaran Namboothirippad, gives a special method of constructing a Nātyamaṇḍapam (Kuthampalam) in temple complexes of Kerala. The method is explained in the verse given below:

paryantē pratiyōnibhāji bāhirutthē vōttarasyā thavā
maddhyasthē dalitē, tatō vibhajitē samyak caturvvarggakai:
syādamśa: pada, māyatistu vitatērdwābhyām padābhyām yutam,
tacchiṣtā tati, ruttaram natanadhāmnām dwitrisamkhyam matam
(Tantrasamuccaya (Śilpabhagam), Chapter 10, slōka 1)

This states that the perimeter along the uttara (beam) of the nātyamaṇḍapa must be of the 'pratiyōni' (opposite yōni) of that of the prāsāda (Srīkovil). [This is due to the fact that the natyamandapam and the Srikovil are facing each other]. This perimeter may be measured either along the central line or along the boundary line of the uttara (beam). Divide the semiperimeter into 16 equal parts and each part is called a 'pada'. The length of the maṇḍapa (along uttara) is obtained by adding 2 pada to the half of the semiperimeter (to ¼ of the perimeter) and the width is determined by subtracting this length from the semiperimeter.

Let us examine the ratio of the length to width in the above construction of rectangular Nātyamaṇḍapa.

Let the perimeter of a Nātyamaṇḍapa be P and a be the side of a square of the same perimeter.

$$\text{Then } P = 4a$$

$$\therefore \text{Semiperimeter} = \frac{P}{2}$$

$$= 2a$$

Dividing by 16, we get, $\frac{P}{32} = \frac{a}{8}$. This is the unit 'Pada' defined in the text. $\therefore$ by the above verse we have,

$$\text{Length of the Natyamandapam} = a + \frac{a}{8} \times 2$$

$$= a + \frac{a}{4}$$

$$= \frac{5a}{4}$$

$$\text{Width of the Mandapa} = a - \frac{a}{8} \times 2$$

$$= a - \frac{a}{4}$$

$$= \frac{3a}{4}$$

$$\therefore \frac{\text{Width}}{\text{Length}} = \frac{\frac{3a}{4}}{\frac{5a}{4}}$$

$$= \frac{3}{5}$$

$$\text{ie, Width:Length} = 3:5$$

$$\text{or } L:W = 5:3 = \frac{5}{3} = 1.66\ldots\ldots$$

But the golden ratio is 1.618 (approximately). Hence the above ratio is very close to the golden ratio.

4.7. CONSTRUCTION OF BIMBA (IDOL) AND GOLDEN RATIO

It is significant to note that the bodies of many living beings (natural organisms) including man (the human body), are really based on golden ratio relationship. For example, the ratio of the height of the navel from the feet to the height of the head from the navel (of a man of standard height) is ϕ. In the construction of Navatāla or Daśatāla bimba (idol), the ratio accepted in Tantrasamuccaya[15] is 1.6, approximately, which is very close to ϕ.

In the case of Navatala bimba, the total height of the bimba (idol) is divided into 108 equal parts and each part is called an angula. Two angula form a 'Kala' or 'Gōlaka' and 12 angula constitute a 'Tāla'. Since the height of the bimba is 9 Tāla, it is known as Navatāla bimba. The height of the idol is divided into two parts at the navel point in such a way that 66 angulas are below the navel point and 42 angulas are above it. Then the ratio of these lengths is equal to $\frac{66}{42}$ = 1.6, approximately, which is very close to the golden ratio. Further, the ratio of the total length to the height of the bimba upto the navel is

$$\frac{108}{66} = 1.6363, \text{ approximately.}$$

This is also very close to the golden ratio and belongs to the arddhādhika.

Similarly, in the case of Dasatāla bimba, the total number of divisions is 120. The ratio of the height of the navel from the feet to the height of the head from the navel is 73/47. The value of the ratio is approximately equal to 1.6 and the ratio of the total height to the height of the navel from the feet is 1.64, approximately. Thus these two ratios are very close to the golden ratio and they belong to the arddhādhika.

Thus the golden ratio which is a special case of arddhādhika ratios is used for constructing artefacts having aesthetic values, in the traditional architecture of Kerala.

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Chapter V

TRAIRĀŚIKA (THE RULE OF THREE) IN TRADITIONAL ARCHITECTURE

5.1. INTRODUCTION

The trairāśika or direct proportion was used as an effective tool in solving problems of Astronomy, Arithmetic, Geometry and Architecture. This method may be traced in Bākhṣhāli Manuscript[32] (about 1st century A.D.), Āryabhatīya (A.D. 499) and in all other works on mathematics. According to Bhāskara II (A.D. 1511), the Rule of Three is the essence of arithmetic[17] and it pervades the whole of the science and calculation. The Rule of Three is largely appreciated because of its simplicity and its universal application to ordinary problems.

In this chapter we explain the application of trairāśika in determining the length of the side of an octagon, sixteen sided polygon etc, and in making the holes for collarpins (vala) on rafters. It is also used in calculating the lengths of rafters.

5.2. DEFINITION OF TRAIRĀŚIKA

Trairāśika is defined in Yuktibhāṣa(66) as in the lines given below:

"trayō rāśaya: samāhṛtā: kāraṇam yasya,
sarāsi: kāryē kāraṇōpacārāl
trirāśirbhavati, saprayōjanam
yasya tal ganitam trairāśikam"

(Yuktibhāṣa, Chapter 4, page 45)

Here three quantities are needed in the statement and computation. So this rule is known as Trairāśika (The Rule of Three terms). If four quantities are in proportion, then any one of them may be determined by knowing the values of other three quantities. Since there are three known quantities, it is called Trairāśika. Similarly, there are Pancarāśika, Saptarāśika, Navarāśika etc, depending on the number of known quantities used for calculating the unknown. In trairāśika, the method of calculating the unknown is given in lines below:

Icchām phalēna saṁhatya pramāṇēna vibhājayēl

Icchāphalam bhavēl labdhamēvam trairāśikam matam!!

(Yuktibhāṣa, Chapter 4, Page 46)

ie, Icchāphalam is got by dividing the product of Iccha and Pramāṇaphalam by Pramāṇam.

$$\text{ie, Icchāphalam} = \text{Icchā} \times \frac{\text{Pramāṇaphalam}}{\text{Pramāṇam}},$$

where Icchā : the desired antecedant, the 3^{rd} term in a proportion

Icchāphalam : the desired consequent, the fourth proportion

Pramanam : the antecedant, the first term of a proportion

Pramanaphalam : the consequent, the second term in a proportion

The above relation may be expressed as

$$\frac{\text{Pramāṇaphalam}}{\text{Pramāṇam}} = \frac{\text{Icchāphalam}}{\text{Icchā}}$$

The pramāṇam and Icchā must be of the same denomination.

If x and y are the magnitude of two quantities of the same kind measured in the same units, the ratio x:y or x/y may be used to compare the magnitudes. It gives the number of times y is contained in x. Here the number of times of pramāṇa in pramāṇaphalam will be equal to the number of times of Icchā in Icchāphalam. If the Icchā becomes larger than Pramāṇam then Icchāphalam becomes larger than pramāṇaphalam and vice versa.

5.3. VYASTA-TRAIRĀŚIKA

The inverse proportion (Inverse Rule of Three) is called Vyasta-trairāśika. According to Srīdhara, the method is to multiply the middle term by the first and to divide by the last, in case the proportion is different (inverse)(17).

The inverse proportion is defined in lines below:

"Icchā vṛddhauphalahrāsa Icchāhrāsēdhikam phalam!
Yatra tatra hikarttavyam Vyastatrairāśikam budhai:!!

(Yuktibhāṣa(66), Chapter 4, Page 48.)

ie, when the Iccha increases than pramāṇam, the Icchaphalam decreases than the pramāṇaphalam and vice versa. This rule is known as Vyastatrairāśika (Inverse proportion). The computation is explained as

"Vyastatrairāśikaphalamicchā bhakta: pramāṇaphala ghāta:!"

$$\text{ie, Icchāphalam} = \frac{\text{Pramanam x Pramanaphalam}}{\text{Icchā}}$$

or this may be expressed as,

$$\frac{\text{Icchā}}{\text{Pramāṇam}} = \frac{\text{Pramāṇaphalam}}{\text{Icchāphalam}} .$$

5.4. METHOD OF FINDING THE INCLINATION OF THE COLLARPIN ON AN INCLINED RAFTER

Consider the rafters (lupas), collarpin (vala), Eaves-reaper (Vāmata) on the roof of a square maṇḍapa. The collarpin (vala) will be perpendicular to the sides of straight rafters and therefore the holes on them for collarpins will be perpendicular to the sides so that the length of the hole is equal to the thickness of the rafter. But in the case of inclined rafters, the collarpin is not perpendicular to the rafters and correspondingly the holes on them are inclined at an angle which may be determined as in the method given below using trairāśika. [cf Figs.5(a) and 5(b)].

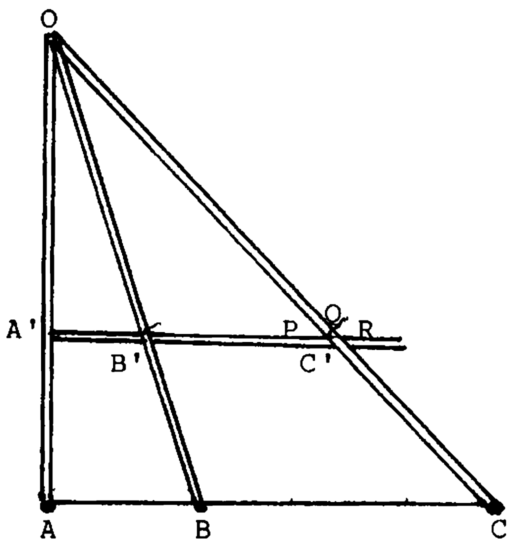

Fig.5(a)

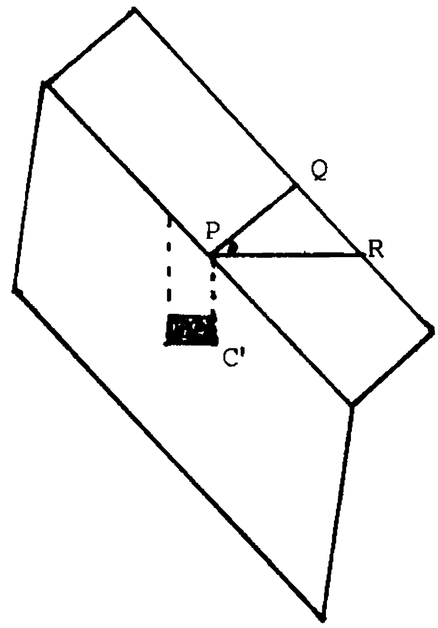

Fig.5(b)

Let O be the position of the Kootam on which an end of each rafter is fixed and $\overline{OA}$, $\overline{OB}$, $\overline{OC}$ represent the positions of rafters. Let $\overleftrightarrow{ABC}$ represents the eaves-reaper at the lower end of the rafters and $\overleftrightarrow{A'B'C'}$ be the collarpin (vala).

$\overline{A'C'} \parallel \overline{AB}$ and $\overline{A'C'} \perp \overline{OA}$, the straight rafter. Let α be the angle between $\overline{OA}$ and $\overline{OC}$, the inclined rafter. Then the inclination of the hole on $\overline{OC}$ will be proportional to the angle: [Fig.5(b)], gives an enlargement of the rafter and the angle α on it.

From the figures above,

$\triangle$ OAC and $\triangle$ PQR are similar, by the rules of similarity of two right angled triangles given in Yuktibhāṣa[66].

The first rule states that the two triangles (right angled) will be similar if there is "parallelism between the hypotenuses and a side of each". This rule may be proved as below.

$\triangle$ OAC and $\triangle$ PQR are right angled triangles.

$$\overline{PR} \parallel \overline{AC}$$

$$\overline{QR} \parallel \overline{OC}$$

$$\therefore \angle C = \angle R$$

Further, $\angle AOC = \angle QPR$ and

$$\angle A = \angle Q$$

$$= 90^\circ$$

Therefore the two triangles are equiangular and by AAA-theorem, the above two triangles are similar.

Since the triangles are similar, by Rule of Three, we have

$$\frac{\text{Icchākṣetrabhuja}}{\text{Pramaṇakṣetrabhuja}} = \frac{\text{Icchākṣetrakōti}}{\text{Pramanakṣetrakōti}}$$

$$= \frac{\text{Icchākṣetra Karṇam}}{\text{Pramānakṣetra Karṇam}},$$

where,

Icchākṣetra	:	desired region
Pramānakṣetra	:	given region
bhuja	:	base of the triangle
kōti	:	attitude
karṇam	:	hypotenuse

ie, $$\frac{QR}{AC} = \frac{PQ}{OA}$$

$$= \frac{PR}{OC}$$

$$\therefore \quad QR = \frac{PQ}{OA} \times AC$$

PQ is the thickness of the inclined rafter, OA is the length of the straight rafter and AC is the distance of the inclined rafter from the straight rafter. $\angle QPR$ is the angle of inclination of the hole for collarpin. Thus the inclination of the collarpin to the side of the inclined rafter is determined by QR.

Note: It is to be noted that in traditional architecture the slope is not expressed in terms of degrees. For example, the pitch of a roof is not expressed in degrees but a ratio of 'rise' and 'run' (vertical projection and horizontal projection). Usually, the rise is expressed as a certain number of angula per kol of run : thus, a rise of 6 angula means that the roof rises 6 angula for each 24 angula that it runs horizontally. Here the pitch is 6 to 24. In the above result QR is known as the length of the inclination of the hole on the rafter.

5.5. DETERMINATION OF HEIGHTS OF THE ROOF FOR DIFFERENT PITCHES

The idea of Trairāśika is made use of in the calculation of the pitch of the roof. Consider a gabled[18] roof of a building which is a 3-dimensional space-frame. The cross section of the roof will be in the form of an isosceles triangle whose base is the width of the house and the sides are the rafters on either sides of the roof. The altitude of this triangle which is the height of the roof from the level of the wallplate, divides the triangle into two right-angled triangles. In general, the normal height of the roof was taken to be equal to the semi-width of the house so that the angle of inclination of the roof with the horizontal was 45°. But certain variations in heights of the roof were adopted depending on the aesthetic considerations and the materials used for covering the roof.

In traditional architecture the decrease in height from the normal height was defined as 'aviccil' or 'amippu' (dip). It was expressed as a ratio of the height to unit length of the semiwidth of the house. Multiplying this ratio by the corresponding semiwidth we get the height of the roof for that 'aviccil'. In this method, an elemental rightangled triangle of unit base (1 kol) was considered for each aviccil. The height corresponding to each width were calculated using Trairāśika. The principle behind this is given by Ganēśa

(1545)[17] as "if the upright, base and hypotenuse of a rational rightangled triangle be multiplied by any arbitrary rational number there will be produced another rightangled triangle with rational sides". It is implied that when the sides of a right triangle are increased proportionally, the ratio of the height to base remains the same ie, the slope of the roof will be the same for the same aviccil (dip).

In traditional system the height is said to be 24 angula if the roof rises 24 angula for each 24 angula of semiwidth, and the aviccil is expressed as 24/24, called 'thankūrmam'[71]. The aviccil is named as 1/4 angula, 1/2 angula, 3/4 angula etc, corresponding to the ratios 22½/24, 21/24, 19½/24 etc. In each case the height is diminished by 1½ angula and each can be expressed in non-recurring decimals.

In a similar way corresponding to each aviccil, the lengths of the rafters may be determined using trairāśika, by knowing the length of the hypotenuse of the elemental right angled triangle with unit base (1 kol). The accurate length of the common rafter is got by multiplying the length of the hypotenuse by the semiwidth of the building and adding half the width of the rafter to it.

5.6. SOME OTHER PROPORTIONS OF HEIGHT AND WIDTH

The height of the ridge from the level of wallplate depends on the width of house. This is evident from the following lines in Vastuvidya(13).

Uttarasyānurūpēṇa
tasām tāramudīritam

(Vāstuvidya, Chapter 10, Verse 1.)

ie, the height is proportional to the semiwidth of the house. The proportions of height to semiwidth are defined as 1:1, 7:8, 6:7, 5:6, 4:5, 3:4, 2:3 and 1:2 [cf Fig.5(e)]. These proportions are named as Ambaram, Viyat, Jyōtis, Gaganam, Vihāyas, Anantam, Antarīkṣam, and Puṣkalam respectively(33).

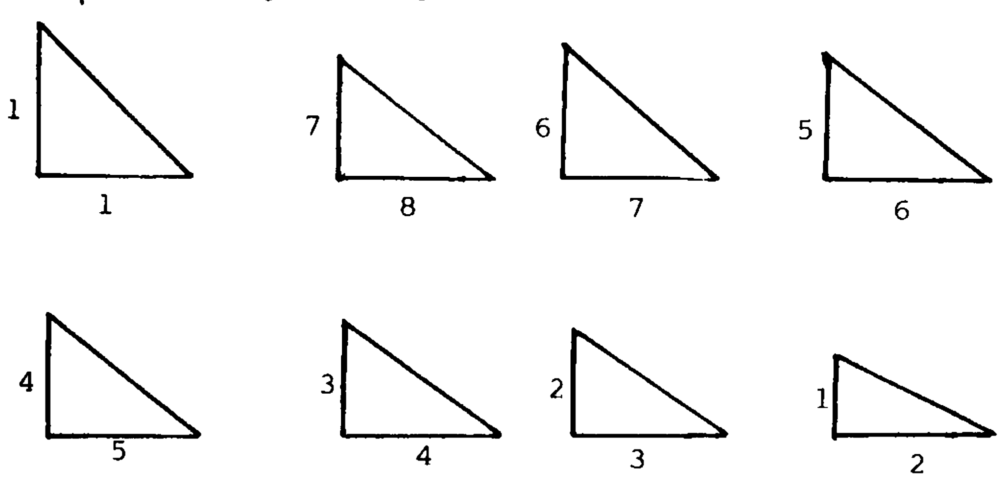

Fig.5(c)

Manuṣyālayacandrika stipulates the height of the ridge equal to the semiwidth of the building. In this case the inclination of the roof will be 45°. The proportion 2:3 is accepted for practical purposes in later construction of buildings where the inclination of the roof is about 33½°.

5.7. DETERMINATION OF THE LENGTH OF THE SIDE OF AN OCTAGON

A given square may be transformed into an Octagon, Sixteen sided polygon, Thirtytwo sided polygon etc, and finally to a circle by the successive division of the sides of the square and deleting the triangles at the corners. The principle of trairāśika is applied in determining the length of sides of the regular polygons[66].

Consider a square ABCD of side a. Let the two lines through the midpoints of the sides intersect at O forming 4 small squares in the given square [cf Fig.5(d)].

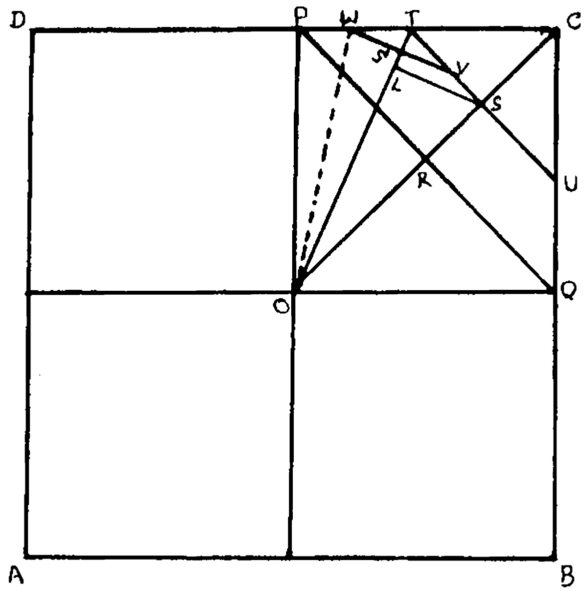

Fig.5(d)

Join O and C. Let $\overline{PQ}$ meets $\overline{OC}$ at R and OS = OP = OQ. ΔOPC is an isosceles triangle. $\overline{PR} \perp \overline{OC}$ and $\overline{TS} \perp \overline{OC}$

CR = Pramāṇam

CP = Pramāṇaphalam

OC - OS = CS

= Icca

$\therefore$ Iccaphalam = CT

$= \frac{CP}{CR} \times CS$

Mark points on each side of the square at a distance of CT from each corner. ie, CT = CU. Delete 4 triangles at the corners each equal to ΔCTU to form the required octagon. TU will be a side of the octagon = a-2CT. Let S' be a point on $\overline{OT}$ such that OP = OS'.

Draw a line $\overline{WV} \perp \overline{OT}$ through S'. Then using trairāśika as above we get,

$$TV = \frac{TS \times TS'}{TL}, \text{ where } SL \perp OT.$$

Delete triangles at the corners of the octagon each equal to ΔTVW to form a regular 16-sided polygon. Continueing this process, we will reach a position when the polygon approximately becomes a circle. The idea of limit is implied in this process.

5.8.1. DETERMINATION OF LENGTH OF RAFTERS USING TRAIRĀŚIKA

The idea of Trairāśika is used in determining the lengths of rafters. In Vāstuśāstras, there are many methods defined for finding the lengths of rafters. The process may be different in each method due to many facts such as tradition, regional difference etc, but the result will be the same. These methods and rules are evolved through years of continuous practice and evaluation. Tedious computational process was a hindrance to the traditional architects and so they formulated simple and easy methods for finding the measurements of various elements of building.

The traditional architects of Kerala have developed some practical methods for finding the lengths of rafters. They defined suitable 'scales' (proportional units) and named as Pramāṇas (Postulates) in terms of the scales which are used for finding the true lengths of rafters. The Postulates (Pramāṇas) are known as 8th Postulate (Ettam Pramāṇam), 4th Postulate (Nālām Pramāṇam), 6th Postulate (Ārām Pramāṇam) etc.[33]

5.8.2. 8TH POSTULATE (ETTĀM PRAMANAM) AND LENGTH OF RAFTERS

In this method the requirements are a wooden board, an axe and a measuring rod. This wooden board is named as measurement board (Pramāṇappalaka). Construct a right angled triangle OAB on this board in such a way that the proportionate scale is 1 kol (72 cm) = 3 angula (9 cm) or 8 angula = 1 angula (3 cm). $\overline{OA}$ is called the bhuja and $\overline{OB}$ is called the koti. [cf Fig.5(e)]

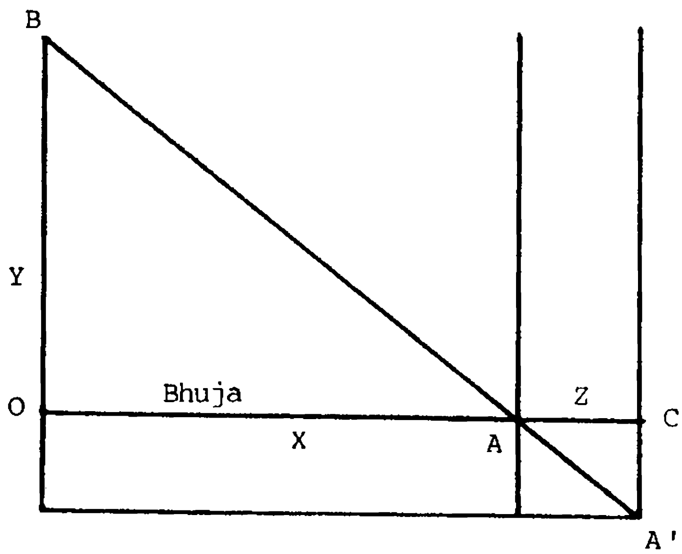

Fig.5(e)

Let x angula be the width of the house. Mark a point A on the bhuja such that OA = $\frac{1}{8} \cdot \frac{x}{2}$ angula = $\frac{x}{16}$ x 3 cms. Let y angula be the height of the roof support. Put a mark at B on the koti such that OB = $\frac{y}{8}$ x 3 cms. Let z angula be the eaves projection (kazhukkol chattam). Mark another point C on the bhuja such that AC = $\frac{3}{8}$ x 3 cms. Draw a line parallel to koti through C. Join the points B and A and produce it to meet the parallel through C at A'. Then BA' is the $1/8^{th}$ of the length of the st. rafter ie, 8BA' gives the length of straight rafter from the ridge to the tip of the eavesprojection. 8BA represent the length of the rafter from the ridge to the notch on the wallplate for fixing the rafter on it. Since the scale is taken as 8:1, this method is known as 8^{th} Postulate in Kerala.

The advantage of this method is that the space used for drawing the figure is diminished to $1/8^{th}$ of the usual method. But calculations and figures are different for different situations. This problem is solved in the 4^{th} Postulate (Nālām Pramāṇam).

5.8.3. 4^{TH} POSTULATE (NĀLĀM PRAMĀṆAM)

Here the requirement is a small rectangled wooden board which is known as 'Mattappalaka' or simply 'Mattam'. This is used as a key instrument for measuring and marking several minute elements of a building [cf Fig.5(f)].

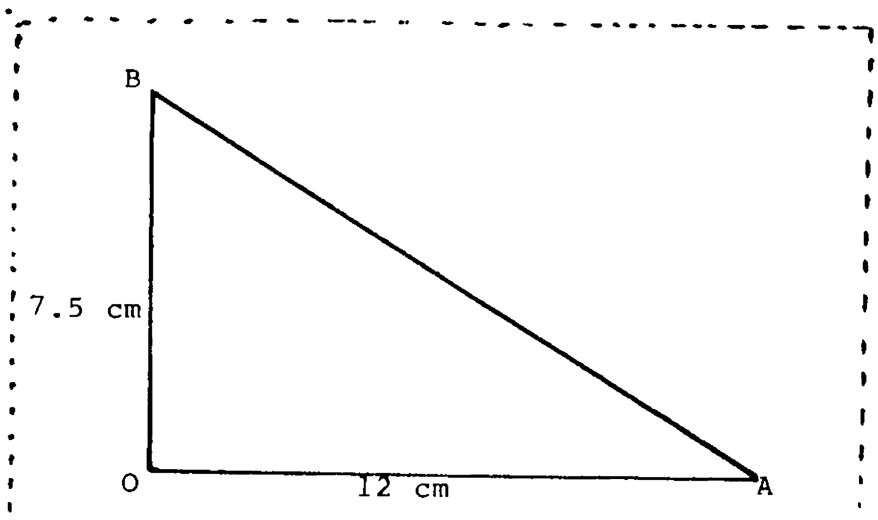

Fig.5(f)

Consider a right angled triangle with base (bhuja) 4 angula (12 cm) and altitude (koti) $2\frac{1}{2}$ angulam (7.5 cm) on this board. The length of the hypotenuse is defined as the 'scale' or unit of measurement in this method. The true length of the straight rafter (common rafter) from ridge to the outer edge of the wallplate is got by taking 6 times of this 'scale' per 1 kol (72 cm) of the semiwidth of the house.

For an illustration, let 2x kol be the width of the house and l be the 'scale' (unit of measurement). Then the length of the straight rafter is 6xl. By giving different values for x, we get the corresponding lengths of the rafters from the above formula, provided the height remains the same. One of the features of this method is that the 'scale' used in this method is independent of the width of the house and may be used for all widths having the same height. Even though this method is not given on any pages of Vāstusāstra texts, this was used by the traditional architects and the idea was transmitted from generation to generation through teacher-student relationship and verbal teachings.

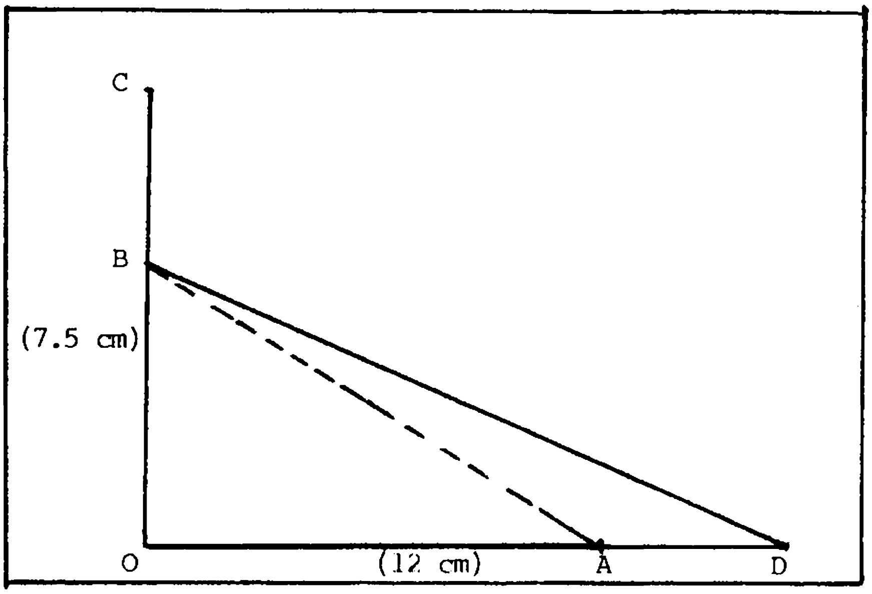

Fig.5(g)

By an extension of this method, the length of the hiprafter may be calculated. For this, consider the diagonal of a square with side 4 angula (12 cm) and mark this length on the bhuja at D. Then BD will be the 'scale' for calculating the length of the hiprafter from ridge to the outer edge of the wallplate [cf. Fig.5(g)].

If we have to increase or decrease the pitch of the rafters, then the length OB is to be increased or decreased accordingly. Thus this was a universal method formulated by the traditional architects of Kerala.

In all these methods the principle of trairāśika is applied. Further it is convenient to have the width of the house in multiples or submultiples of pada (8 angula) units.

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Chapter VI

GEOMETRICAL CONSTRUCTIONS AND RELATED MATHEMATICAL CONCEPTS

6.1. INTRODUCTION

The plan shape, determined by a bounding perimeter (paryanta sūtra), is known as the maṇḍala. In the traditional architecture of Kerala seven geometrical shapes are defined for maṇḍala which are given in the following lines.

"Vṛttam vṛttāyatamapyāyata caturam ca samacaturam
ezhuntākṛti sadanē ṣadaṣtakon hastipṛṣṭha mennittham".

(Bālārāmam, page 66)

The plan shapes are circle, elongated circle, rectangle, square, hexagon, octagon and gajapṛṣṭham (apsidal). Usually triangular shape is not accepted for buildings of domestic purposes. Most of these shapes are used in vedic period for constructing different types of yajna-vedis and mantra-yantras.

In this chapter we illustrate the method of construction of these shapes and their architectural values implied in vāstuśāstras. The constructions of a triangle, rectangle, hexagon, octagon and circle each of which having the same perimeter of a given square and deduction of mathematical values assumed in them are explained in detail. The geometrical method of determining the lengths of rafters are also included in this chapter.

6.2.1. SQUARE

The square is literally the fundamental form of Indian architecture. The form of a Vāstupuruṣamaṇḍala is a square. Earth is symbolically represented by square and it is known as the Brahmamaṇḍala. The square maṇḍala has the highest efficiency of space enclosure when compared to other quadrilaterals. It can be converted into a circle, triangle, hexagon, octagon and a rectangle. The method of construction of a square is given in Tantrasamuccaya(15). A rectangle may be obtained from a square by elongation (āyāmam) and regular polygons of 8 sides, 16 sides etc, are derived from the square.

6.2.2. CONSTRUCTION OF A SQUARE

The method of construction is given below:

Prāgagram sūtramurvya mṛjūtara mabhikalpyāsya mūlāgragābhyām
sūtrābhyām matsyayugmam yamasasiharitō: kalpayi tva tra/sūtram
kṛtvā dikṣvankayitvā samamiha vihitai ssūtra kai: koṇamatsyān
kṛtvā /sphalyaiṣu sutram racayatu caturasram pura: kṣetraknuptau

(Tantrasamuccaya, patalam 12, slokam 23)

To construct a square, draw a line segment in the plane of the earth in the East-West direction with the help of a rope (about 1 kol in length) [cf Fig.6(a)].

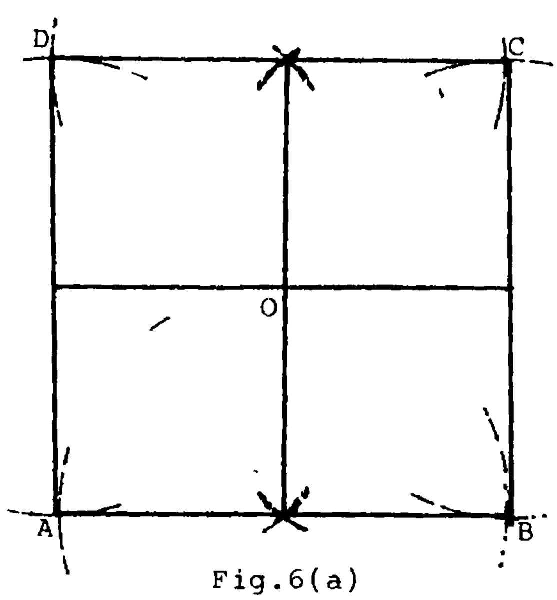


Fig.6(a)

Then draw two circles with their centres at the extremities of the line segment and radii equal to 3/4th of the length of the line segment. The intersection of the circles will be in the shape of a fish (fish like line) and the line through the points of intersection of the circles will determine the North-South direction. Draw four equal circles with their centres on four directed line segments at a fixed distance from the point of intersection of the two lines. Join the points of intersection of the circles (tips of fish like lines) to get the required square.

6.3. CONSTRUCTION OF A RECTANGLE WHOSE PERIMETER EQUAL TO THAT OF A SQUARE[58]

Consider a square of the given perimeter. Divide the square into 64 cells (pada) (8 x 8 grids). Delete a row of cells along a pair of opposite sides of the square. A column of equal square cells is adjoint to the other two sides of the square. Then the resulting figure will be a rectangle whose perimeter is equal to that of the square and whose sides will be in the ratio 3:5 [cf Fig.6(b)].

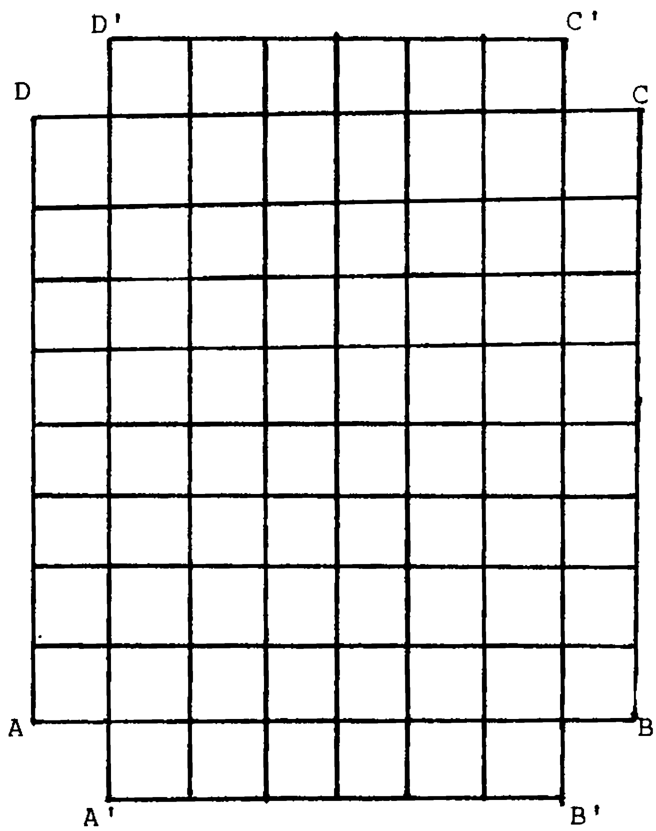


Fig.6(b)

ABCD is a square of 8 x 8 (pada) space module and A'B'C'D' is a rectangle of 10 pada x 6 pada module. The perimeter of the square is equal to 4 x 8 units and the perimeter of the rectangle is (10 + 6)2 unit, ie. 32 units. Hence the perimeters are equal where as the areas are different. This principle is made use of in the construction of Nātyamaṇḍapa.

6.4.1. CIRCLE

A circle may be defined as the locus of a point which moves such that its distance from a fixed point always remains a constant. It was considered the most perfect shape in Vāstuśāstra. In Tantrasamuccaya(15) a method of drawing a circle is given (explained in Chapter III). Square and circle are coordinated in architecture from the vedic period.

6.4.2. CONSTRUCTION OF A CIRCLE WHOSE PERIMETER IS EQUAL TO (APPROXIMATELY) THAT OF A GIVEN SQUARE

The method is given in the following lines.

Karṇṇārddha sūtrasya bhujārddhatōti
riktamśakārddham bahi rankayitva
madyastha sūtram parivarttya kuṇḍam
kurvīta caṇḍadyuti maṇḍalābham

(Tantrasamuccaya(15), patalam 12, sloka 29)

This rule states that take the half of the difference between the semidiagonal and semiside of the given square. Add this quantity to half the length of the side. Then draw a circle with this length as radius and centre at the centre of the square. This will give the required circle.

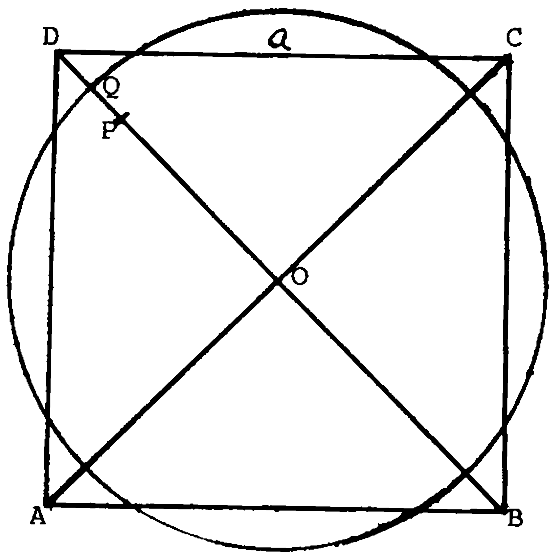


Fig.6(c)

Let a be the length of the side of a square ABCD. Let the diagonals $\overline{AC}$ and $\overline{BD}$ intersect at O, which is the centre of the square. Take a point P on $\overline{OD}$ such that OP = a/2, half of the length of the side of the square. Let Q be the midpoint of $\overline{PD}$. Draw a circle with centre at O and radius equal to OQ. Then this will be the required circle whose perimeter is (approximately) equal to that of the square [cf Fig.6(c)].

Since a is the length of the side of the square,

$$OD = \frac{\sqrt{2}a}{2}$$

$$\therefore r = \frac{a}{2} + \frac{1}{2}\left(\frac{\sqrt{2}a}{2} - \frac{a}{2}\right)$$

$$= \frac{a}{2} + \frac{a}{4}(\sqrt{2} - 1)$$

$$= \frac{(1 + \sqrt{2})a}{4}$$

When $a = 4$, the perimeter of the square is 16 units and the perimeter of the circle is $2\pi(1 + \sqrt{2})$.

Another method is stated for circling the square of the same perimeter. According to this method we have to add a quarter of the half length of the side of the square to the half length of the side, ie, add 1/8th of the side length to half of the side length. This will give the radius of the circle.

ie, radius of the circle is $\frac{a}{2} + \frac{a}{8}$

$$\therefore \text{perimeter of the circle} = 2\pi\left(\frac{a}{2} + \frac{a}{8}\right)$$

$$= \frac{5\pi a}{4}$$

If we take the value of ¶ as 3.14, the perimeter of the circle, in the first case, will be

$$2\pi r \quad = \quad 2 \times 3.14 \times \frac{a(\sqrt{2} + 1)}{4} \ ,$$

where a is the side of the square.

When a = 4,

$$\text{Perimeter, } C \quad = \quad 2 \times 3.14(\sqrt{2} + 1)$$

$$= \quad 15.16126 \text{ units}$$

But the perimeter of the square is 16 units. Similarly in the second case perimeter of the circle is 15.7 when ¶ is 3.14.

Thus in both the cases the value of ¶ was assumed to be greater than 3.14.

Further it may be seen that the perimeter of the circle will be approximately equal to that of the square if we take the radius of the circle as

$$r \quad = \quad \frac{a}{2} + \frac{2}{3}\left(\frac{\sqrt{2}a}{2} - \frac{a}{2}\right)$$

$$\text{ie} \quad r \quad = \quad \frac{a}{2} + \frac{a}{3}(\sqrt{2} - 1)$$

$$= \quad \frac{3a + 2\sqrt{2}a - 2a}{6}$$

$$= \frac{a(2\sqrt{2} + 1)}{6}$$

$$\therefore \text{Perimeter, } C = 2\P r$$

$$= 2\P\left[\frac{a(2\sqrt{2} + 1)}{6}\right]$$

When $a = 4,$

$$C = \frac{4\P}{3}(2\sqrt{2} + 1)$$

If $C = 16$ units

= the perimeter of the square, then

$$\P = \frac{16 \times 3}{4(2\sqrt{2} + 1)}$$

$$= \frac{12}{2\sqrt{2} + 1}$$

$$= 3.13445 \text{ (approximately)},$$

which is very close to the value of ¶ and the perimeter is 16.000017, approximately equal to the perimeter of the square.

6.5.1. GAJAPṚṢṬHA AND VṚTTĀYĀTA

There are two shapes which are unique in Indian architecture. They are gajapṛṣṭha (apsidal) and vṛttāyāta (elongated circle) or Āyatavṛtta shapes. The

The apsidal shape, resembling the rear side of an elephant, is a combination of a square and a semicircle. The vṛttāyāta shape consists of a square with two semicircles at the ends. Generally these two shapes are used for temple construction. The method and measurements of constructing gajapṛṣṭha and vṛttāyāta maṇḍalas are given in Tantrasamuccaya(15) and Kuzhikkāṭ Pacca(47). Vṛttāyāta is sometimes called by the name Dīrghavṛtta. The method of construction of gajapṛṣṭha shape is explained in chapter III.

6.5.2. METHOD OF CONSTRUCTION OF DĪRGHAVṚTTA (ELONGATED CIRCLE)

The method of construction of Dīrghavṛtta is explained in the verse below:

bhāgadvayē dviradapṛṣṭha samuktanītyā
vṛttīkṛtē, tadubhayāntarabhāgadairghyam
swēddhmām'satō virahitēna guṇām'sakēna
vṛttāyatē vitanuyāt suravaryadhiṣṅyē
(Tantrasamuccaya(15), patalam 2, sloka 68)

Construct semicircles at the front and rear side with radius equal to 2 parts as described in the case of

Gajapṛṣṭha shape. Then divide the length of 3 parts into 21 divisions and delete one division from it. The remaining length will be the length of the middle line segment (lateral sides) joining the two semicircles on either sides [cf Fig.6(d)].

Divide the desired perimeter into 64 equal parts. Then the semicircles are determined with diameter equal to the length of 14 parts and the lateral sides of the rectangular portion in between the semicircles are defined by 10 parts.

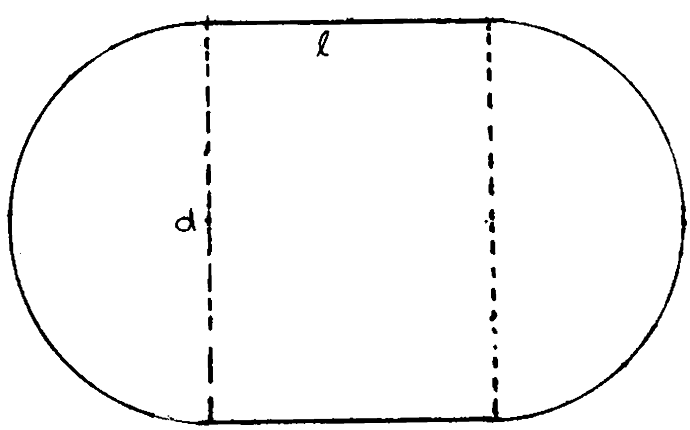


Fig.6(d)

After dividing the perimeter into 64 parts, delete one part from it. Then divide the remaining length into 18 divisions and length of each division will be $3\frac{1}{2}$

parts (of the former division).

$\therefore$ radius of the semicircle = 2 divisions

= 7 parts

$\therefore$ diameter = 14 parts

The length of the lateral side = 3 divisions $- \frac{3}{12}$ divisions

$= 10\frac{1}{2}$ parts $- \frac{10\frac{1}{2}}{21}$ parts

$= (10\frac{1}{2} - \frac{1}{2})$ parts

= 10 parts

Thus the perimeter of the elongated circle is equal to the sum of the perimeters of two semicircles and two lateral lengths of the rectangular portion.

ie, Perimeter $= \pi \times 14 + 2 \times 10$ parts

If the perimeter is 64 units, then

$$64 = 14 \times \frac{22}{7} + 20$$

= 64 units which is true.

Here the value of π is implied to be 22/7.

6.5.3. DETERMINATION OF THE PERIMETER OF THE DĪRGHAVṚTTA

Let P be the perimeter of the elongated circle.

Then P = 2 x perimeter of the semicircle + 2 x length of the lateral side of the rectangular portion

= $2 \times \P r + 2\,l$, r, the radius of the semicircle

= $\P d + 2\,l$, d, the diameter of the circle

and d = width between the lateral sides

From above,

the width = d

$$= \frac{P}{64} \times 14$$

and $\frac{d}{l} = \frac{14}{10}$

$$\therefore l = \frac{d \times 10}{14}$$

$$= \frac{d}{1.4}$$

∴ Perimeter,

$$P = \P d + 2\,\frac{d}{1.4}$$

$$= d\left(\P + \frac{1}{0.7}\right)$$

When d = the diameter of the semicircle is known, P may be calculated.

If P = 64,

then $P = 14(\pi + \frac{1}{0.7})$

$$\therefore \frac{64}{14} = \pi + \frac{1}{0.7}$$

$$\frac{64}{14} - \frac{1}{.7} = \pi$$

$$\frac{2.2}{.7} = \pi$$

$$= \frac{22}{7}$$

When $\pi = \frac{22}{7}$,

$$P = d(\frac{22}{7} + \frac{1}{.7})$$

$$= \frac{32}{7} d$$

Thus the perimeter of the elongated circle is determined when the width (max. width) of the rectangular portion is known.

Note: In some texts it is seen that the length of the rectangular portion is taken as the radius of the semicircle.

6.6.1. TRIANGLE

A triangle appears to be a mystic shape in tantric rites and architectural ornamentations, but not much used as gṛha-vāstumaṇḍala. The inscription of triangles in a 'Srīcakram' is an example for this. Bharata Muni in his 'Nātyasāstra' describes triangle as a suitable shape for the construction of 'Natyagrha' (Kūthampalam). Throughout history the commonest covering of the building is the trussed roof, constructed upon a frame composed of triangular sections spaced crosswise at intervals and made rigid in length by beams. The truss is based on the geometric principle that a triangle is the only figure that cannot be changed in shape without a change in the length of its sides. Thus a triangular frame of strong pieces firmly fastened at the angles cannot be deformed by its own load or by external forces such as the pressure of strong wind or rain. This principle is made use of in the construction of Malabar gable - a triangular projection at the top extremities of tiled or thatched roofs. It is the characteristic feature of Kerala style of architecture which is noted for its beauty and utilitarian simplicity.

The higher derivatives of triangles regular polygons of 6 sides, 12 sides etc, were rarely used except for ornamental works and temples.

6.6.2. CONSTRUCTION OF A TRIANGLE WHOSE PERIMETER IS EQUAL TO THAT OF A GIVEN SQUARE

The method is described in the following lines.

ṣaṣṭhāmśakam yamahimāmśudiśō: pratīcya
sūtrē suyōjya haridigbahirankayitva
tēnaiva tēṣu suvidhaya ca sūtrapātam
kuryattrikōṇaparimaṇḍita vahnikuṇḍam

(Tantrasamuccaya, patalam 12, sloka 28)

Divide the length of the side of the square into 6 equal parts. Extend the western side of the square by adding one part each to the Southern and Northern ends. Put a mark on the exterior side of the square at a distance of $1/6^{th}$ of the length of the side of the square from the Eastern side. Draw lines joining this mark and the ends of the Western side. The resulting triangle will be the required one.

Let ABCD be the given square with side a. Divide the length a into 6 equal parts and add one part each to either end of the side $\overline{AB}$.

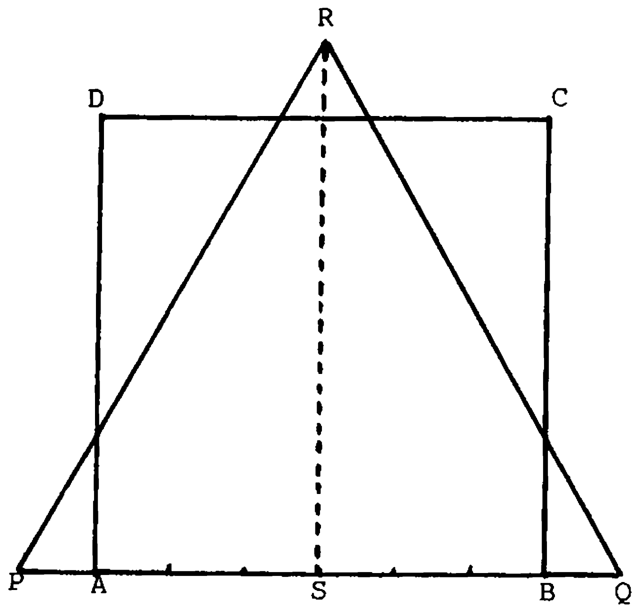


Fig.6(e)

Let $\overline{PQ}$ be the extended side and R be the point at a distance of $1/6^{th}$ of $\overline{AB}$ from $\overline{CD}$. Join $\overline{PR}$ and $\overline{QR}$. Then PQR is the required triangle [cf Fig.6(e)].

From Fig.,

$$AB = a \text{ cm}$$

$$PQ = a + 2.\frac{a}{6}$$

$$= \frac{4a}{3}$$

$$RS = a + \frac{a}{6}$$

$$= \frac{7a}{6}$$

$$\therefore PR^2 = (\frac{2a}{3})^2 + (\frac{7a}{6})^2$$

$$= \frac{4a^2}{9} + \frac{49a^2}{36}$$

$$= \frac{65a^2}{36}$$

$$\therefore \text{Perimeter of } \triangle PQR = \frac{2\sqrt{65}\ a}{6} + \frac{4a}{3}$$

$$= \frac{\sqrt{65}\ a + 4a}{3}$$

$$= \frac{a}{3}\ (8.062 + 4)$$

$$= \frac{12.062}{3} \times a$$

$$= 4.02 \times a \text{ cm}$$

When $a = 6$ cm, Perimeter $= 4.02 \times 6 = 24.12$ cm. But the perimeter of the square when $a = 6$ cm is 24 cm. Hence the perimeter of the triangle is greater than that of the square by $.02 \times a$ units.

6.7. CONSTRUCTION OF A HEXAGON WHOSE PERIMETER IS EQUAL TO THAT OF A GIVEN SQUARE

This method is given in the verse below.

ankau prakalpya haripancamadikpadikthau
ṣaṣṭhamsatō bahi ratō nijamaddhyatasca
dvau dvau jhaṣau paradisōrapi matsyacihna-
ṣatsūtrakairvviracayē drasaķōṇakuṇḍam
(Tantrasamuccaya(15), patalam 12, sloka 30)

Draw a line in the East-West direction through the middle points of the side and take two points on this line on either side at a distance of $1/6^{th}$ of the length of the side. Draw three equal circles with their centres at the extremities of this central line segment and at its mid point and radius equal to the semilength of this line segment. Join the points of intersection of these circles (two fish like lines) and the end points of the line segment successively to form the required hexagon [cf Fig.6(f)].

Instead of taking the East-West line we can take the South-North line and proceeding in the same method we get the required hexagon.

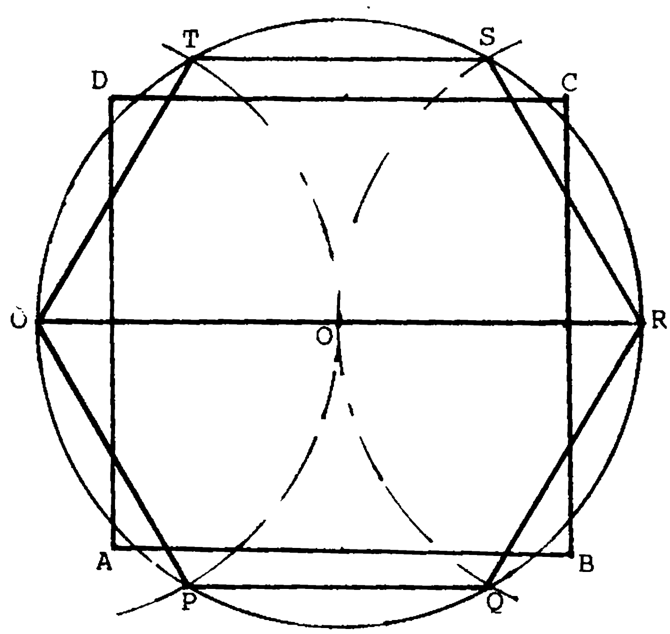


Fig.6(f)

Let ABCD be the square and R and U be points on the line through the midpoints of $\overline{AD}$ and $\overline{BC}$. Let P,Q,S and T be the points of intersection of the circles. The PQRSTU is the required hexagon.

Let a be the length of the side.

Length of $\overline{UR}$ $= a + 2.\frac{a}{6}$

$= \frac{4a}{3}$

$\therefore$ radius of the circle $= \frac{2a}{3}$

ΔOPQ is an equilateral triangle, since the sides are radii of equal circles.

$\therefore$ the side of the hexagon $=$ the radius of the circle

$$= \frac{2a}{3}$$

$\therefore$ perimeter of the hexagon $= \frac{2a}{3} \times 6$

$$= 4a,$$

which is the same as the perimeter of the square.

6.8. CONSTRUCTION OF AN OCTAGON WHOSE PERIMETER IS (APPROXIMATELY) EQUAL TO A GIVEN SQUARE

The method of constructing an octagon is given in the following lines.

kṣētrē tatra samantatō dinakarāmśam nyasya turyasritē
kōnēbhyō bhujasūtrakēṣu nihitai: svai: karṇṇasūtrārddhakai:
dvau dvau dikṣu jhaṣān prakalpya makarēṣvāsphalitai raṣṭabhi:
sūtrai rīswaradiñmukhē viracayē daṣṭāśrakuṇḍam sudhī:

(Tantrasamuccaya[15], patalam 12, sloka 32) ie, construct another square circumscribing the given square by extending each side by $1/12^{th}$ of the length of the side of the given square. Put two marks on its each side by drawing circles with centre at the corners and radius equal to half the length of its diagonal. Form two fish like lines (intersecting circles) on each side by drawing 8 circles with centres at these points and join these points successively to get the required octagon [cf Fig.6(g)].

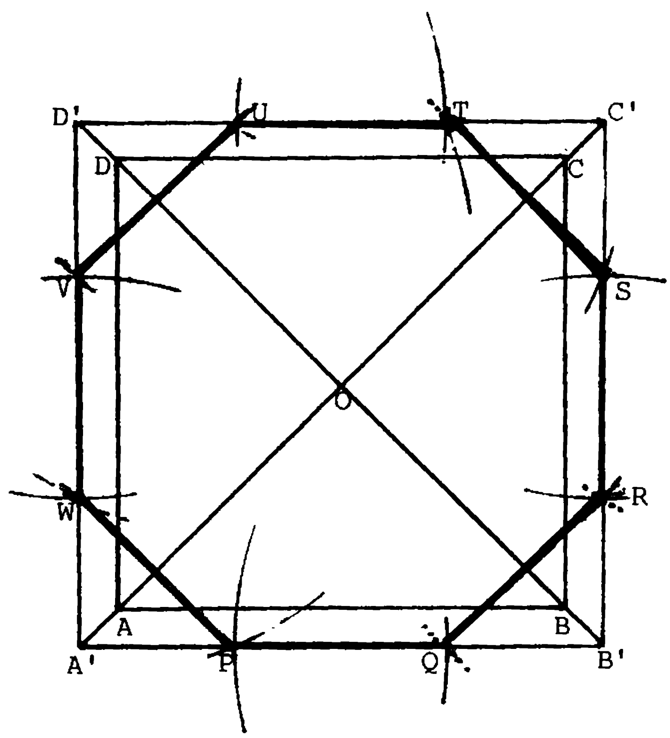


Fig.6(g)

Let ABCD be the given square and A'B'C'D' be the circumscribing square. A'C' is the length of the diagonal and OA' is the half the length of the diagonal. Let the circles with centres at A',B',C' and D' and radius OA' cuts the sides at P,Q,R,S,T,U,V and W. The circle with centre at P and radius PR passes through R and V. Similarly, by drawing circles with centres at the other seven points will give 8 points of intersection of circles (four fish like lines). Joining these points successively we get the required octagon.

Let the length of the side of the square ABCD be a. Then length of the side of the square A'B'C'D' will be

$$A'B' = a + 2.\frac{a}{12}$$

$$= \frac{7a}{6}$$

$$\therefore \text{ Length of the diagonal } A'C' = \sqrt{2}.\frac{7}{6}a$$

$$\therefore OA' = \sqrt{2}.\frac{7}{12}a$$

$$PQ = \text{Length of the side of the Octagon} = A'B' - 2A'P$$

$$AP = QB'$$
$$= A'B' - PB'$$
$$= A'B' - OA'$$
$$= \frac{7a}{6} - \sqrt{2}\,\frac{7}{12}a$$
$$= \frac{7}{12}a(2 - \sqrt{2})$$
$$\therefore\ 2A'P = \frac{7a}{6}(0.586)$$
$$\therefore\ PQ = \frac{7a}{6} - \frac{7a}{6}(0.586)$$
$$= \frac{7a}{6}(0.414)$$
$$\text{when } a = 6 \text{ cm},$$
$$PQ = \frac{7}{6} \times 6(0.414)$$
$$\therefore \text{ Perimeter of the octagon} = 8 \times 7(0.414)$$
$$= 23.184 \text{ cm}$$

But the perimeter of the square is 24 cm. Hence the perimeter of the octagon is less than the perimeter of the square.

6.9. THE METHOD OF INSCRIBING AN OCTAGON (ETTU PATTAM) IN A GIVEN SQUARE

The method is described in the following lines.

yasya vistāramarkkāmśam
bāṇāmśam pattamēva ca
saptāmśēna dvibhāgattu
karttavyam kōṇabhāgikam

(Bālārāmam, page 59)

Divide the side of the square into 12 equal parts. Retain five parts in the middle and delete 3½ parts on either end of the sides of the square to get the required octagon [cf Fig.6(h)].

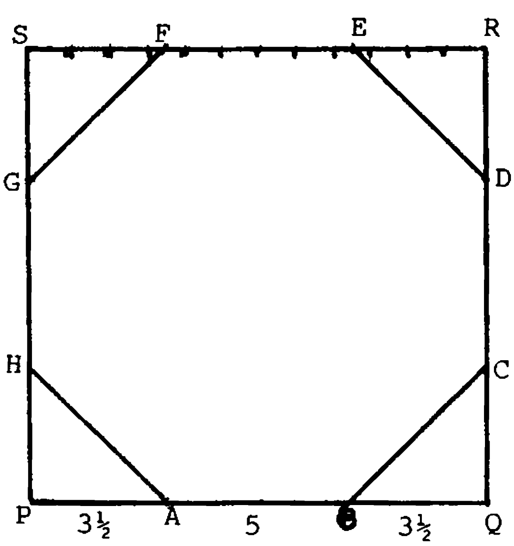


Fig.6(h)

Let PQRS be the given square of side a. Divide each side into 12 equal parts. AB is the middle portion of PQ having a length $\frac{5a}{12}$. PA = BQ = $3\frac{1}{2}$ parts each. Similarly we get CD, EF, and GH on each side of length $\frac{5a}{12}$. Draw line segments BC, DE, FG and HA to get the octagon ABCDEFGH inscribed in the square.

Let the length of the side be 12 units. Then AB = 5 units. From triangle BQC, we get,

$$BQ^2 + CQ^2 = BC^2$$

$$3.5^2 + 3.5^2 = BC^2$$

$$12.25 + 12.25 = BC^2$$

$$\therefore \quad BC = \sqrt{24.5}$$

$$= 4.949, \text{ approximately}$$

Or from the right angle triangle BQC,

$$\text{Sin } 45 = \frac{3.5}{BC}$$

$$\frac{1}{\sqrt{2}} = \frac{3.5}{BC}$$

$$\therefore \quad BC = 3.5 \times \sqrt{2}$$

$$= 4.949, \text{ approximately.}$$

This value of BC is very close to 5. For practical purposes the above value is acceptable.

6.10. METHOD OF CONSTRUCTION OF 'SRĪCAKRA' (OR SRĪYANTRA)

From the mathematical point of view, Srīcakra is an ancient geometrical portrayal consisting of a bindu, angles formed by the intersections of triangles, 8 and 16 petalled lotus, circles and squares (bhūpura). The method of construction of 'Srīcakra' is explained in Tantrasamuccaya (Silpabhagam)[16] in three verses. The first verse describes the method of drawing lines for bhūpura (squares), circles and the required number of petals of lotus. The rule is stated in the verse below.

ṣaṇṇavatyamgulāyāmam sūtram prākpratyagāyatam
caturbhiramgulai: śiṣṭai: suvṛttāni ca bhūpuram
antarnavāngulam prōktam maddhyē patram, tu ṣōḍaśa
ēkādaśāmgulōpētamaṣṭapatram vidhīyate.

(Tantrasamuccaya (Silpabhagam), Annexure I(F), sloka 1)

This means that draw a line of length 96 angula (about 288 cms) in the East-West direction on a plane where the Srīcakra is to be constructed. Draw three squares for bhūpura through the ends of the line and three circles inside the square with the diameter of the outermost circle is equal to 46 angula. The squares and circles must be within a width of 4 angula (1 angula = 3 cm). Then 16 petals of width 9 angula and 8 petals of width 11 angula are to be constructed inside the circle.

The next verse describes the method of drawing the angles at the middle portion. The 'Katapayadi' system is used in representing the numbers in this verse. The verse is given below(16).

vyāsē 'dē, vi' kṛtē ta, tta, ma, la, la, vi, ga, tē, cā, ṣa, bhāgē 'jha' sūtrān

kṛtvā 'pū, rī, da, ḷa, 'ntē ga, va, va, la, mubhayō 'rvvā', ta 'yō stōya bhāgān

'dhanyām' śā 'nmē' pravṛjya grathayatu varuṇā sādi sūtradvayāni

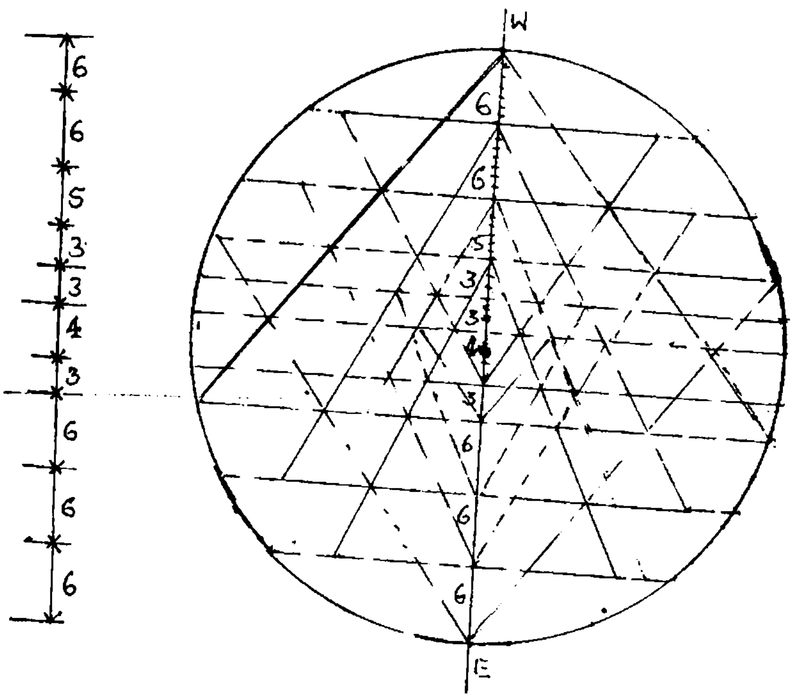
prākpōtam' rē,dhi' gānam vi,di ma,tha dhuginam di,vya sūnum ciram prāk

The diameter (remaining part of East-West line) of the circle inside the 8 petals is divided into 48 parts. Draw 9 lines in the North-South direction (perpendicular to the East-West line) cutting the East-West line at widths of 6 parts, 6 parts, 5 parts, 3 parts, 3 parts, 4 parts, 3 parts, 6 parts, 6 parts and 6 parts in order from the west side. Delete segments of lines of length 3 parts at both the ends of 1^{st} and 9^{th} lines, and remove 4 parts from both the ends of 2^{nd} and 8^{th} lines. Remove 16 parts each from both the ends of 4^{th} and 6^{th} lines and delete 19 parts at the ends of 5^{th} line.

To form the angles, join the ends of 1^{st} line segment to the midpoint of 6^{th} line from the west. Similarly, join the ends of 2^{nd} line to the midpoint of 9^{th} line. Join the ends of 3^{rd} line to the point on the circle when the East-West line meets the circle and join the ends of 4^{th} line to the midpoint of 8^{th} line and the ends of 5^{th} line are joined to the midpoint of 7^{th} line.

From the other side join the ends of 9^{th} line to the midpoint of 3^{rd} line. The ends of 8^{th} line are joined to the midpoint of 1^{st} line and the ends of 7^{th} line are joined to the point of intersection of the East-West line with the circle. The ends of 6^{th} line are

SRICAKRAM



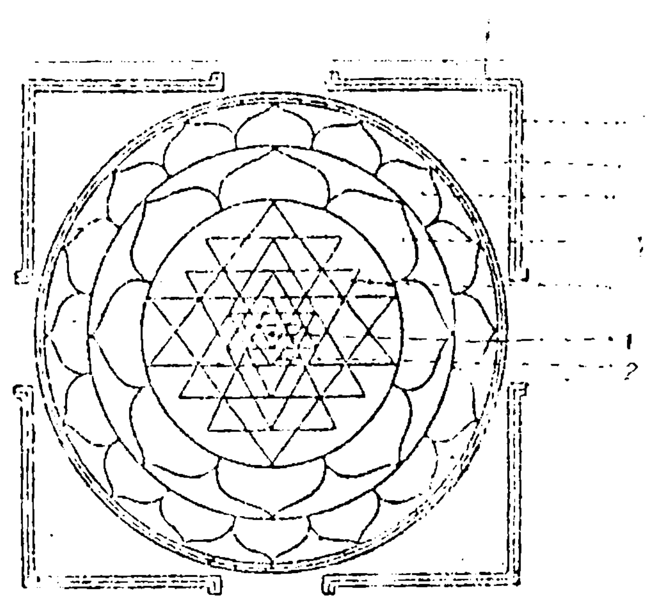


Fig.6(i)

joined to the mid point of 2^{nd} line. Then the East-West line is rubbed off. Then we get the angles at the middle of the Srīcakra [cf Fig.6(i)].

The resulting Srīcakra consists of the following elements as given in the third verse(16).

bindu, trikōṇa, vasukōṇa, dasārayugmam
manvaśra, nāgadaḷa, ṣōḍaśa, karṇṇikāram
vṛttatrayam ca, dharanī valayatrayam ca
Srīcakramētaduditam paradēvatāyā:

The cakra consists of a point at the centre which is inscribed in a triangle. This triangle is surrounded by 8 angles, 10 angles, 10 angles and 14 angles in order. Then there are 8 petalled and 16 petalled lotus. All these are enclosed in vṛttatria and in the three squares (bhūpura). This is known as the bhūprastāracakra.

Srīcakra in the three dimensional form is called Mērucakra.

6.11. TO FIND THE LENGTH OF THE DIAGONAL OF A SQUARE WITHOUT USING PYTHAGORAS THEOREM

The method is given in the following lines.

Yasya vistāram sūryāmśam
pancāmśam yuktamēvaca
tasya yōgāmśatōssūtram
karṇṇamānam vidhīyate

(Bālarāmam, page 56)

Divide the length of the side of the square into 12 parts. Add the length of 5 parts to the length of the side of the square which give the length of the diagonal of the square (approximately) [cf Fig.6(j)].

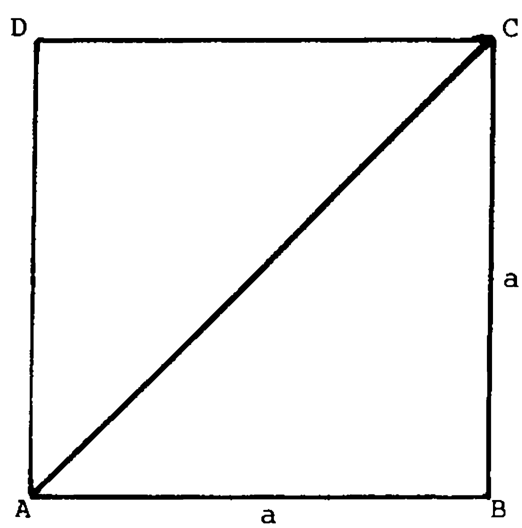


Fig.6(j)

Let a be the length of the side of the square ABCD. By this method, the diagonal of this square is given by $a + \frac{5a}{12} = \frac{17a}{12}$. When a = 12 cm, the length of the diagonal is 17 cm. By using Pythagoras theorem, the length of the diagonal is $\sqrt{2}\ a = \sqrt{2} \times 12$ ie, d = 16.9705 cm. The difference between the two values is very small.

By the above method the length of the diagonal is

$$
\begin{aligned}
a + \frac{5a}{12} \quad &= \quad 12 + .416 \times 12, \\
\text{(when } a \quad &= \quad 12) \\
&= \quad 12 + 4.999 \\
&= \quad 16.999, \text{ nearly.}
\end{aligned}
$$

Hence the difference between the two values is nearly .029 which is very small for practical purposes.

$$
\begin{aligned}
\text{Further, if } \sqrt{2}a \quad &= \quad \frac{17}{12}\ a, \\
\text{then } \sqrt{2} \quad &= \quad \frac{17}{12} \\
&= \quad 1.416,
\end{aligned}
$$

which is a very good approximation of the value of the irrational number $\sqrt{2}$.

6.12. CONSTRUCTION OF LAMBA AND VITĀNA (VERTICAL AND HORIZONTAL DIRECTION)

Let $\overline{PQ}$ and $\overline{QR}$ represent the dhwaja sūtra (kotinūl) on the rafter and the wallplate respectively. Consider a rectangular wooden board ABCD whose width AB is 5/9 the width of the rafter, ie, equal to the width of the rafter above the dhwaja sūtra. This board, known as 'mattam', is placed along the dhwaja sūtra with its long side coinciding with it [cf Fig.6(k)].[33]

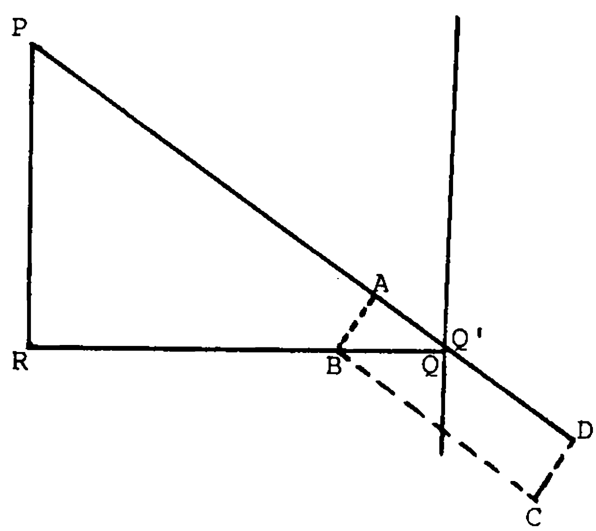
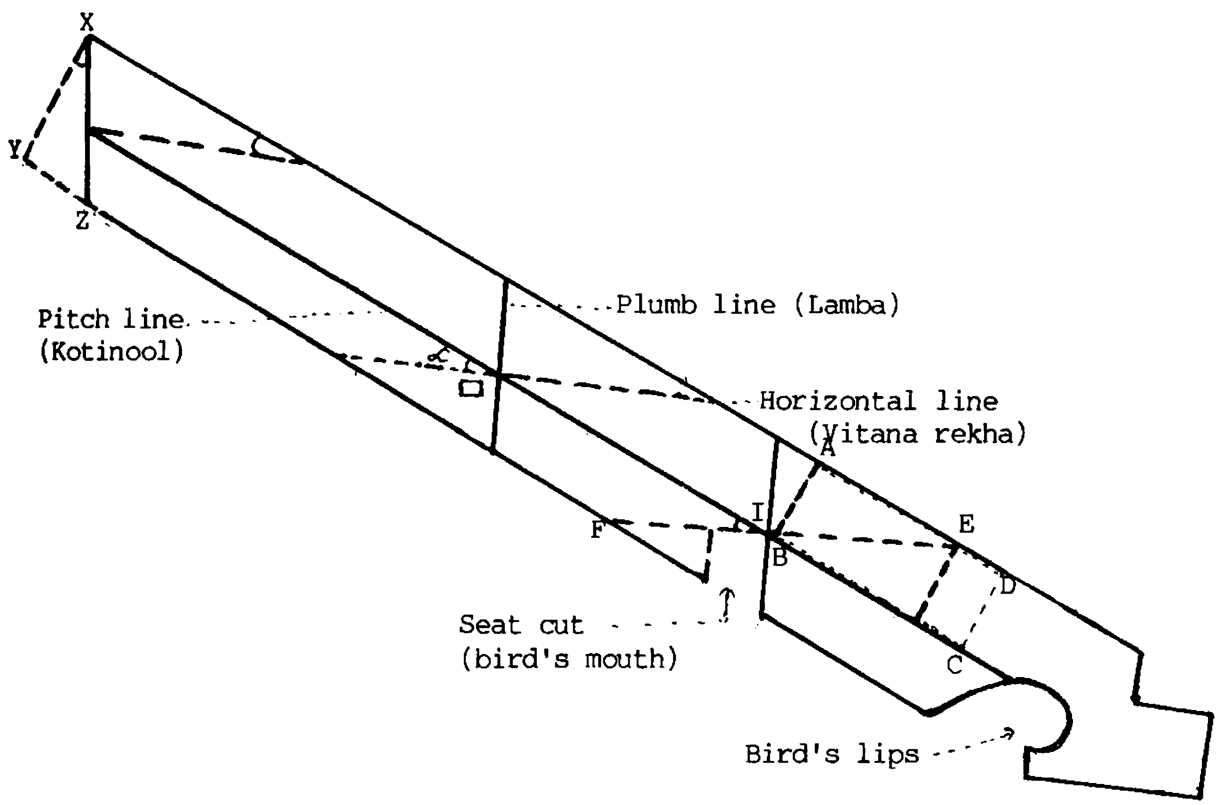


Fig.6(k)

It is pushed upward until its vertex B just touches the wallplate at B. Put a mark Q' on the upper edge of the mattam where it meets the point of intersection of the dhwaja sūtra and wallplate.

Let I be the point on the dhwaja sūtra at which the lamba and vitāna are to be determined. The 'mattam' is placed along the dhwaja sūtra in such a way that its vertex B is at I and its upper edge coincides with the



Straight rafter (Common rafter)

Fig.6(1)

upper edge of the rafter. Put a mark at E on the edge of the rafter when the point Q' on the mattam coincides with the rafter. Join EI and produce it to meet the lower edge of the rafter at F. Then EF will be the horizontal line (vitânam) and the line perpendicular to this line is the lamba (perpendicular lline) through I [cf Fig.6(1)].

Thus the horizontal line (vitānam) and vertical line (tũkku) are drawn with the help of a mattam and an axe. The simplicity of this method is that mathematical computations are completely avoided.

However, the length that is to be cut off from the lower edge of the rafter in order to fix it with the ridge may be calculated from the above figure. Let XZ represent the plumbcut and α be the inclination of the rafter with the wallplate YZ in the length to be cut off from the lower edge of the rafter. It can be seen that $\underline{|YXZ} = \alpha$ and Δ XYZ is a right angled triangle.

$$\frac{YZ}{XY} = \tan\alpha$$

$$\therefore YZ = XY \tan\alpha$$

XY is the width of the rafter and if $\alpha = 45°$, then,

$$YZ = XY$$

In Manuṣyālayacandrika, the inclination is stipulated as 45°.

6.13. GEOMETRICAL METHOD OF FINDING THE LENGTH OF RAFTERS

The method given in Manusyalayacandrika[54] is explained below. Consider a square with side equal to half the breadth of the house on a smooth plane or ground. Let the horizontal side of the square represent upper side of the cittuttaram and the vertical side be the koti. Draw three lines parallel to the base of the square representing the lower sides of cittuttaram, wallplate and eaves one below the other in order. If the house is a square one, the roof will be in pyramidal shape. Now determine the number of rafters and gaps between them on one side of the roof and mark their positions on the wallplate in such a way that a gap occurs exactly at the centre of the wallplate. The number of gaps (panti) will be one less than twice the number of rafters. Hence they will be in odd number and the number of rafters will be in even number. Since there is no rafter perpendicular to the wallplate, all the rafters will be inclined rafters on each side together with the four hiprafters.

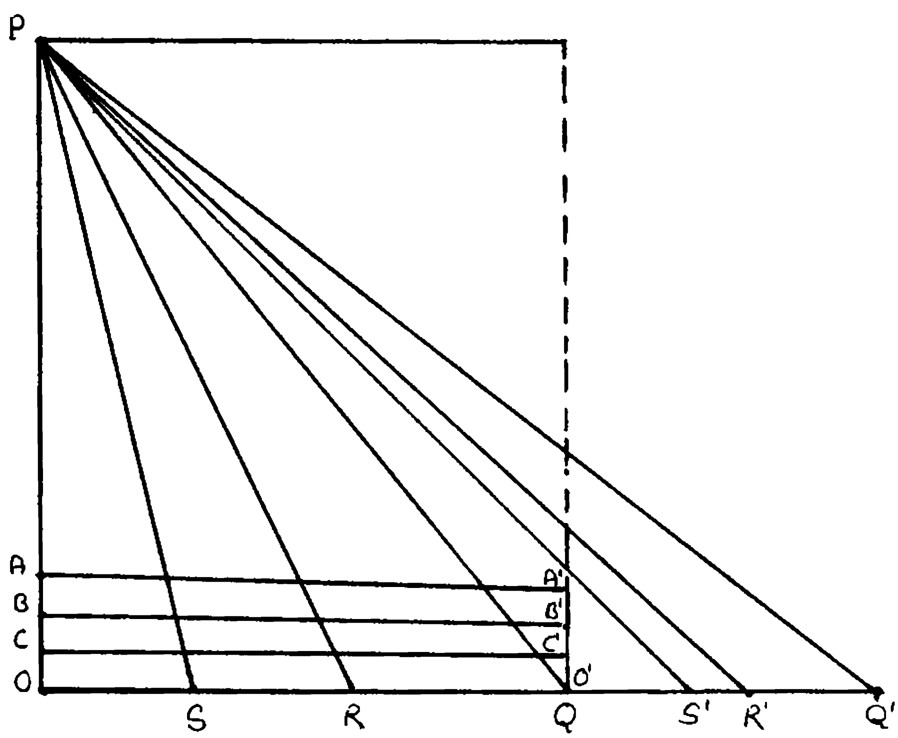


Fig.6(m)

To find the length of the inclined rafters the procedure is given in the following lines.

Iti vikṛtilupānām pañkti mākalpyatattal-
sthitiniyamakrtānkō yattadākrānta karṇṇam
niyata kṛtalupālambādathākūtapārśvam
bhavatipathagamīṣām dīrghamānam lupānām
(Manusyalayacandrika, chapter 6, sloka 19)

After fixing the positions of the rafters, the marks on the wallplate are joined to the upper end of the koti and produce them to meet the lower tip of the roof - the line representing the lower tip of the roof as in the above figure [cf Fig.6(m)]. Construct rectangles with these lines as bases and koti as the other side. The diagonals of these rectangles will give the lengths of the inclined rafters. If the height of the roof is less or greater than half the width of the house, then the koti of the above rectangles must be decreased or increased accordingly.

In the above figure $\overline{B}B'$, $\overline{C}C'$ and $\overline{O}O'$ represent the lower levels of cittuttara, wallplate and eaves. Q, R and S are the positions of rafters. Then PQ', PR' and PS' are the lengths of corresponding rafters.

In this method there are two systems of right angled triangles, one on the horizontal plane and the other on a vertical plane. In the above figure Δ OPQ is on a horizontal plane. PQ is the hypotenuse of the ΔOPQ, which is the base of right angled triangle in the vertical plane whose hypotenuse is the length of the inclined rafter. In the same manner we can find the length of the common rafter. The diagonal of the rectangle whose base is OP and AP as the vertical side will give the length of these rafters.

6.14. GEOMETICAL METHOD OF DETERMINING THE WIDTH OF A RAFTER

In general, there are two types of rafters, namely, straight rafter (or common rafter) and inclined rafter. The width of the rafter is proportional to the width of the wallplate (uttara). In the case of common rafter (Nermancu) the width is taken to be equal to that of the wallplate. This may be diminished or increased by 1/8, 1/7, 1/6, 1/5, 1/4 or 1/3 of the width of the wallplate. There are practices of selecting the width of the rafter as $1\frac{1}{2}$, $1\frac{3}{4}$ or 2 times of the width of the wallplate. Its thickness may vary from one angula to 6 angula.

In the case of inclined rafter, the method of finding the width is explained in Manusyalayacandrika as given below. [cf Fig.6(n)]

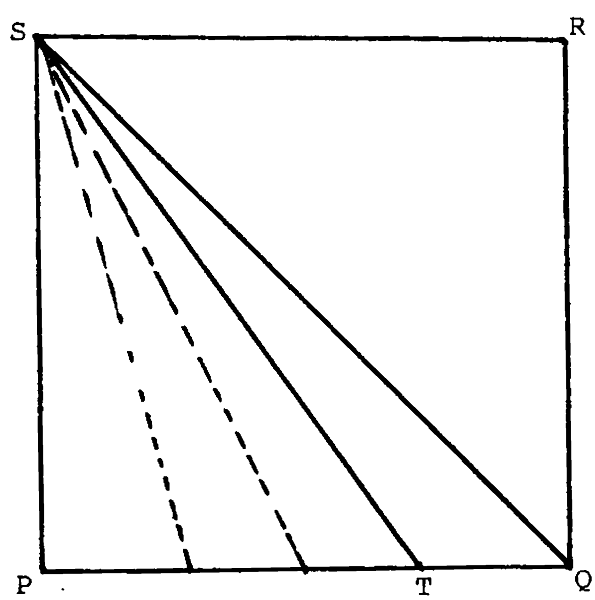


Fig.6(n)

Consider a square PQRS with side equal to the width of the common rafter. $\overline{PQ}$ is the bhuja, $\overline{PS}$ is the koti and $\overline{QS}$ is a diagonal of the square. Let T be a point on PQ such that

$$PT = \tfrac{1}{2}\ QS,\ \text{the length of the diagonal.}$$

Then TS will be the width of the hip rafter. Put marks on PT representing the positions of other inclined rafters. Then the length of line segments joining these points to S will give the widths of corresponding inclined rafters.

Let the width of the common rafter be a.

$$\text{ie, } PQ = PS$$

$$= a$$

$$\text{Then } PT = \tfrac{1}{2}QS$$

$$= \frac{\sqrt{2}a}{2}$$

$$= \frac{a}{\sqrt{2}}$$

$$\therefore \text{Width} = TS$$

$$= \sqrt{PT^2 + PS^2}$$

$$= \sqrt{\left(\frac{a}{\sqrt{2}}\right)^2 + a^2}$$

$$= \sqrt{\frac{3a^2}{2}}$$

$$= \sqrt{\frac{3}{2}}\ a$$

This is the width of the hiprafter and the widths of others are determined accordingly.

But another version of the Manuṣyālayacandrika states that the width of the hiprafter is the same as the diagonal of the square.

ie, width of the hiprafter $= QS$

$$= \sqrt{2}\ a$$

Thus the width is determined in two ways. Evidently this value is greater than the previous one.

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APPENDIX

ENGLISH TRANSLATION AND

SANSKRIT TEXT OF MANUSYALAYACANDRIKA

MANUṢYĀLAYACANDRIKA

(English Translation)

Chapter I

1

In Rajarajamangalam temple, two divine powers in the forms of Srīkrisna and Narasimha glistens eternally in unison.

2

May the divine powers glistening enormously in temples at Trkkandiyur, Tṛprangode, Tirunāva, Mallīvihara, Ālathiyur, and Srikeralapuram, shine unitedly in my mind.

The author prays for the blessings of the Supreme power.

3

Ganēśa, the refuge of all good people, the recipient of extreme love of Nilakantha and son of

MANUṢYĀLAYACANDRIKA

(English Translation)

Chapter I

1

In Rajarajamangalam temple, two divine powers in the forms of Srīkrisna and Narasimha glistens eternally in unison.

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The author prays for the blessings of the Supreme power.

3

Ganēśa, the refuge of all good people, the recipient of extreme love of Nilakantha and son of

Pārvathi, the giver of all wishes of his devotees, respected by all and having abode at the great Srīmangala temple, shines prosperously.

4

One who takes refuge only in the padakamala (lotus-foot) of that Ganesa and is inspired by the immense blessings of his great teacher (guru) in learning various subjects, becomes active with self-determination for educating the pupils.

The author begins to write this text for the use of the disciples.

5

I always prostrate before the pad-kamalas (lotus-foot) of those brahmaṇas whose intellect indulgent in srutis can describe the body of even Paramēśwara (Lord Siva) in imagination.

6

After saluting the Brahma, the Ādipuruṣa, (firstborn man) who is spontaneously ingenious in all types of architecture this 'Manusyalayacandrika' is written by me for the use of those of lesser intelligent.

7

Two Mayamatas, Prayōgamanjeri and two Bhāskarīyams, Manumatam, Gurudēvapadhati, Srīharīyajanam and such other famous texts (sāstras) prosper.

8

After seeing the two texts of Mârkaṇḍēya, Ratnāvalisāras of Parāśara and Murāri, Matas (opinions) of Kāśyapa and Viśwakarma, Kumārāgama, Harisaṁhita (Vishnu Samhita) with explanations, Vāstuvidya and various other texts I summarise here briefly (this text on Vāstuśāstra) as given in Tantrasamuccaya.

9

Firstly, one who belongs to Brāhmaṇa or other castes and desires to construct a house must adopt a local brāhmaṇa (Ācārya) of all noble qualities. He determines the bhūmi suitable to one's caste and then performs vāstupūja (offerings) and such others on this bhūmi. After this the house is to be constructed by very eminent artisans (śilpins) as stipulated in the vāstusāstras.

10

These brāhmaṇas (Āchāryas) after considering the saying in Vēdas, Āgamas etc, prescribe the rules for constructing houses and temples. It is the duty of the craftsmen to mix or join earth, stone etc, in all the buildings under the advice of these Āchāryas.

11

Depending on the nature of the work the artisans (śilpins) are classified into four categories, namely, Sthapati, Sūtragrāhi, Takṣaka and Vardhaki. These artisans, who are experts in their respective fields are to be selected properly.

12

One who is an expert in all crafts prescribed in every sāstra, well versed in all the sciences, always disinterested, free from the vices like envy, competition etc, truthful, just and clean may become the Sthapati.

13

It must be known that Sthapati is the competent person in constructing the building. Then either his son who is almost equally competent or one of his disciples who is able to understand his mind properly may become the Sūtragrāhi. The person who reduces the size of materials to the appropriate size is known as the Takṣaka and he must always be happy. One who is always careful and an expert in the craft of assembling pieces of timber and other materials is known as Vardhaki.

14

Without these four types of Śilpins like Sthapati etc, the construction of houses and other buildings is impossible. Therefore a most intelligent brāhmaṇa (Āchārya) must get the house built by them after pleasing them properly.

15

Misfortune will occur to those who are living in houses not properly constructed (without proper lakṣaṇa).

So the entire work from beginning to end should be decided mentally and then proceed doing it.

16

In constructing a house, the testing of bhūmi in several ways, the determination of directions etc, the choice of auspicious Vīthi, the formulation of the measurements of the house, determination of parts of the house like ankaṇa, kuttima etc, and, in a similar way, the formulation of rules regarding outhouses etc, are to be done in successive order.

17

An even ground which is blessed with the presence of cows, human beings, trees bearing flowers, fruits and milk, slightly inclined to the East, smooth, having majestic sound, water course flowing to the right, having large quantity of earth and seeds growing rapidly, having equal climatical conditions either in hot or cold season, and without shortage of water is described as the most suitable (uttama) for the construction of houses. A bhūmi whose characteristics are opposite to these is least suitable (adhama) and bhūmis which satisfy some of these characteristcs and not the others are medium (madhyama).

18

The bhūmis which are in circular or semicircular shape, having 3, 5 or 6 angular corners, in the shape of sūla or sūrppaka, like the upper side of fish, or elephant or tortoise, like the face of a cow, having depression at the centre, having cavities or hollow inside containing ash, charcoal, husk of grain, bone, hair, worm, termite hill etc, having bad smell and which face unfavourable directions (vidiks) are to be rejected.

19

The bhumis which are low from East onwards and high from West onwards are the eight vithis, namely, Gōvu, Vahni, Antaka, Bhūta, Vāri, Phaṇabhrth, Mātanga and Dhanya in their order. These bhūmis will provide prosperity, loss of money, self-destruction, loss of wealth, poverty, loss of son, wealth, and mangalam respectively to those who are residing in them.

20

Bhūmis having depression at the centre will cause exile and having mounds at the centre will cause destruction of wealth and happiness. Bhūmis which are slightly low towards Agni (South-East) corner and upto Vāyu (North-West) corner may generally give poverty.

21

In a middle elevated plot the first constructed house will give prosperity for ten years. The east elevated as well as South-East elevated plot will give prosperity for hundred years. The prosperity remains for thousand years or half of it according as the house is on a plot with Nirṛti (South-West) corner or western portion elevated. If the plot is elevated on its Vāyu (North-West) corner, northern side or Īśa (North-East) corner the prosperity remains for 12 years, 8 years or 100 years respectively. The results prescribed for each plot (bhûmi) in the above verse will be effective only after the completion of these periods defined in this verse.

22

Ilaññi and Baniyan trees on the east side of the house, the country-fig (Atti) and Tamarind tree on South, provides prosperity. The Pipal tree and Ēzhilampāla (Saptaparṇaka) on the West side are considered auspicious. The trees like Nāga and Itti on the North side are considered to be fortunate. Jack tree, Arecanut tree, coconut tree and Mango tree on the four sides of the house from the eastern side onwards, considered to the owner of the house to have special prosperity.

23

The Peepul tree which occupies a position different from its prescribed position will cause difficulties from fire. The Itti tree situated in the wrong position brings many sorts of manias. Similarly the Baniyan tree makes difficulties from enemies, Atti generates stomach diseases. Trees which are not in their prescribed positions and those whose heights exceed their distances from the house are to be cut off even if they are precious.

24

The presence of trees like Kumizhu, Kuvalam (crateva religiosa), Katukka (Terminalia chebula), Gooseberry, Fistula, Devatara, Śami (Plakṣa), Asōka, Sandalwood, Punna (Callophyllium), Veñña (Avicenna), Campakam, Kariññali (Mimosa catechu) etc, on the rear and other two sides are auspicious. Similarly, the growth of Jasmine, betalvine and such other plants, plantain etc, on all sides of the house is considered auspicious.

25

Jack tree and such other trees having internal core (antassāra). Trees like Tamarind, Teak etc, are having internal and external core (sarvasāra trees). Palm, coconut tree, arecanut palm etc, are with external core (bahirssāra trees). The drum-stick stree (Muriñña), Ezhilampala, Silk-Cotton tree, Murikku (Erithrina Indica) etc, are coreless trees (Nissāra trees).

Out of these, the trees of the first type are to be planted in the middle of the space between the house and its boundary. Trees having internal and external cores (Sarvasāra) are to be cultivated in a region exterior to the first type and the others are to be planted outside the region of the second type.

26

Trees like Kanjiram, Cēru (Marking-nut tree), Vayyamkata, Naruvari, Taññi, Ūka (tooth brush tree), Neem tree, Euphorbia (Kallippala), Karamussu and Swarṇṇaksheeri, are not at all permissible inside the plot. The drum-stick tree is not permitted within the prescribed boundary of the house.

27

It is dangerous to construct houses on the left and rear sides of the abode of Lord Visnu and on the right and front sides of Ugramūrthis (violent deities) like Kāli, Narasimha, Siva etc. If the deity situates in a lower region, then the houses on the right and front sides are dangerous. It is not considered auspicious to have the heights of the houses higher than that of the abode of the deity. Those who are the dependents (attendants) of the deity may build their houses near to the deity except on their prohibited sides.

28

Houses in the immediate neighbourhood of farm, mountain, temple, sea, river, hermitage and stable are dangerous in many ways. The house having height equal to or less than the height of temple is more auspicious. Houses having heights greater than it or having two storeys are not at all advisable.

29

Bhumis having Kusagrass, Darbha, Karuka, and Ama, having equal length and breadth (square), length increased by $1/8^{th}$, $1/6^{th}$ and $1/4^{th}$ parts of breadth, having colours white, red, yellow and black, having the smell of ghee, blood, rice and alcohol and having tastes sweetness, astringent, bitter and pungency are prescribed for brāhmaṇas and others in order.

30

The bhūmi which is inclined from south to north and containing an Atti tree on it is auspicious for brahmins. Bhūmi which is inclined from west to east and with a pipal tree on it is suitable for Kṣatriya. The bhumi with a slope towards west and with a Baniyan tree on it is recommended for Vaiśya. If the bhūmi prescribed for the Vaiśyas contains an Itti tree on it then it is appropriate for Śūdra. A bhūmi which contains an Itti tree on it and having slope from north to south is also suitable for Sūdra. If the bhūmi is of opposite type then it is not suitable for any of them.

31

The bhūmi which is of mixed character with respect to the colour, smell and taste is to be rejected by all.

When the nature of the bhūmi is not known it is to be tested at night by using nimittam (omen) in the prescribed method.

32

Make a pit on the bhumi and place an unbaked clay-pot filled with 'dhānya'. Its mouth is closed by another mud-pot and pour ghee into it. Four wicks in white, red, yellow and black colours representing four varṇas (castes) in order are placed in the pot in such a way that the white wick is directed towards east and the other wicks in the remaining directions. The wicks are lighted in order accompanied with 'mantratantras'. After a short while, see which of the four wicks is still gleaming. Then the bhūmi is suitable for the caste represented by the colour of the wick. If all the wicks are glowing then the bhūmi is suitable for all castes.

33

Make a pit on the bhūmi and fill it with water. Drop flowers of phlomis (thumpappuvu) and such other flowers into it. The clockwise movement of the flowers is auspicious where as the anticlockwise movement is inauspicious. If the flowers remains on the (NWES) sides then it is good and if they remain at the corners then it is bad. After understanding the merits and demerits of the bhumi in this way the intelligent sthapati has to get the bhumi properly levelled.

Chapter II

1

The selected bhūmi is to be properly levelled using the apparatus like avanata or such others or by water filling method by expert craftsmen. Then a uniform cylindrical strong wooden rod of ½ kol (36 cm) length is to be constructed with its lower end of diameter 2 angula (6 cm) and upper end of 1 angula. The tip of the rod must be in the shape of the bud of a lotus flower. This rod is named as 'śanku'.

2

Draw a circle using a rope whose length is double that of the 'śanku'. After determining the centre of the circle accurately, fix the śanku firmly at that point.

3

In the morning, when the image of the tip of the śanku just touches the circle on the west, one (sthapati) who is disinterested must put a mark on the circumference of the circle. Similarly, put a mark on the opposite side (East side) in the afternoon. Put another mark on the West side also the next morning. Divide the arc length between the two marks into three equal parts. Then the mark which is nearer to the first day's mark will be the accurate mark on west side.

4

The line (sūtra) through these two points which are determined on two consecutive days as explained above, will generate the East and West directions very accurately.

5

The line (sūtra) which is well defined in the middle of the bhūmi (kṣētra) as explained above is called the Brahma sūtra. Construct two intersecting circles in the middle of this line (sūtra). Determine a line through the middle of the fish-line (intersected circles form curve in the form of a fish) which is detained crosswise due to the intersection of those circles. This line in the South-North direction is called the Yama sūtra.

6

After determining the Brahma sūtra and Yama sūtra, mark a point on each of the four branches of the two intersecting sūtras at a fixed distance from their point of intersection and with these points as centres draw four equal circles intersecting in pairs. Here, in corners, four fish shaped lines are formed by the intersections of pairs of circles. Draw two lines passing through the middle of the fish shaped lines in pairs having their terminal ends at the Īśa (North-East) and Agni (South-East) corners and a square is drawn accordingly.

7

The square bhūmi (square maṇḍala) is then divided into four quadrants (khaṇḍas) by the two lines (sūtras) having their terminal ends at the East and North sides. Īsa khaṇḍa or Dēvakhaṇḍa may be prescribed for constructing houses for Brāhmaṇa and others. If the area of the bhumi is too large then each quadrant may further be divided into 4 parts (sub khaṇḍas). Then the Nirṛti part in the Īśa khaṇḍa and Isa part in Nirṛti khaṇḍa are suitable for the construction of houses.

8

When the bhūmi is divided into four khaṇḍas, the Īsa khaṇḍa (North-East) is known as the Manuṣyakhaṇḍa which provides prosperity and Nirṛti (South-West) khaṇḍa is named as the Devakhaṇḍa which gives favourable results to the residents of the house. These two khaṇḍas are auspicious for the construction of houses for man.

9

Agni khaṇḍa (South-East khaṇḍa) is named Yama khaṇḍa. This provides death (destruction) to the family and therefore is to be avoided by all castes. The Vāyu khaṇḍa (North-West khanda) is known as Asura khaṇḍa which is not auspicious for the construction of houses. But in some places, it is accepted for the construction of houses for Vaisyas.

10

After deleting the elongations of the bhūmi prescribed for Kṣatriyas and others its middle portion is made into a square. The two diagonals having initial points at Nirṛti and Vāyu corners and terminal points at Īsa and Agni corners respectively are known as rajjus.

11

The intersections (or coincidence) of the ends of Brahma sūtra, Yama sūtra and Rajjus with the central axes of house, well, tank etc, will cause difficulties, except in the case of Catussāla without elongation (Mukhāyama) to the ankaṇa.
(The intersection or coincidence is known as vēdha)

12

The results of Vĕdha (intersections of axes as in the above verse) from east direction onwards are separation from husband, leprosy, difficulties from enemies, loss of son, loss of wealth, rheumatic complaints, loss of family, and loss of grain (agricultural products) respectively.

13

If the Īśa khanda or any other khaṇḍa of the kṣētra (bhūmi) is divided into 9 x 9 padas (cells), then it is known that the widths of the Sutras and Rajjus are given by 1/12 of a pada. Similarly, when it is divided into 10 x 10 padas, 1/8 of a pada will be the width of the sutras and rajjus. If the khanda is divided into 8 x 8 parts then their widths are given by 1/16 of a pada.

14

The mutual intersections (vēdha) between the central axes of houses, ankaṇa (courtyard), well, tank, door etc, and the vēdhams between the rajjus and the diagonals of the corner houses are to be avoided.

15

To determine the width of the vīthi (envelopes) there are several types of daṇḍus, depending on the area of the bhūmi. For this, the height of the owner of the house is taken as 'tālam'. Three types of daṇḍus are defined by taking its length 10 tālam, 9 tālam or 8 tālam. If the bhūmi is of sufficiently large size then any one of these three daṇḍus is taken as the width of the vīthi.

16

By dividing into 18 putas (calyxes), there will be nine expanding envelopes (avṛtti) of which from the outermost to the innermost are the vīthis of Piśaca, Dēva, Kubēra, Yama, Nāga, Jala, Agni, Vināyaka and Brahma respectively. Of these, the vithis of Piśāca, Agni, Nāga and Yama are considered to be inauspicious for the construction of houses on the four sides.

17

It is best (uttama) to have the width of the vīthi as 1½ times the length of the ankaṇa (courtyard) which has already assumed in building the house. It is madhyama (intermediate) when it is equal to the length and it is adhama (worst) when it is less than the length of the ankaṇa. In small plots the width of the vīthi may be taken as half of the length of the ankaṇa. In such case the houses on the east and north sides will have to include also the Jala vīthi which is a special case of determining the width of the vīthi.

18

In some places, it is seen that, catussala (courtyard houses) is constructed in a very small plot with a prescribed shift (gamana) of its centre from the point of intersection of the Brahma sūtra and Yama sūtra. Since the vīthis are too small, the merits and demerits due to them will be negligible. Hence the division of the bhūmi into khaṇḍas like Īśa, Agni etc, and vīthis like Piśāca, Dēva etc, are considered unnecessary.

19

The width of the vīthi is determined by 1½ times the length of the ankaṇa and 18 times the width of the vīthi will be the width of the bhūmi (plot). Thus from the centre (ankaṇa) the measure of the bhūmi may be determined. If the house is situated in a bhūmi whose boundary is not known it may be calculated from the length of the ankaṇa of the house. After determining the boundary of the house, the boundary wall may be constructed (appropriately to the status of the owner).

20

After combining the vīthis of Brahma and Ganēśa together in Īsa or Nirṛti khaṇḍa, that region (Vāstu pada) is divided into 81 padas or 64 padas or 100 padas as mentioned earlier. Here, the parts (organs), marmmas (nodal points), and deities of the Vāstu are to be determined accordingly.

21

In 81 pada system there are two sets of Nāḍis (lines) containing 10 Nāḍis each with their terminal points on the east side and north side respectively. Similarly, there are two sets of rajjus each set having 5 rajjus passing through 9 padas, 6 padas and 3 padas and having their terminal ends directed to the Agni corner and Īśa corner respectively. There are hundred murmmas formed by the intersections of 8, 6, 5, 4 and 3 sūtras occuring at the corners of the cells and they have to be avoided in the construction of walls, pillars and such others.

22

The difficulties due to the placement of walls, pillars etc, at the marmmas, may be avoided by shifting their positions towards east or north by 1/24 of pada from the marmmas. Anyhow, if the difficulties due to marmmas occur, then the images of the heads of buffalo, lion, elephant, tortoise and pig in gold must be installed properly by a priest for the relief from the difficulties.

23

In the system of 81 cells, the 9 cells at the centre, 6 cells on each side and 2 cells on each corner in two surrounding envelopes and each cell in the outermost envelope, define 1 position each so that there are 45 positions inside the boundary of the system of cells. Brahma, Āryaman, Vivaswan and such other deities are occupying these 45 positions and exterior to these cells there are 8 deities so that there are 53 deities in total on a vāstumaṇḍala.

24 & 25

The padas (cells) in the outermost envelope from Īśa corner onwards are the positions of Īśāna, Pārjanya, Jayanta, Indra, Ravi, Satyaka, Bṛśa, Antarīkṣaka, Agni, and Puṣāv, then Vitatha, Grahakṣata, Yama, Gandharva, Bṛṁga, Mṛga, Nirṛti, Dharapāla, Sugrīva, Puṣpadanta, Varuṇa, Asura, Śōṣa, Rōga, Vāyu, Nāga, Mukhya, Bhallāta, Indu, Arggala, Aditi and Diti in order. In the two middle envelopes there are the positions of Āpa, Āpavalsa, Ārya, Savitāv, Savitra, Vivaswān, Indra, Indrajith, Mitra, Siva, Sivajith, and Bhubṛth.

26

The central position is occupied by the Brahma. Outside the cells, there are Sarvaskanda in the east, Aryamav in the south, Jṛmbaka in the west and Pilipincaka in the north of the vāstu. Further, deities like caraki, Vidarya, Pūtanika and Pāparākṣasi are positioned at the corners from Īsa corner onwards.

27

There lived a demon (asuran) who was most arrogant and an enemy to Dêvas. He conquered the whole world by his wonderful courage and strength. In a battle with Dêvas he become weak and fell down to earth. Even then he survived on the earth and troubled it by whirling several times. So the human beings were unhappy and in the same way the Sages and Dēvas became unhappy.

28

When the vāstupuruṣa flourished everywhere especially in city, town, vāstu, kṣetrakhaṇḍa and ankaṇa like the sky in small and large pots, with his back on earth, legs at the Nirṛti corner and head at Īsa corner, the dēvas suddenly seated on his body permanently.

29

Isa resides on his head, Pārjanya and Diti on eyes, Āpa on face, similarly, Āpavalsa on neck, Jayanta on right ear, Aditi resides on his left ear, Indra situates on his left shoulder and Arggata resides on his right shoulder.

30

Sun, Santhya and such others resides on his left arm and Moon, Bhallata and others dwells on the right arm. Savithav and Savitri occupies the left prakōṣta and Siva and Sivajith on the right prakōṣta.

31

Mahīdhara and Ārya reside on his breast, Vivaswan and Mitra on stomach, Brahma on the navel, Indra on his phallus (Mandrum), Indrajit on vṛṣaṇa (testicles) and others reside upon his legs.

32

If the deities residing on the Vāstu are properly propitiated then they will provide favourable results.

Otherwise, they will produce bad results. So offerings (Vāstupūja) are to be performed for propitiating the deities on the Vastupuruṣamaṇḍala.

Chapter III

1

The thickness of 8 gingelly seeds contained in its shell is called a 'yavōdaram'. Eight 'yavōdaram' constitutes a 'mātrāngulam'. Vitasti is defined by 12 angulam. Twice the vitasti is named a kara (hasta), Kiṣku, Aratni, Bhuja, Dōh, Muṣti etc. There are different types of measurement (kol) based on the varying length of an angula with the size of seeds and increasing the length of hasta by 1 angulam each.

2

The measurements having 25 matrangulam is named 'Prajapathyaka' which is defined for measuring Vimana and in some places it is also used for measuring temples. The hasta of length 26 angulam is called 'dhanurmuṣtikam' and it is suitable for measuring for all houses and temples (for all buildings).

3

The intellectuals (Śilpins) define the hasta of 27 angulam as Dhanurgraha. It is used for measuring villages, markets, garden etc, and also for measuring tank, lake etc. It is used for measuring all types of houses which is evident from its name. Dhanurmuṣti is also acceptable for measuring the markets, garden, tank, lake etc.

4

The hasta consisting of 28 angulam is called Pracyam. The hasta constituted by 29 angulam is known Vaidēham. The measure formed by 30 angulam is called Vaipulyam. Adding one angulam to this will get the hasta named Prakirnam. In this way there are eight types of hastas (kols).

5

Dhanurgraha and Prakīrṇam are used for measuring Brahmin's houses and Vaipulya and Dhanurmuṣti are employed for measuring King's houses, palaces etc.

6

Prajapatya and Vaideha are used for measuring houses and all other equipments of Vaisyas and Prācya and kiṣku are prescribed for 'Sūdras. In particular, kiṣku is suitable for all.

7

It is not auspicious to kings and others to accept the measures (hastas) which are prescribed for the upper castes and not for themselves. All the measures which are prescribed for lower castes are acceptable to Vaisyas, Ksatriyas and Brahmins in order.

8

All the madhyama and adhama hastas which are formed due to the differences in the measure of angulas are acceptable in the case of temples according to the situations.

9

The matrangulam which is comprised of 8 yavas is said to be the best (Uttama) and which are comprised of 7 and 6 yava are considered to be intermediate (madhyama) and worst (adhama) respectively.

10

Angulams of uttama, madhyama and adhama types occur according to the measures of widths of 8, 7 and 6 śali(red-paddy or Navara) grains respectively. The above three types may also be obtained from the lengths of 4, 3½ and 3 śali grain respectively.

11

There will be 9 types of hastas of uttama, madhyama etc, nature depending on the nine distinct types of angulams. These 9 types of hastas together with the 8 types of hastas as given in the above verse will form 72 types of hastas.

12

The kara (hasta) comprising of 24 matrangulam which is defined earlier is auspicious for all castes and situations. Other hastas are acceptable to all depending on their respective castes and types of hastas prescribed for them for different situations.

13

The measurements of house and others are expressed in hastas (karas) itself and in some cases they are defined in terms mātrāngulas. When it is impossible to measure the length of the perimeter and gati (change or shift) in terms of hasta and angula, it may also be expressed in terms yavas. In houses and such other buildings of human beings, the gatis (changes or shifts) and boundaries of outhouses (upalayas), stable etc, are measured in terms of 'daṇḍu' of 4 hastas. This unit of measurement is also known as 'yaṣti'. Eight times a daṇḍu will be a rajju.

14

Statue (idol) or such others are to be measured using tālam (a proportionate measure), yavam etc. Yavam is to be used for measuring ornaments. Vitasti is the unit of measure for measuring silk, blanket, cloths etc. Arms such as sword, arrows etc, are measured using the measure (width) of two ring-fingers or by the width of one ring-finger of their owner. The pots for sacrificial (yāga) purposes are to be measured using the measure the muṣti of the master of the sacrifice (yāgakartta). Other items are to be measured using the measure of pada (foot).

15

There are various types of villages depending on the number of houses of brahmins in a locality. These villages are again classified into uttama, madhyama and adhama types depending on their areas.

16

A region of area of one yojana square is called an uttama village. A village is said to be madhyama if its area is half yojana square and it is said to be almost adhama when the area is a quarter of yojana square.

17

For towns (nagaram) there must be an area of thousand to two thousand daṇḍus. Similarly, the region having a sea shore with shipping facilities is called a city (pattana).

18

A region which is famous due to the presence of a King's palace and merchants and such others is named a puram (town). A region having palaces of kings and residences for all sorts (varṇas) of people is famous by the name nagara (city).

19

A brāhmin's family together with the subordinates or assistants and their families living under the same brāhmaṇa (kāraṇavar) is called a village (grâma).

20

Depending on the number of brāhmaṇa houses in a village and their extensions, the villages may be classified into uttama, madhyama and adhama categories.

21 & 22

In temples, the external width of the prāsāda measured along the beam is called the perfect (best) daṇḍu (uttama daṇḍu). Similarly, the measure along the Jagati is the madhyama (intermediate) daṇḍu and along the paduka is known as adhama (worst) daṇḍu. In temple, outside the srīkovil (prāsāda), five boundaries are to be determined using this daṇḍu.

23

Kētuyōni is defined for all objects which are used for transportation since it is auspicious in these objects. Gajayōni is prescribed for cot or such other equipments and for seat (pīṭham), stool etc, siṁhayōni is recommended. In the case of box and such others and in defining well, tank, lake, nest etc, the vṛṣayōni and dhwajayōni are acceptable. Kētuyōni is prescribed for all types of foundations such as the foundation of pipal tree etc.

24

To determine the yonis of measuring jar and such other pots, tank, well etc, ankaṇa, garbhagraha etc, interior perimeters are considered. In the case of Turyaśra sāla (Madhyaprarūda sāla) the perimeter is measured along the central line of the width of the beam. In all other cases yōnis are determined with respect to the exterior perimeter. The yoni defined using the interior perimeter is sometimes called antaryōni.

25

Multiply the perimeter which is the sum of the desired lengths and breadths by 3 and then divide it by 8. The remainder will represent the corresponding yōni. If the product is divided by 14, the remainder will be vyaya (expenditure). Then multiply the perimeter by 8 and divide it by 12, the remainder is the āya(income).

If it is divided by 27, the remainder will be the star (nakṣatra) and the quotient is called the age (vayassu). The remainder will represent the tithi (pakkam) when the product is divided by 30. If the product is divided by 7, the remainder will be the day of the week. When the perimeter is multiplied by 9 and divide it by 10, the remainder will represent an alternate vyaya.

26

The eight yonis dhwaja, dhūma, simha, kukkura, vṛṣa, khara, gaja and vāyasa occur in eight directions from east onwards in order. Of these, the odds will provide prosperity and evens will cause misfortune.

27

Kētu (dhwaja) yōni provides all favourite wishes to the owner of the vāstu. It has satvika quality, represents the guru of devas (Jupitar) and is a brāhmin. Even though it is defined for the east side, it is acceptable to all objects and especially in all directions (it appears that in the last line it should be 'abhihita' and not 'avihita').

28

Simha yōni situates on the south side and represents kuja. It has tamasa quality and is ksatriya and provides prosperity. Gaja yōni defines on north side, represents Budha, having rajass quality and is a vaisya. It provides fortunes.

Vṛṣa yōni with tamo quality situates on the west side, represents Śani and is a sūdra. It gives prosperity in agricultural production. Then the yōnis defined at the corners are despicable (desertable).

29

Dhūma yōni provides anxiety, quarrel will be the result of Kukkura yōni. Khara yoni will generate fickleness and Kāka yōni will result in no prodigy. Therefore, the corner yonis are to be avoided for the construction of houses.

30

Kētu yōni is prescribed for the east direction and it is suitable for houses on any side. Simha yōni is defined for houses on the south side and Kētu yoni is also suitable for this side. Gaja yoni is suitable for north sāla (house) and Kētu and Simha yōnis are also auspicious on this side. Vṛṣa yōni will be on the west side and Kētu, Simha, and Gaja yōnis are also suitable on this side. For corner houses, the yonis which are prescribed for their related side-houses are to be accepted.

31

It is generally admitted that yōni is the vital air (prāṇa) of all houses. Therefore, suitable yōnis which are prescribed for each direction must be accepted accordingly. In all houses 'the death' (due to the selection of inauspicious yōnis) must be avoided. If the death (unfavourate yōni) is accepted then it will cause several misfortunes.

32

In all cases the āyam (income) must be greater than the vyayam (expenditure). Otherwise misfortune will be the result. The merits and demerits of the star (nakṣatra), yōga etc, are to be learned from astrology and such others accordingly.

33

There are five stages of age (vayassu), namely, bālya, kaumāra, youth, oldage and death. Out of these, the last one is not auspicious in the case of houses. Others are auspicious for the construction of houses.

34

Yōni, āya, age, nakṣatra (star), tithi, rāśi, and the castes, such as brahmaṇa and like others, are defined in two ways. Vyaya is defined in 4 ways and the days of week and dhruva etc, are explained in 3 ways. Out of these, the first set of definitions of yōni etc, are accepted by all and the above definitions are to be accepted only if necessity arises.

35

Generally, the prescribed yōni, āya etc, for each are to be obtained from the perimeter. It will be very prosperous to have the same yōni etc, with respect to the length, breadth, heights of pillar, pādamāna, adhiṣtāna, and area of the house and also by the alternate methods explained earlier.

36

In all houses, the measurements of length, breadth, pādamāna, pillar, adhiṣtāna, garbhagraha, door, statue etc, beams like ārūḍam and all different parts of the two-storey building are to be determined with respect to the perimeter of the main beam. If these are determined by parts (divisions) as given in the alternate method then they are to be adjusted to get the nearest appropriate yōnis.

37

The product of the length and breadth is known as area. After determining the appropriate length and breadth in order to get the desired yōni, the vyaya, āya etc, are to be determined as in the case of perimeter. This is also an accurate method.

38

It is mentioned earlier that the usual vyaya is obtained by dividing the perimeter multiplied by 3 by 14. Multiply the perimeter by 9 and divide it by 10 or 8. Then the remainders will be the vyayas. When the nakṣatra, determined by the prescribed rule, is divided by 8, the remainder will be the vyaya. Thus there are 4 types of vyayas. In all these cases, the vyaya must be less than the āya. Otherwise it will cause disaster to son, wealth etc.

39

Add one-third of the perimeter to itself. Multiply it by 2 and divide by 8. Then the remainder is the āya. Multiply the perimeter by 27 and divide it by 20, the remainder is the age. The bālya, kaumāra etc, are to be known by the quotient in order. The remainder will represent the number of years passed over by the respective age. Of these, the youth is the best age.

40

Divide the perimeter itself or nine times of it by 30. Then there remains the tithi of the two pakṣas (pūrvāpara pakṣas) as before. Multiply the perimeter by 3 or 8 and divide it by 4, then the remainder will represent the castes of brāhmaṇa, kṣatriya and others in order. When the perimeter is multiplies by 4 or 8 and divided by 12, the remainder will be the rāśi (month) corresponding to that perimeter.

41

Divide the perimeter itself or 3 times of it by 7. The remainder is the day of the week (vāra). Multiply the perimeter by 2 or 3 and then divide it by 16. The remainders will represent the dhruva and such others.

42 & 43

Add the number corresponding to the vyaya to the area and divide it by 16. The remainders will represent the dhruva, dhanya, jaya, vināsa, khara, kanta, mamaprasāda, sumukhatva, vaimukhyam, asaumyatva, virodham, vittōlbhava, kṣayam, ākranda, vṛdhi, jaya respectively. The result of each is implied in its name.

Chapter IV

1

Determine the appropriate length and ankaṇa of the house in such a way that suitable yōni, āya, nakṣatra (star), age etc, are obtained from their respective perimeters in all methods as explained earlier. Then an expert person (architect) have to determine the length and width of the house according to the rule of 'Iṣtadīrgha' (preferred length) or guṇāmśa (multiples of part) so that the intermediary spaces (antarāla or alinda) become small.

2 & 3

The perimeter of every house is obtained from its preferred length. The corresponding width is got from this perimeter. Pādamānam (height of the house from the level of pāduka to the level of wallplate) is obtained from the width and from the pādamāna, the height of the foundation is determined. The height of the pillar is the difference between the pādamāna and the height of the foundation. From the height of the pillar, the width of the beam (wallplate) is obtained. Based on the width of the each beam, the width of rafters, brackets (vāmaṭa) etc, are to be determined. Similarly, the thickness of beams, brackets etc, are to be obtained from their respective widths.

4

The preferred length of 6 hasta or above is multiplied by 8 and the corresponding yoni number is added to this number. Then one-third of this will be the required perimeter of the house. If the process is reversed, the length is obtained from the perimeter. When the length is subtracted from the semiperimeter, the width of the house is obtained.

5

Multiply the preferred length in hasta (kol) by 2 and add one-third of this to itself: Adding one-third of the prescribed yōni number to the above sum will provide the perimeter of the house.

6

In a square house, 1/4th perimeter will be the length which is equal to the width of the house. If the semiperimeter is divided into 9 parts, then four parts will be the width and the remaining parts will form the length of the house. This is the 'pādādhikam'. When the semiperimeter is divided into 10 parts, four parts will form the width and the remaining 6 parts form the length. This is known as 'arddhādhikam'. These three types of divisions are prescribed for temples.

7

In houses (manuṣyālayas), the pādādhikam division is accepted and in some cases, samatalam is also adopted by some. Arddhādhikam is not recommended here (in houses). According to sages all pādōnam divisions will provide calamities to all and hence they are not acceptable at any cost.

8

If the semiperimeter is divided into 12, 13, 14 parts or into 16, 17, 18 parts or into 20, 21, 22 parts or into 24, 25, 26 parts or into 28, 29, 30 parts or into 32 parts then the width is determined by 4 parts and the remaining parts form the length of the house. Thus the sages defines width in gunāmśamethod from 8, 9, 10 divisions onwards except the 4th divisions of the samatatam.

9

When the semiperimeter is divided into 11 parts, the width may be determined by 3 parts and the length by 8 parts. Width, much larger than ½ of length is considered inauspicious by the sages like Gargga, Dakṣa etc.

10

In the plan of a house (sāla) there will be 4 detached side houses (Diksālas) and their respective 4 corner houses (Vidiksālas). Thus there are 8 houses prescribed by sages for human beings. Depending on the specialities in direction, measurement, name etc, of beams in houses, there will be 9 types of Sālas (houses). The measurements of the parts of the storeys of the houses are to be defined in accordance with the measurements of the respective sālas (houses).

11

Salas are classified into two groups bhinna and abhinna according to their detached or nondetached nature. Sāla without corner houses and each sidehouse is complete in all respects of its parts in the bhinna sāla. A sala whose perimeter is of kētu yōni and in which the corner houses are differentiated by the joinings of the exterior and interior beams is called an abhinna sāla.

12

A sāla having four side-houses without common portions and each having the prescribed characteristics of gamana, width, yōni etc, upto the patramāna and having prescribed pāduka all around, without corner houses is known as bhinna sāla. These sālas are suitable to all especially suitable to brāhmanās since the corner-houses are not defined in them. Here the perimeter of the ankana must be of kētu yōni and this defines the characteristics of viśuddhabhinna sāla.

13

The sālas on the southern and western sides are relatives. Similarly the eastern and northern salas are relatives. So they may be combined together by adjoining the corner-house in between them. The other two corners should not be joined. This portion may be used as a passway for wommen after delivery, sudras etc.

14

By adjoining one, two or three corner-houses to the side-houses, the sāla becomes Sliṣṭa bhinna. Even though it is prescribed for brâhmaṇa, it is suitable to all castes because of its bhinna and miśra nature (detached and attached).

15

The rear ends of the beams of the side-houses are to be joined with ends of the beams of ther corner houses just like the arrangements of petals in the flower of Nantyārvaṭṭa, arranged in the anticlockwise direction in order. Here the perimeter of the ankaṇattara (perimeter along the inner beams) must be of kētu yōni. It will be auspicious if the perimeter of the paryanta (outer beams) too is of kētu yōni. This sāla is known as Saṁślista bhinna sāla.

16

It is stated that, in all sālas, the yôni of the corner-houses must be the same as that of the corresponding side-house. It is known that the corner-houses are janyās (products) and the corresponding side-houses are janakas (producer). Therefore in human houses, Kètu yôni for Īśa corner, Simha yōni for Agni corner, Vṛṣa yōni for Nirṛti corner and Gaja yōni for Vāyu corner are to be obtained accordingly.

17

All the beams of the sāla are determined properly as in the case of samsliṣṭa bhinna sala. Then the perimeters of the corner-houses are so determined to get the same yōni as that of their related side-houses. The joints of the beams of the side-houses and corner-houses must be made in the left antarālas (intermediary spaces) of the side-houses, slightly shifted from the middle of the main door. This is the aṣtasāla which is called Sliṣṭasāla.

18

When the ends of the beams of the side-house and corner-house are placed very close without joining them firmly, the sāla will be of bhinna nature. Thus four types of bhinna sālas are told in this way.

19

If the lengths of the beams are not sufficient for the length and width of the sāla then they may be increased upto to the ends of the corner-houses by joining the beams according to the rules of joints prescribed for each sāla. The joints of the beams at the 4 corners are done in such a way that the external beams on the east and west sides form the ādhāram and the other two on south and north sides become the ādhēyam.

20

In miśrabhinna sāla, the perimeters of the paryanta and ankaṇa are assumed to be of kētu yōni and the corner-houses are without interior beams. The beams of ankaṇa are joint at the corners according to the same norms which are defined for the paryanta (external beams). All the 4 side-houses must be with their respective characteristics of yŏni, gati etc. This sāla is a catussāla which is the miśrabhinna sāla.

21

Since the beams of all the houses are inter-connected at the corners, this sāla will have the mixed characteristics. Since the corner-houses are not there and the side-houses satisfy their respective characteristics such as yōni, gati etc, this sāla has the qualities of bhinna sāla.

22

The perimeter of the paryanta must be of kētu yŏni. The perimeters of the external and internal patramânas, the perimeter of the ankaṇa, exterior perimeters of the side-houses and the interior perimeters of the corner-houses must be of kētu yŏni. In this sammiśra bhinna sāla, the width of the beam (uttara) is to be determined using ingenuity.

23

The perimeter of the ankaṇa is to be subtracted from the desired perimeter of the paryanta. From the remainder subtract 8 times of the length of the interior side of a rectangular corner-house. Then the width of the beam is to be determined by 1/16 of its remainder. The external and internal beams are to be extended upto the paryanta and they are to be joined on four sides.

24

As in the case of sammiśra bhinna sāla, the internal patramana of the sala must be of kētu yōni. Similarly, the external patramāna and the inner perimeter of the corner-house also must be of kētu yōni. The side-houses may occur with their respective yōni and gati. This sāla is recommended for Kings (Royal families) and is called Miśraka Cattussāla. Since the side-houses are having their respective yōnis, they are suitable for all classes. But these sālas are not so perfect for Brāhmanās.

25

The ankaṇa of a sāla is defined by equal length and width (square). The inner and outer perimeters of beams and patramānas (pādukas) must be of kētu yōni. The perimeters of openings in the middle of these houses, without gati (shift), also must be of kētu yōni. This sāla prescribed for Kings, is called Caturassāla.

26

If in a catussāla, the perimeters of all houses are measured along the central line of the beams then it is called a Maddhyaprarūḍa sāla.

27

If we propose to construct only a single house then it must be the south house. If there are two houses then they must be the south and west houses. When three houses are to be constructed, the north house is to be adjoined to the above two houses. If four houses are needed the above three houses together with the east house is to be constructed. In some cases, west house is accepted instead of south house for a single house. In the construction of sala having more than one house, the order of construction must be as given above.

28

If there are three houses in a sala without the east house then it is called 'Sukṣetram' which provides prosperity to the owner of the house. The sāla without the south house is called 'Culli' and this causes destruction of wealth. The sala comprising of 3 houses without the west house is named 'Dhvamśam' which causes destruction of son and difficulties from enemy. If there are three houses excluding the north house, it is called 'Hirannyanābhi'. This will always provide wealth.

29

When the two houses are constructed without the east and west houses, it is called 'Kāca'. This will provide quarrel and fear. If the other two, namely, the east and west houses are constructed without the south and north houses then it is called 'Siddhārthakam'. This will generate wealth and fortune. It is told that if two houses are deleted, in order, from east side onwards then they will provide death, fear, quarrel, and wealth respectively.

Chapter V

1

The region selected for the construction of house is to be raised to a height of 8, 12 or 16 angulas with earth, stone etc, in order to avoid the difficulties due to the dip at the central courtyard for water to ooze out from the inner and outer ankaṇas (yards).

2

In all buildings an upapīṭha of width one or two hastas is to be constructed below the adhiṣṭāna for strength, beauty and height of the building. A Kuzhiyankaṇam (central courtyard) of Kēthu yōni or Vṛṣa yōni with South-North elongation is to be constructed inside the house. Then a water-let is arranged in the Īsa-corner with its opening towards the north or east direction.

3

The height of the upapīṭha in a house for man may be equal to that of the height of the adhiṣṭāna or one part less than this when it is divided into 6, 7, 8, 9 or 10 parts as required. The pāduka, jagati etc, are to be constructed by dividing their respective heights accordingly.

4

A square is determined in the middle of the Kuzhiyankaṇam (central courtyard) by deleting equal lengths (which is equal to half of the difference between length and width of the ankaṇa) at the south and north ends of the ankaṇa. Then the square is divided into 64 cells (padas). The Mullathara (the place for growing jasmine) may be constructed at the southern side in the Apa pada or at the northern side in the Āpavalsa pada in the middle envelope of cells.

5

Mullathara may be in the shape of square, octagon, sixteen-gon or circle and must be of kētu yōni. It may be constructed with upapitham and such other parts, with decorations of Kumuda, pattam etc, on it. Its height may be determined as the height of the adhistana of the house or one part less than when it is divided into 6 to 11 parts as required. Thus the Mullathara is defined without its vēdha (intersection or coincidence) with the rajju (diagonal).

6

The 'Cherippu' (upanāham) of the adhiṣṭāna is to be done strongly upto the level of upapīṭha. Pāduka is to be constructed above the upapīṭha on all sides of adhiṣṭāna. All other parts on adhiṣṭāna are to be constructed accordingly upto the level of patramāna as prescribed earlier.

7

The onward projection of the adhiṣṭāna from the foot of the perpendicular from the outer-edge of the beam (uttaram) is defined as the Patramāna. The outward projection may be taken as 8 angulas or two times or 3 times of it as required. As a special case the projection on south side and north side may be taken as 6 angulas and an outward projection of 12 angulas on the west side is acceptable in some cases.

8

In houses the inner and outer patramānas may be of the same or different widths. They are determined in such a way that they satisfy their respective yōnis. In temples the patramānas of the dīpamāla (vilakkumādam) in antahāra and the gōpura (entrance) are determined in the same manner.

9

According to scholars, the region outside the pādukas of the four houses (central courtyard) is called 'prānkaṇa'. This have elongation in South-North direction and in the form of a rectangle. The length may be larger than the width by 1, 2, 4, 8, 9, 12 or 16 angulas or this may be greater than the width by 1, 2, or 3 hastas. Otherwise, the length may be determined by the gunām'sa method. In any case, the perimeter may be of the Kētu yōni.

10

If the central lines of the ankaṇa (courtyard) and the four side-houses (diksālas) intersect then the residents will suffer from several calamities to their children. Therefore the centres of the houses are to be shifted in the clockwise direction. These shifts from the east-house onwards are 3, 9, 7, and 5 angulas respectively so that they provide the yōni corresponding to each side. If the shifts are to be small, the gamanas (shifts) may be done using yavas instead of angulas.

11

When 8, 16, or 24 angulas are added to the respective angulas of shifts of four-side houses, their respective yōnis will be the same. Therefore, in houses where the intermediary spaces (antarālas) are small, the increased shifts are to be accepted.

12

To distinguish between the side-houses and the corner-houses there will be eight antarālas. If the antarāla is too large, the result will be loss of wealth. If it is too small, illness will be the result. When the walls coincide, there will be no space between them and the result will be death. Therefore it is not auspicious to have antarālas greater than 1/6 the length of the house or less than it by more than 2 or 3 angulas.

13

The inner width between the respective beams and cerippu is known as the pādamāna. In small houses it is seemed to be 3¼ hastas. According to great acāryās the pādamāna is to be equal to the width of the house or 1½ times of it. It may also be determined by adding or subtracting one part of width to or from it when it is divided into 4, 6, 7, 8, 9, 10 equal parts.

14

When this padamana is divided into 3, 4, 5, 6, 7, 8, 9 or 10 equal parts, the measure of one part will be the height of the addhiṣṭāna. If it is divided into 21 parts, the measure of 6 parts will be the height of the adhiṣṭāna. Further, when it is divided into 18, 24 or 7 parts, the measure of 5, 7, or 2 parts respectively will be the height of the adhiṣṭāna. Similarly, when it is divided into 15 or 14 parts, the measure of 4 parts is the height of the adhiṣṭāna.

15

As explained above, the heights of the adhiṣṭāna are defined in 14 ways. By subtracting one part each from their respective heights when they are divided into 6, 7, 8, 9, 10, or 11 parts, the height of the adhiṣṭāna will occur in 84 ways.

16

When the chosen height of the adhiṣṭāna is divided into 9 parts, the height of the pāduka and jagati are determined by 3 parts and 6 parts respectively. This may also be done by taking the measures as pāduka by 2 parts and jagati by 7 parts in order. Thus there are two types of mancakas (adhiṣṭàna) without pati and gala. The projection of the paduka from the edge of jagati may be determined as 3/4, 1/2 or 1/3 of the height of the paduka or it may be defined by 3 parts when the height is divided into 5 parts.

17

When the desired height of the adhiṣṭāna is divided into 6 parts, the heights of the pāduka, jagati, gala and pati are to be determined on the mancaka by 1 part, 3 parts, 1 part and 1 part respectively.

18

When the height of the adhiṣṭāna is divided into 5 parts, the height of the paduka is determined by 1 part. The heights of jagati, gala and prati are determined by 2 parts, 1 part and 1 part respectively. Mancaka may be constructed also by this method.

19

When the height of the adhiṣṭāna is divided into 14 parts, the pāduka is to be constructed by 2 parts. The heights of jagati, the lower vājana, an ornamentation of the gala, gala, upper vajana galamancaka with vajana and is very prosperous.

20

Thus the galamancaka are defined in 3 ways. The shift of the pati will be equal to that of jagati. In these galamancakas the inward shift of gala will be $\frac{1}{4}$ of the height of the gala.

21

In this way the adhiṣṭāna (basement) is constructed strongly. Then the height of the pillar (stambha) is defined as the difference between the pādamāna and the height of the adhiṣṭāna. The height of the pillar may be defined by adding or subtracting one part to or from it when it is divided into 6, 7, 8, 9, 10 or 11 parts. From this height (length) of the pillar, the height of the pàdapeeḍam (pedestal) (ōma) and the thickness of the pōtika (bracket) are to be subtracted.

22

The pedestal (ōma) must be made of strong stone or by the core of strong timber. This may be done in the shape of square, octagone, or sixteen-sides and in some case this may be done in circular shape. The width of the pedestal must be the length of the diagonal of the foot of the pillar and the height must be half of it. This height may be reduced by 1/4, 1/3, or 1/2 of it. In some cases, this is done in the shape of a lotus flower together with ornamentations like vājana etc. The pedestal (ōma) is to be placed above the adhiṣṭāna.

23

All pillars must have rectangular projection at their ends with a width of 1/3 of the width of the pillar. These pillars are placed on the pedestal placed at their respective positions in such a way that the projections (kutuma) at their ends are exactly inserted into the holes on the pedestals (ōma).

24

The breadth of the foot of the pillar is determined by one part of the height of the pillar when it is divided into 4, 5, 6, 7, 8, 9, 10 or 11 parts. The width of its upper end is given by 1 part less than the width of its lower end when it is divided into 8, 9, 10 or 11 parts. The width of the upper end is known as a daṇḍu. In some cases this dandu is used as a unit of measurement. This daṇḍu is used for measuring the ornamentations on the walls. The width of the upper end of the pillar on wall is also known as daṇḍu.

25

On all pillars a rectangular block is to be constructed at the upper end whose length is equal to the length of the diagonal of the foot of the pillar. At the lower end the rectangular block will have length equal to 3½, 4, 5 or 6 times of the length of the diagonal. In the middle of the pillar there must be a rectangular block of length equal to the length of the diagonal of the pillar at the middle. The remaining parts may be done in the shape of octagon (ettupattam). Otherwise, the whole portion of the pillar may be done in the shape of circle, octagon or sixteen-side (ṣōdhaśa pattom).

26

The three types of pillars in the shapes of circle, octagon and sixteen-sides are to be done with their lower half in rectangular shape or with a rectangular block at their lower ends having length equal to the length of the diagonal of the foot of the pillar.

27

When the pillar is too tall, its breadth is to be taken as $1\frac{1}{4}$, $1\frac{1}{2}$ or 2 times of the respective pillar which is defined above. The breadth is to be increased upto the middle of the pillar or upto a height of the adhistana or $1\frac{1}{2}$ times of the height of the adhiṣṭāna. In this way, the pillar is to be constructed with granite or fried bricks using the prescribed quantity of 'cunna'. In some cases this is to be done from top to bottom or upto the middle of the pillar.

28

If there is only one vājana on the beam the rectangular block in the middle of the pillar is avoided. In the case of patrōttara or beam with a small vājana, the rectangular block at the middle is auspicious. On pillars which are meeting the patrōttara and vajanōttara, ornamentations of muthupatta, kuzhitāra, valaya etc, are to be constructed. All parts of the house below and above the beam (uttara) are to be done according to the nature of the main beam.

29

The width of the pōtika is the average of the widths of the beam and the upper end of the pillar or it may be the width of the pillar at the middle. The thickness of the pōtika will be half of its width. The length of the pōtika is equal to 3 daṇḍu, 4 daṇḍu or 5 daṇḍu or it may be equal to 3 times of its width. The potika may be decorated with vājana and such other ornamentations and is to placed on the Roopōthara of the house.

30

If the beam is a patrōttara the above mentioned pōtika must have thickness equal to 3/4 of its width. If it is a khandōttara the thickness must be equal to its width. All parts, at all situations, are to be done beautifully.

31

The appropriate width of the beam is to be determined according as the rules defined for the determination of the width of the foot of the pillar. The width may also be determined by 8, 16, 12 or 6 angulas. The beam with equal width and thickness is called khaṇḍōttara and is auspicious. The beam having thickness 3/4 of its width is known as Patrôttara and considered madhyama and when the thickness is half of its width is named as Roopōttara and is adhama.

32

In some cases, the width and thickness of the beam may be done in the reverse order. Such beam is known as chūli (choozhika). Since it is in an inclined position, the rafters are fixed on it directly.

33

If there is only one vājana on a beam then it is divided into 5 parts. The upper patta is to be done by 2 parts and the lower patta by the remaining 3 parts.

34

If there is the alpavājanam also on a beam then the mahavājanam (small vajānam) by 1 part and the remaining 4 parts will constitute the lower pattam when the thickness of the beam is divided into 8 equal parts. (The inward projection of the mahāvājana and alpavājana is to be done by 1 part.)

35

When the thickness of the beams are divided into 5 parts, the mahavājana is to be done by 2 parts, the small vajana by 1 part and the pattam is to be done by the remaining parts beautifully. If the thickness of the beam is divided into 4 to 11 parts, the shift of the two vajanas is to be done by 1 part, accordingly. In all other cases, the rules for vājana are the same.

36

Then the pōtika is to be placed on the top of the pillar. The upper end of the pillar projects upward through the hole on the pōtika. The beam is placed on this pōtika and is fixed on the protruding end of the pillar.

37

Then an uttarappattika known as Chittuttaram of height equal to the thickness of the beam and thickness of half it is to be placed over the beam and is fixed to it using appropriate wooden pegs.

38

These wooden pegs are to be fixed in the middle of houses and in koota sūtras. All these pegs are to be fixed by shifting them from the central areas by one yava towards the right side. The gap between the rafters on the beam are to be determined intelligently. These pegs are to be fixed in the middle of the interspaces between the rafters so that the number of pegs will be odd and the number of rafters will be even on each side.

39

A vajana-beam having thickness 3/4 daṇḍu or more is to be placed on the main beam. On this vājana-beam, beams with height 1 daṇḍu and thickness 3/4 dandu are to be arranged in the crosswise direction on them, short beams (Jayantis) having thickness equal to half the height of the beam are to be arranged according to the nature of the roof of the house. The upper side of the beams is uniformly levelled and wooden bands of appropriate thickness are fixed on it without gaps.

40

Or the ceiling is to be done magnificiently with decoration like kapōtam, valaru, tulapādam, uruvu, netram etc. Beautiful pictures and statues of different deities may be engraved on the ceiling board to make it artistic.

Chapter VI

1

In the case of small houses, only the outer-beam is sufficient. The Ārūḍam (secondary beam), is also necessary if the house is big. The ārūḍam is to be placed upon the viṣkambham (etavattom) with an inward shift of 8 angulas, 16 angulas, 24 angulas etc, from the outer-beam (vārōttaram) so that it satisfies the yōni, aya etc, prescribed for the house. The height of the Ārūḍam from the level of varottara is equal to the shift of the Ārūḍam and the length of its support is equal to the hypotenuse of the isosceles right angled triangle formed by the height. The intermediary space between the Ārūḍam and the Vārottaram is known as the aliṇḍa.

2

The support of the Viṣkambam is to be done beautifully with special decorations like chippam etc, together with vine on it bearing flowers and buds appearing to be emerging out from it (chippam).

3

The dip of the rafters (kazhukkol chattam) is determined by 2/5, 4/9, 3/8, 3/7, 1/3 or 1/2 of the length of the pillar. Anyone of these may be adopted accordingly.

4

Divide the height of the pillar below the level of the prescribed dip of the rafter into 6 to 11 parts. Subtract or add one part from or to the dip as prescribed in the case of determine the height of the pillar. In some cases, this may be done by subtracting 1, 2, 3, 4, 5, 6, or 7 angulas. The dip may be done on either side of the house as equal or unequal.

5

The dip of the rafter may be determined by 1, 1½, 2, 3, 4, 5, 6, or 7 times of the width or thickness of the uttaram (beam). When the house annexed to other houses, the dimensions of the rafters, vāmata, fillet etc, may be reduced accordingly. Uttara (beam) is the most important part of a house and therefore it should not be cut into pieces.

6

Rafters which are straight and having the same lengths and widths are known as 'nērmanju' (common rafter). Rafters having different lengths and widths placed in slanting positions are called kōti (hiprafter) and upakōti (jack rafter). All the rafters on either sides of the house must be of the same dimensions.

7

One end of the hiprafters, jackrafters etc, are to be fixed on the kūta and the straight rafters (common rafters) are to be fixed on the 'mōntāya' (Ridge). The other ends are to be placed on the Cittuttara properly.

8

Since the rafters on either sides of the ridge are fixed on the mōntāya (ridge), it is called Vamśa. The thickness and width of the ridge may be equal to 3/4 of the width of the uttara or they may be determined by 6 or 7 angulas. At the positions of the rafters, the patra and vajana are to be made with a measure of 3 or 4 times of the thickness of the rafter.

9

The kūtam is fixed on the pivot at the end of the hiprafters. The rafters on the sides are to be fixed on the kutam using iron nails at their ends. The pivot at the end of the rafter is the basis of the kūta and therefore the base of the kuta must be on the lower side. In the case of square houses all the rafters will be jack-rafters or slant-rafters (Alasi).

10

The kūtam is to be done in the shape of a 'Durdura' flower (Thorn-apple flower) or in a cylindrical shape, or polygon of 8 sides or 16 sides. This may be constructed in the shape full-blossomed lotus flower. The lower half must be in spherical shape and its length will be double the width. Its length may be reduced by 1 part when it is divided into 8 to 11 equal parts in order. Its middle portion is to be decorated by constructing 'patras' having width of 4 yavas or more.

11

The perimeter of the kūta will be approximately equal to the totality of the thicknesses of all rafters or may be equal to the width of the uttara. This may be determined in the unit of angula in order to suit the prescribed yoni conditions. The pattam where the rafters meet the kuta must be of height equal to the line of vitāna of the hip-rafter. Kūtam is an upward directed element of a house and is decorated with special features of Patra. The shape and dimensions of the kuta are said to be as above.

12

In rectangular houses having length greater than the width, the rafters like kōti, upakōti etc, are to be fixed on the kūta which is fixed on the ridge of the house. Other straight rafters are to be fixed on the vamśa (ridge) using iron nails at the ends.

13

If the pivots at the ends of the ridge are screwed into the holes on the sides of the kūta then this joint is named 'Ajayudha sandhi'. Here also, depending on the nature of the joint, the base of kuta must be on the lower side.

14

In houses (rectangular) with side elongation (Mukhāyāma) the length of the ridge must be equal to that of the uttara (beam) of the house. The rules regarding the joins at the ends of the beams will be the same as those prescribed for the houses.

15

The pivots at the two ends of the ridge are inserted into the holes on the lower portion of the kūtas and are to be fixed on it using wooden nails. Since the kuta depends on the montaya (ridge), it will be in the upside down position. In the same way, the bālakūtam also depends on the element above it.

16

In all desired squares, the side below in the crosswise direction (horizontal direction) is known as 'bhuja' (base). The line through the corners is the diagonal (karṇa).

17

On a smooth wooden board or on smooth ground construct a square with its side equal to half the width of the house. Draw lines parallel to the bhuja representing the height of the cittuttaram, the thickness of the uttara and the dip of the rafters in descending order. Determine the positions of the rafters on the line representing the uttara.

18

Double the number of rafters like hiprafter, slantrafter, jackrafter etc, and then subtract one from this number in all cases. The intermediary spaces between the koti, upakoti, and slant rafter are determined by two parts each and one part near to the vertical side of the square. This kind of representation of the positions of the rafters are recommented by all sāstras.

19

In this way the positions of the slant rafters are determined on the line of beam. Then the lines through these points joining the kūta and dip-line will determine lengths of the corresponding rafters.

20

In all houses the width of the straight rafter (common rafter) will be equal to the width of the uttara (beam) or it may be determined by adding or subtracting 1/8, 1/7, 1/6, 1/5, 1/4, or 1/3 of width to or from it. Or it may be done by 2, $1\frac{3}{4}$, or $1\frac{1}{2}$ times of the width of the uttara. The thickness of the rafter may be determined by 1 angula to 6 angula, each time increased by 1 yava successively.

21

Consider a square with side as the width of the common rafter (Manju). Mark a point on the bhuja representing half the length of the diagonal of the square. The line joining this point and the terminal end of the koti (vertical side) will give the width of the hiprafter. The widths of each of the slant-rafters is given by the lengths of the lines joining the upper end of the koti and the corresponding positions of the slantrafters on the bhuja. On either sides of the rafters three lines like dwaja line etc, and plumb line etc, are to be constructed.

22

Divide the width of the rafter into 9 parts and the dwaja sutra is to be drawn in the middle of the rafter on both sides such that 5 parts are above and the remaining 4 parts are below the dwaja sūtra. Or this may be drawn in such a way that 4 parts are on the upper side and 3 parts are on the lower side of this line. It may also be determined such that 3 parts are above it and 2 parts are below it when the width is divided into 5 parts.

23

On either side of the dwaja sutra (line) draw two lines parallel to it at a distance of 2 angula from it. The widths of the rafter below and above these lines are to be determined properly.

24

On both sides of all rafters construct squares of sides 4 angula on the dwaja sūtra. The diagonals of the square are known as vertical line (Tuku rekha) and horizontal line (vitana). These lines are to be drawn at the positions where the vala (collarpin), the beam, the ridge etc, meet the rafter. They are to be constructed at the ends of the rafters where the rafters meet the kūta and vāmaṭa.

Chapter VII

1

In the case of small houses, Cuzhika (slant beam) may be used in the construction of roof. But viṣkaṁbam (vittam) must be in even number. The ridge is to be placed on the pillar of length equal to the semiwidth of the house. The pillar is placed at the centre of the vittam. The length of the pillar may be reduced by 1/7, 1/8, 1/9, 1/10 or 1/11 of its length. The rafters are to be placed on the Cūzhika (slant beam) with their other ends on the prescribed ridge.

2

The width of the vamata is determined by 6/10, 7/10, 8/10 or 9/10 of the width of the beam. Or it may be defined by 3/4 or 3/7 of the width of the beam. Its thickness is 1/3 of its width. It may also be determined by 2/5 of its width.

3

If the width of the vāmata is divided into 5 parts then the upper pattam is done by 2 parts, the tālam by 2 parts and the lower pattam is done by 1 part. Similarly, when it is divided into 6 parts then the upper pattam is done by 2 parts, the talam by 3 parts and the lower pattam by 1 part. If the width of the vāmata is divided into 8 parts then the above parts may be done by 3 parts, 4 parts and 1 part respectively.

4

Divide the width of the vāmata at the paryanta (Tumbu vāmata) into 5, 7 or 9 parts. On all sides, the level of the vamata along the vitāna is to be raised by 3 parts according to the rule of koti-karma and is fixed at the ends of the rafters. A light wooden board known as 'tuvānapalaka' is to get fixed along the edge of the vāmata by the expert craftman. This is to be done carefully after performing Vāyavya-hōma.

5

The vala (collarpin) is to be done in square shape with thickness from 14 yavas to 3 angulas increasing by

2 yavas at a time. The thickness of vala is defined in 6 ways by the sages. Of these, the appropriate thickness may be accepted depending on the width of rafters.

6

The width of the pattika (reapers) is determined by 17 yavas and its thickness is the measure of 9 yavas. The space between the pattikas (reapers) is 63/4 of its thickness and these are to be fixed on the rafters using iron nails.

7

In all houses, for covering the roof using tiles the pattika (reapers) is to be fixed on rafters as prescribed above. In some cases, thick wooden boards are used instead of pattika and fixed on the roof with nails. On these wooden boards sufficient grooves are made in order to fix the tiles on them properly. In the case of temples, palaces etc, if copper plates are used for thatching, to protect from heavy rainfall, then there is no need of groove on them.

8

The turban of the Gṛhapuruṣa is known as the Apidhānam (end). It is to be placed upside down on the roof. The width of the Apidhānam is to be 1/2 or 3/4 of the height of the foundation and its thickness is equal to the height of the pāduka.

9

The doors (openings) to the ankaṇa are to be placed in such a way that their central line coincide with the centre of the space between the central axes of the houses and ankaṇa. Their perimeters in terms of angulas must be auspicious with respect to yoni, aya, vyaya etc, prescribed for each side from east onwards. The width of the door-frame will be equal to that of the beam and the thickness will be equal to or half of its width or 1 part less than the width when it is divided into 3 or 4 parts. On the door-frames decorations of vajana etc, are to be constructed properly. There must be 'patis' at the lower and upper ends of the frame.

10

The lower pati (Cettupati) of the door will have thickness 1 part greater then the thickness of the frame when it is divided into 3 or 4 parts and without decorations of vājana. The thickness of the upper-pati (Kurumpati) must be the same as that of the thickness of the frame. The upper ends of the door-frame are to be extended to meet the beam placed above them. The inner-perimeter of the door must have the respective yoni, aya etc, prescribed for each side. The width of the door is to be determined by subtracting the desired length from the semiperimeter or by gunāṁśa method (Multiple division method).

11

Then the 'Kurumbappalaka' is to be placed upon the upperpati (Kurumpati) of the door. It is decorated with the images of Ganēśa, Srīkrishna, Mahalakshmi and such others together with pictures of different birds carved on it beautifully according to the situations.

12

If the wall is too thick then it is divided into 12 parts and consider the line which separates the parts into 7 parts inside and 5 parts outside of it. The door-frame is to be placed with its central line coinciding with the above line. In some cases, one more pati is placed upon the upperpati (Kurumpati) and above it wall is constructed using granite and mortar or mud.

13

In houses where the innerperimeter is considered important and walls of much thickness, they may be constructed strongly along the outer edge of the pāduka (without the inward shift). The positions of door-frame and beam are to be shifted outward upto the prescribed limits of the wall and placed properly according to the conditions of axes of houses and ankaṇa.

14

Each of the two shutters of the door is to be constructed with its width equal to half the sum of the width of the door and thickness of the shutter. The thickness of the shutter may be determined by 2, 2½, 3, 3½ or 4 angulas.

15

There must be pivots (hinges) at the lower and upper ends of the door. Sūtrappattika (Blinding reaper) and a metal ring for holding the shutter are to be fixed on the shutters. Copper or iron strips are to be fixed on the door both in lengthwise and crosswise using nails with their nuts in the form of buds and flowers. Further, the image of the face of Mahalakshmi and part of moon (Candrakala) may be done on the door to make it beautiful.

16

The width and thickness of the sūtrappattika (blinding reaper) are determined by 1 part of the width of the opening when it is divided into 4 to 8 parts. The thickness may be fixed as 1/2 or 3/4 of the width of the sūtrappattika. Its length (height) will be equal to the length of the door. It may be decorated with an odd number of (3, 5, 7 etc,) projections in the shape of breasts, images of Ganēśa, Srīkrishna, Mahalakshmi resting on the lotus flower, muthumala etc, on it.

17

The shutter on the left side of the door is called the mother and the sūtrappattika is to be fixed on it. The right side shutter is known as the daughter. The shutters in all the doors are defined like this. Then the 'arama' (matiyan) is to be constructed with height equal to 1/3, 1/4, 1/5 or 1/6 of the height of the door and its width and thickness equal to 1/4, 1/5, 1/6 or 1/7 of its height.

18

The bolts (sāksha) are to be made with length equal to 1/4, 1/5, 1/6. 1/7 or 1/8 of the width of the door. Its width is defined as 1/6, 1/7 or 1/8 of its length and thickness is equal to half of its width. Two rectangular blocks where projection is equal to the thickness of the bolt are to be constructed at the ends of the bolts. These bolts are fixed on the arama through the grooves at their lower and upper ends such that the rectangular blocks on the bolts will be on either sides of the arama.

19

The lower bolt (saksha) is to be placed on the mother-shutter and the upper bolt on the daughter-shutter. Then the 'arama' (matiyan) is to be fixed on the inner side of the door using nails with its centre is just above the centre of the door.

20

It is considered auspicious to have the door-frame, shutters etc, made of the same kind of timber. If they are done by different kinds of timbers then according to some acaryas, the ladies residing there will be of bad character.

21

If the door is having only one shutter then it must be placed on the left door-frame. The arama is to be fixed on the opposite frame just below or above its centre. The bolt of this 'arama' is to be done in circular, octagonal or rectangular shape. The door may be fastened using strong chain also.

22

Divide the length of the house into 11 or 13 parts by 10 lines and 12 lines respectively. Then the outward door is to be placed in such a way that its centre coincides with the 6^{th} or 7^{th} line on the right side of the house. This is to be done in accordance with their appropriate yoni, aya etc, prescribed for each house. If there is only one shutter then it must be fixed on the left side with respect to the exit of the house.

23

The main door which is used for the transportation between the ankana and outside is to be placed upon the paduka. If the corner-house has wall then the width of the antarāla (alinda) is to be so chosen that when it is multiplied by 4 gives a perimeter of appropriate yoni.

24

The patippuras (gōpuras) or the large entrances to the house are to be done at the positions of Puṣpadanta, Ballāta, Indra and Grahakshata at a distance of 4, 5, 6 or 7 daṇḍus from the centre of the ankaṇa. These large entrances and eight other small entrances may be constructed at positions where the region is higher than the surroundings. These patippuras may be done with upstairs together with projection on it.

25

The padas (positions) of eight small patippuras (gate-house) are defined for houses of man. They are at the padas of Pārjanya, Bruṁśa, Pūṣāvu, Bṛnga, Dvārapāla, Śośan, Nāga and Aditi.

26

The vēdika for sitting is to be constructed, on both sides of the entrance, above the foundation of the gopura. The height of the vēdika may be determined by the width of the pillar at the entrance or by 1/6, 1/7 or 1/8 of the height of the pillar or by the height of the pati or by 1½, 2, or 3 times of it. Upon the vēdika there must be pillars in even number and on either side walls are constructed with beams on it. The width of the beam may be equal to the width of the pillar or it may be equal to half or 3/4 of it.

27

The required shift in the position of vēdika may be incorporated in accordance with the order of patramāna. The shift of the vēdika from the edge of uttara is defined by 2½, 3 angulas etc, in order.

28

According to some scholars, vēdika is to be done using the same materials which are used to construct the wall and foundation of the house. In all houses, it is seen that, the vedika is done by materials like stone, fried bricks, mud etc, or by different kinds of timber. As in the case of garbhagṛha, when the yoni is determined with respect to the inner perimeter, the door-frame is to be placed upon the ankaṇa-pāduka or below the pati.

29

The number of pillars below the beam, rafters etc, must be of even number and the number of interspaces (gaps) between them must be of odd number. It will be inauspicious if the lengths of interspaces exceed 1 kol (hasta) and it will provide calamities.

30

The east-house is prescribed for Puja, sacrifice etc, and the north-house is defined for family members. These two may be interchanged. The south-house is utilised for reception of guests and the west-house is used for storage of wealth. These may be used in the reverse order. The remaining spaces of these two may be used for sleep and study.

31

The region is divided into 100 padas, 81 padas or 64 padas (squares). Then the portion at the centre comprising of 16 padas 9 padas or 4 padas respectively will form the ankana. The surrounding two envelopes of padas will be the space for the construction of houses. The outermost envelope provide the space for cattle-shed, kalappura, well etc.

32

The Kalappura (barn house) will be done on southern side and the grain-house may be constructed on the southern side or in the Nirrti corner. Then the treasury-house may be built on north, east, or west side or at the signs of Simha, Vrscika, Tula or Karkilaka and at all positions which are defined for the grain house. If necessary, the grain-house may be constructed at all positions which are prescribed for the wealth house.

33

'Gosala' (cow-shed) may be constructed at the positions of Indra, Varuṇa and in the antarālas of Vitatha and Pūṣavu. It may be done at the padas of pārjanya and jayanta and in the anterālas of kusumadanta and dvārapāla. In the case of the Mahiṣālaya, it may be done at the positions of Bṛunga and Śōṣa or on the south side. The ox-shed must be made on the south side. In all these constructions the vāstumarmas and sūlas are to be avoided.

34

Some acaryas are of the view that on all sides, the passage for cows across the karṇa sūtra (rajju) is not auspicious. For cowsheds, vrsa yoni is the most auspicious and Simha yoni is inauspicious. The Karanas of Simha, Puli, Śunaka (dog), Gardabha (ass) etc, are to be avoided in the construction of cowsheds.

35

Kitchen is prescribed at the padas of Pārjanya and Agni or it may be at the signs of Mēśha, and Etava or at the Vāyu corner. Dining hall is wished to be at these positions itself or at the sign of Makara and on west side also. The house for entertainment is to be constructed at the signs of Kumba and Makara and at the Vāyu corner. If necessary, this may be done at the signs of Etava and Mēsha. Similarly, the grinding house is to be done at the vāyu corner.

36

Well at the Meena sign (rasi) is defined to be the most auspicious. This will increase wealth in all ways. Well at the signs of Mēsha and Kumba will provide prosperity and at the signs of Makara and Etava will provide immense wealth. It is auspicious at the padas of Apa and Apatvalsa. It may be constructed at the pada of Indrajit also. Well on west side is auspicious whereas at the Vāyu corner is not good for women.

37

Well at the Antarīkṣapada is prosperous. Similarly, a lake is defined at the padas of Mahēndra, Mahidhasu, and Varuṇa, on the sides of Sōma and Śiva and at the sign of Mēsha. It is seen that the lake is done at Vāyu corner or Nirṛti corner. It is not auspicious to use the water from the same tank for bathing and drinking. Therefore, if there is no river passing by them water for bathing and drinking is to be collected separately.

38

If the construction of well and similarly, of lake have been completed previously at the Agni corner, then they will cause difficulties from fire etc. The tank on the south side will also provide the same results. Some acaryas consider it inauspicious to have lake like 'dīrghika' etc, on the southern side of the grāmas (village) etc. In a similar way, the presence of park, holes of snakes etc, in the immediate vicinity of the houses are not auspicious.

39

In the houses of Kings and Brāhmaṇas, the house for daily worship is to be done in the ankaṇa and the installation of the dharmadēva (deity of the family) etc, are to be done at the positions of Īśa, Indra, Agni and Varuṇa. The buildings like temple etc, at the positions of Isa, Indra, Agni and Yama are to be done with perimeters of Kētu yōni and from Nirrti to Isa corner they are to be done in Vrsa yoni for prosperity.

40

The temples of family-kuladēvatas are to be done with Kētu yōni from Isa corner onwards and with Vṛṣa yōni from Nirṛti corner onwards. They must be faced towards the positions of houses, puram, pattaṇam, nagaram, grāma etc.

41

Images of deities may be installed in some houses without the prescribed combination of its parts. There are two types of deities, namely, temporary and permanent depending on their varying and nonvarying nature and on the nature of offerings made to them.

42

For Kings, the chamber for enjoyment is to be done at the Mitra pada and the house for entertainment is to be constructed at the Vāyu corner. The house for exercise is made at the Arggala pada and at the Nirṛti corner. Bathrooms and such others are constructed at Parjanya pada and dining hall is to be done at Indra pada and Varuṇa pada. Nātyasāla is to be made at Gandarva pada and the arsenal must be done at the Nirṛti corner. Chambers for sleeping are to be made at the Grahakṣata pada and on the east side.

43

It is said to be auspicious to have the compound wall outside the boundary limit constructed with stone or mud properly. A trench along this limit is considered Madhyama and a fence using the branches of trees is adhama. For making the fence branches of thorn-trees, vines, bamboo etc, may be used. Any one of these may be accepted depending on the wealth conditions. Then the trees prescribed for each side are to be planted in order as explained earlier.

44

The ācarya has to get the house completed by the artisans according to the above rules and at the end of its construction the silpins must be awarded with presentations like bracelets, orṇaments with jewels on them etc, to make them happy. After accepting the house from the śilpins, the acarya together with the owner and family must enter the house at an auspicious time accordingly. The vāstupūja and other offerings are to be performed as prescribed in this connection.

45

At the end of the offerings, the owner of the house has to propitiate the acarya by awarding him presentations like cows, earth, gold, feasts etc, according to his satisfaction and after getting his permission the house-owner must give presentations to all for making them happy. Then the gṛhakarta may live in the house with pleasure and satisfaction.

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॥ श्रीः ॥

मनुष्यालयचन्द्रिका।

नृसिंहयादवाकारतेजोद्वितयमद्वयम्।
राजते नितरां राजराजमङ्गलधामनि ॥ १ ॥

श्रीमत्कुण्डपुरे विराजति पेरक्कोडे च तेजः परं
नावानाम्नि च धाम्नि यच्च नितरां मल्लीविहारालये।
अश्वत्थाख्यनिकेतनेऽपि च पुरे श्रीकेरलाधीश्वरे
सम्भूयैतदुरुप्रकाशविषये चित्ते ममोज्जृम्भताम् ॥

श्रीमङ्गलारपदसदाश्रयनीलकण्ठ-
प्रेमप्रकर्षनिलयः सकलाभिवन्द्यः।
श्रीमद्गिरीन्द्रतनयातनयोऽङ्घ्रिभाजां
कामप्रदो जयति मत्तमतङ्गजास्यः ॥ ३ ॥

तद्देवपादकमलैकसमाश्रयः को-
ऽप्युद्द्योतमानगुरुवर्यकृपाभियोगात्।

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१. 'व' ख. पाठः.

विद्यापरिश्रमपरो बहुधात्मशुद्ध्या-
सुयोगवान् भवति बालविबोधने च ॥ ४ ॥

येषां श्रुतिप्रणयिनी धिषणा यदीय-
सङ्कल्पकल्पिततनुः परमेश्वरोऽपि ।
तेषां महीसुमनसां महनीयभासा-
मुत्तंसये परमुदारपदारविन्दम् ॥ ५ ॥

निसर्गसंसिद्धसमस्तशिल्प-
प्रावीण्यमाद्यं द्रुहिणं प्रणम्य ।
मया मनुष्यालयचन्द्रिकेयं
विलिख्यते मन्दधियां हिताय ॥ ६ ॥

मयमतयुगलं प्रयोगमञ्ज-
र्यपि च निबन्धनमा[illegible] ।
अनुमतगुरुदेवपद्धतिश्री-
हरियजनादिमहागमा जयन्ति ॥ ७ ॥

मार्कण्डेययुगं पराशरमुरारिप्रोक्तरत्नावली-
सागन काश्यपविश्वकर्ममतयुग्माद्यं कुमारागमम् ।
मय्याख्यां हरिसंहितां विवरणाद्यं वास्तुविद्यादिकान्
दृष्ट्वा तन्त्रसमुच्चयोक्तमनुसृत्यैवात्र संक्षिप्यते ॥ ८ ॥

मर्त्यो विप्रादिवर्णेष्विह भवनविधानोत्सुको यः स पूर्वं
विप्रं तद्देशसम्बन्धिनमखिलगुणैरन्वितं संवृणीत ।

सोऽयं तद्वर्णयोग्यां क्षितिमथ परिकल्प्यात्र पूजादि कृत्वा
वास्तोः शास्त्रोक्तरीत्या गृहमतिनिपुणैः कारुभिः कारयेत ॥

वेदागमादिविहितान्यवधार्य विप्रैः
कार्यो विधिः सकलदेवनरालयानाम् ।
तद्वाक्यतः सकलधामसु मृच्छिलादे-
रन्योन्यमेलनमुशन्ति हि कारुकृत्यम् ॥ १० ॥

स्थपतिः सूत्रग्राही तक्षकसंज्ञश्च वर्धकिः क्रमशः ।
स्वोचितकर्मणि दक्षा ग्राह्यास्ते कारवश्चतुर्धेति ॥ ११ ॥

सर्वशास्त्रविहितक्रियापटुः
सर्वदावहितमानसः शुचिः ।
धार्मिको विगतमत्सरादिको
यः स च स्थपतिरस्तु सत्यवाक् ॥ १२ ॥

जानीयात् स्थापनार्हं स्थपतिमथ गुणैः प्रायशस्तेन तुल्यः
सूत्रग्राही सुतो वा स्थपतिमतिगतिप्रेक्षकः शिष्यको वा ।
स्थूलानां तक्षणात् तक्षक इति कथितः सन्ततं हृष्टचित्तो
दार्वाद्यन्योन्यसंमेलनपटुरुदितो वर्धकिः सावधानः ॥ १३ ॥

विना स्थपत्यादिचतुष्टयेन
गृहादि कर्तुं न च शक्यतेऽस्मात् ।
प्रसादितैस्तैरथ विप्रवर्यैः
सुसूक्ष्मधीः कारयतां गृहाणि ॥ १४ ॥

लक्षणहीने धामनि वसतामशुभानि सम्भवन्त्येव ।
जन्माद्यवसानान्तं मनसा निश्चित्य कारयेत् तस्मात् ॥ १५ ॥

तत्र क्रमेण बहुधा धरणीपरीक्षा
दिङ्निर्णयादिशुभवीथिपरिग्रहश्च ।
धाम्नां प्रमाणविधिरङ्कणकुट्टिमादी-
न्यङ्गानि बाह्यविधयश्च तथा विधेयाः ॥ १६ ॥

गोमत्यैः फलपुष्पदुग्धतरुभिश्चाढ्या समा प्राक्प्लवा
स्निग्धा धीररवा प्रदक्षिणजलोपेताशुबीजोद्गमा ।
सम्प्रोक्ता बहुपांसुरक्षयजला तुल्या च शीतोष्णयोः
श्रेष्ठा भूरधमा तु तद्गुणविपरीता मिश्रिता मध्यमा ॥ १७ ॥

वृत्तार्धेन्दुनिभा त्रिपञ्चरसकोणा शूलशूर्पाकृति-
र्मत्स्यानेकपकूर्मपृष्ठकपिलायक्रोपमा मेदिनी ।
भस्माङ्गारतुषास्थिकेशचितिवल्मीकादिभिः संयुता
वर्ज्या मध्यनता सगर्भकुहरा विस्रा विदिक्स्थापि च ॥

इन्द्राशादिनतावनी तदितराशासून्नताष्टौ क्रमाद्
गोवह्न्यन्तकभूतवारिफणभृन्मातङ्गधान्याह्वयाः ।
वीथ्योऽत्र क्रमशोऽभिवृद्धिधनहान्यन्तार्थहानिप्रदा
दारिद्र्यात्मजहानिवित्तशुभदास्तादृक्क्षितौ तस्थुषाम् ॥

प्रवासदा मध्यनता धरित्री
मध्योन्नता वित्तसुखादिहन्त्री ।

वह्न्यादिवाय्वन्तनता धरित्री
प्रायेण दारिद्र्यफलप्रदा स्यात् ॥ २० ।

मध्योच्चायां धरित्र्यां प्रथममथ गृहे कल्पिते स्याद् दशाब्दं
वृद्धिः प्रागुन्नतायामपि हुतवहयाम्योन्नतायां शताब्दम् ।
साहस्राब्दं निर्ऋत्युन्नतधरणितले वारुणे स्यात् तदर्धं
शेषास्वर्कोष्टषट्काः शरद इह ततः स्वोक्तरूपं फलं स्यात् ॥

पूर्वस्यां बकुलो वटश्च शुभदोऽवाच्यां तथोदुम्बर-
श्चिञ्चा चाम्बुपतौ तु पिप्पलतरुः सप्तच्छदोऽपि स्मृतः ।
कौबेर्यां दिशि नागसंज्ञिततरुः प्लक्षश्च संशोभनाः
प्राच्यादौ तु विशेषतः पनसपूगौ केरचूतौ क्रमात् ॥

अश्वत्थोऽग्निभयं करोति बहुधा प्लक्षः प्रमादप्रदो
न्यग्रोधः परशस्त्रपातमुदरव्याधिं तथोदुम्बरः ।
सम्प्रोक्तप्रतिदिक्स्थितास्त्वपि च ते चान्ये सुवर्णात्मका-
स्त्वेद्या मन्दिरतस्तरुद्वयुगसीमाभ्यन्तरस्था यदि ॥ २३ ॥

रम्याढ्या मन्दिरपार्श्वपृष्ठदिशि तु श्रीवृक्षबिल्वाभया
व्याधिघ्नामलकीसुरद्रुमपलाशाशोकमालेयकाः ।
पुन्नागासनचम्पकाश्च खदिरस्तद्वत् कदल्यादयो
जातीनागलतादयोऽपि सकलाः सर्वत्र संशोभनाः ॥

अन्तःसारास्तु वृक्षाः पनसतरुमुखाः सर्वसाराश्च शाका-
श्चिञ्चाद्यास्तालकेरक्रमुकयवफलाद्या बहिस्सारवृक्षाः ।

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१. 'शस्ता म' ग. पाठः

निःसाराः शिग्रुसप्तच्छदशुकतरवः किंशुकाद्याश्च कायो-
स्तेष्वाद्या मध्यभागे बहिरपि च ततः सर्वसारास्ततोऽन्ये ॥

कारस्करारुष्करकण्टकिद्रुश्लेष्मातकाक्षद्रुमपीलुनिम्बाः ।
स्नुहीपिशाचद्रुमहेमदुग्धाः सर्वत्र नेष्टा अपि शिग्रुरन्तः ॥

विष्णोः पृष्ठे च वामे नरभवनमनर्थप्रदं दक्षिणे चा-
प्यग्रे भागे च कालीनरहरिशिवतद्भिन्नसर्वोग्रमूर्तेः ।
आर्यो निम्नस्थलस्थो यदि मनुजगृहं दक्षिणेऽग्रेऽस्य तस्मा-
दुच्चत्वं नेष्टमिष्टं निकटमपि तदन्यत्र तत्पादभाजाम् ॥

व्रीहिक्षेत्रादिदेवालयजलधिनदीतापसागारगोष्ठ-
ग्रामादीनामतीवान्तिकमपकुरुते नैकधा मन्दिरेषु ।
देवागारान्नराणामतिशुभदमिदं किञ्चिदूनं समं वा
तस्मादभ्युन्नतं च छितलविधिरयं नेष्यते तत्समीपे ॥

विप्रादिक्रमतः कुशेषुवनदूर्वाकाशयुक्ता भुव-
स्तुल्यातानवितानसिन्धुररसाब्ध्यंशाधिदीर्घा अपि ।
श्वेता पाटलपीतमेचकरुचश्चाज्यासृगन्नासवा-
मोदाः स्वादुकषायतिक्तकटुकास्वादान्विताश्च स्मृताः ॥

विप्राणां भूरवागुन्नतधनदनतोदुम्बराढ्या शुभा स्यात्
प्राङ्निम्ना वारुणोच्चा चलदलसहिता भूः शुभा बाहुजानाम् ।
प्रागुच्चाब्धीशनिम्ना वटतरुसहिता भूर्विशां पादजानां
सा सप्लक्षा तथा चेद् यमनतधरणी चान्यथा सर्ववर्ज्याः ॥

१ बे' ग्र ग पाठः

सङ्कीर्णरूपा वसुधात्र वर्णैर्गन्धै रसैश्चाखिलवर्जनीया ।
एनामनालक्षितवर्णचिह्नां नक्तं परीक्षेत निमित्ततश्च ॥ ३१ ॥

क्ष्मां खात्वामघटं निधाय भृतधान्यं वर्धमानं मुखे
कृत्वासिच्य घृतं निशासु सितरक्तापीतकृष्णा दशाः ।
विप्रादिक्रमतः प्रदीप्य विधिवन्नीते मुहूर्ते ज्वलेद्
वर्त्तिर्यस्य धरास्य तासु सकलास्विद्धासु सर्वोचिता ॥
भूगर्ते जलपूरितेऽत्र विधिवद् द्रोणादिपुष्पं क्षिपेत्
प्रादक्षिण्यगतिः शुभं सुमनसां यद्यन्यथा निन्दितम् ।
पुष्पो दिक्ष्वथ संस्थिते सति शुभं कोणेषु चेन्निन्दितं
ज्ञात्वेत्यादिशुभाशुभान्यथ समीकुर्यात् क्षमां सूक्ष्मधीः ॥

इति मनुष्यालयचन्द्रिकायां भूपरीक्षापरिग्रहो नाम
प्रथमोऽध्यायः ॥

अथ द्वितीयोऽध्यायः ।

यन्त्रेणावनतादिना च निपुणो यद्वाम्बुसम्पूरणे-
नोर्वीं चारु समीकरोत्वथ दृढं शङ्कुं करार्धायतम् ।
मूले द्व्यङ्गुलविस्तृतः क्रमवशादग्रे तदर्धोन्मित-
व्यासं वृत्ततरं सरोजमुकुलाकाराग्रमाकल्पयेत् ॥ १ ॥
शङ्कुदीर्घयुगसम्मितसूत्रेणाकलय्य परिवृत्य सुवृत्तम् ।
वृत्तमध्यमवधार्य सुसूक्ष्मं शङ्कुमत्र तु दृढं निवेशयेत् * ॥२॥

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१. 'प्य' क. पाठः.

* इह स्वागतारथोद्धतयोरुपजातिः ।

शङ्कुच्छायाग्रभागे त्ववहितहृदयो वृत्तलग्नेऽङ्कयित्वा
प्राह्णान्ते पश्चि(मस्यां ? मायां) दिशि तदितरदिश्येवमेवापराह्णे ।
पाश्चात्त्येऽन्येद्युरप्यङ्कनमपि च विधायाङ्कयोरेतयोर-
प्यन्तर्भागत्रिभागे नयतु गतदिनाङ्कं तदेवेह सूक्ष्मम् ॥ ३ ॥

पूर्वापरेद्युः प्रभवाङ्कयुग्ममेवं सुसूक्ष्मं परिकल्पितं यत् ।
तदङ्कयुग्माहितसूत्रमेव पूर्वापराशाप्रभवं सुसूक्ष्मम् ॥ ४ ॥

एवं क्षेत्रस्य मध्ये सुविहितमिह यद् ब्रह्मसूत्रं तदाहु-
स्तन्मध्येऽन्योन्यमन्तर्गतमथ रचयेद् वृत्तयुग्मं च धीमान् ।
तद्योगात् तिर्यगुद्यज्झषजठरसुषुम्नाध्वना सूत्रमेकं
याम्योदग्गामि सूक्ष्मं रचयतु यमसूत्रं तदित्यामनन्ति ॥ ५ ॥

तत्सूत्रद्वितयेऽथ दिक्षु चतसृष्वङ्कान् समं कल्पयि-
त्वाङ्कारोपितमध्यकानि सुसमं चत्वारि वृत्तानि च ।
सिध्यन्त्यत्र विदिक्षु वृत्तयुगलीयोगेन मत्स्याः शिवा-
न्यग्रास्तद्गतसूत्रयुग्ममपि चात्राभ्यश्रमाकल्पयेत् ॥ ६ ॥

सूत्रे प्रागुदगग्रके क्षितितले कृत्वा चतुःखण्डिते
खण्डे कल्पयतु द्विजादिवसतिं शार्वेऽथ वा नैर्ऋते ।
क्षेत्रे विस्तृतिरस्ति चेत् पुनरपि श्रुत्यंशिते गृह्यते
शैवे नैर्ऋतखण्डमेव निर्ऋतौ शैवं शुभं चोभयोः ॥ ७ ॥

धात्रीतलेऽभ्यंशिनि मानुषाख्यं गृहाभिवृद्धिप्रदमैशखण्डम्
देवाह्वयं नैर्ऋतमिष्टदं स्यादुभे शुभे गेहविधौ नराणाम् ॥ ८ ॥

आग्नेयखण्डं यमसंज्ञितं स्यान्मृतिप्रदं चाखिलवर्ज्यमेतत् ।
वायव्यमप्यासुरसंज्ञितत्वान्निन्द्यं विशां क्वापि च गृह्यते तत्

भूपादिवर्णनियमेन यमोदगाया-
मोपेतमध्यचतुरश्रमहीतले तु ।
कर्णाध्वना निर्ऋतिमारुतकोणमूल-
शैवानलाग्रभवसूत्रयुगं हि रज्जुः ॥ १० ॥

सूत्रस्य रज्ज्वोरपि चाग्रमूलैर्विद्धे गृहादिस्थितमध्यसूत्रे ।
हीनायतिप्राङ्गणतश्चतुःशालागारतोऽन्यत्र भवन्ति दोषाः ॥

प्रागादि क्रमशः स्याद् वेधफलं पतिवियोगकुष्ठरुजौ ।
रिपुपीडात्मजधनहान्यनिलरुजः स्वकुलधान्यहान्याद्याः ॥१२॥

क्षेत्रस्यैशादिखण्डे नवकृतिपदसम्भिन्नवास्त्वङ्गकोष्ठ-
ष्वेकस्यार्कांशतः स्याद् विततिरिह महासूत्ररज्ज्वोः प्रसिद्धा ।
तत्तद्दिग्वर्गकोष्ठैर्विहितशतपदेष्वेककोष्ठे भगागो
विस्तारं सूत्ररज्ज्वोरहिकृतिपदभिन्नेष्वथैकांशभागः ॥ १३ ॥

समस्तगेहाङ्गणकूपवापीद्वारादिमध्यस्थितसूत्रवेधः ।
मिथः समस्तेष्वपि वर्जनीयो रज्ज्वोश्च कोणालयकर्णयोश्च ॥

वीथीविस्तृतिकल्पनासु बहुधा दण्डो भवेन्मेदिनी-
विस्ताराद् गृहकर्तृपूरुषसमोत्सेधोऽत्र तालो मतः ।
तालैस्तैर्दशनन्दवारणमितैर्दण्डस्त्रिधा तेषु त-
द्वीथीविस्तृतिमेकतो वितनुयाद् यद्यस्ति भूविस्तृतिः ॥१५॥

नन्दद्वन्द्वपुटेन वा वृतितया बाह्यादिमध्यान्तिमा
वीथ्यः स्युः परितः पिशाचदितिपद्दित्याधिभूदण्डगाः

१. 'लतं वा' ग. पाठः.

नागाग्न्यम्बुविनायकद्रुहिणनाम्नां चासु निन्द्याः स्मृताः
पैशाचाग्न्यहिदण्डिनां गृहविधौ वीथ्यश्चतुर्दिक्ष्वपि ॥ १६॥

यावत् कल्पितमङ्गणं गृहविधौ स्वार्धान्विता तावती
वीथीविस्तृतिरुत्तमाङ्गणसमा मध्या तदल्पाधमा ।
क्षेत्रेऽल्पे पुनरङ्गणार्धविततां वीथीं प्रकुर्यात् तदा
प्राच्योदीच्यगृहं भवेत् सलिलवीथ्यारूढमेवं च वा ॥

क्षेत्रेऽत्यल्पे तु मध्येऽङ्गणमपि च कृतान्तात्मभूसूत्रयोगात्
किञ्चिन्नीत्वा स्वगत्यापि च भवनचतुष्कं कृतं दृश्यते च ।
अत्यल्पा एव वीथ्यो ह्यशुभशुभफलान्येवमेवाल्परूपा-
ण्यस्मादीशादिखण्डाद्यधिगतनववीथीविधिर्नेष्यतेऽत्र ॥

यावत् प्राङ्गणदैर्घ्यमानममुनैकाध्यर्धवीथीततं
तेनाष्टादशभूमिमानमिति वा क्षेत्रावितिरन्तः क्रमात् ।
मर्यादानियमप्रहीणमनुजागारेऽपि तत्प्राङ्गणा-
देवं क्षेत्रमितिं करोतु च पुनर्वप्रान्तमौचित्यतः ॥ १९ ॥

एकीकृत्य गणेशपङ्कजभुवोर्वीथीमथैशेऽथवा
खण्डे नैर्ऋतकेऽत्र वास्तुपदमेकाशीतिखण्डात्मकम् ।
यद्वा नागकृतिप्रभिन्नमथवा दिग्वर्गखण्डोदितं
कुर्यादेकमिहाङ्गमर्मरचनां वास्तोश्च तद्देवता ॥ २० ॥

नाड्यः प्रागुदगग्रगा दश दशैकाशीतिकोष्ठे शिवा-
ग्न्यग्राः पञ्च पृथङ् नवोर्मिगुणकोष्ठस्थास्तथा रज्जवः ।

१. 'स्वोल्पत' क. पाठः. 'स्वोच्चत' ख. पाठः.

मर्माण्यष्टरसाशुगाङ्घ्रिगुणसङ्ख्यानैरकोष्ठस्थितैः
सूत्रैर्योगसमुद्भवानि तु शतं वर्ज्यानि कुड्यादिषु ॥ २१ ॥

प्राग्वोदक्पदभास्करांशदलमात्रं मर्मसूत्रस्थितै-
र्नीत्वा विन्यसनाच्च मर्मपरिपीडा स्तम्भकुड्यादिषु ।
वास्तुन्यत्र निपीडिते महिषसिंहानेकपानां शिरो
हैमं कूर्मवराहयोश्च निखनेत् तच्छान्तये शान्तिकृत् ॥

एकाशीतिपदे प्रकल्प्य नवकं मध्येऽस्य बाह्यावृतौ
षट्कं दिक्षु विदिक्षु युग्मयुगलं चैकैकशस्तद्बहिः ।
चत्वारिंशदथैषु पञ्च च विरिञ्चाद्याः पदेषु स्थिता
बाह्येऽष्टावपदस्थितास्त्र्यधिकपञ्चाशत् स्युरेवं सुराः ॥ २३ ॥

ईशाद्यं बहिरावृतिस्थपदकेष्वीशानपर्जन्यका-
वैन्द्रीन्द्रौ रविसत्यकौ भृशखगैव्यादांस्तथा पूषणः ।
भूयो वै वितथं गृहक्षतयमौ गन्धर्वभृङ्गौ[1] भृगं
पित्राख्यान् प्रतिहारपालमपि सुग्रीवं क्रमात् कल्पयेत् ॥

भूयः पुष्पादिदन्तं वरुणमसुरशोषाख्यरोगेरनागान्
मुख्यं भल्लाटमिन्द्रर्गलमदितिदिती चेति बाह्यावृतौ स्युः ।
ईशाद्यावापवत्सार्यकसवितृकसावित्रसंज्ञौ विवस्वा-
निन्द्राख्यश्चेन्द्रजिन्मित्रकशिवशिवजिद्भूभृतोऽन्तर्वृतौ स्युः ॥

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१. 'गौ', २. 'खमु' (!), ३. 'वृति स्युः' ग. पाठः.

ब्रह्मा मध्यपदेऽथ शर्वसहितः स्कन्दोऽर्यमा जृम्भकः
प्रागादौ पिलिपिञ्छकश्च चरकीशादौ विदार्याह्वयौ ।
भूयः पूतनिका च पापपदपूर्वा राक्षसी बाह्यत-
श्चैतेऽष्टावपदस्थिताश्च परितो देवग्रहास्तद्बहिः ॥ २६ ॥

आसीद् दैत्यः प्रवृत्तो निजभुजबलवीर्याविनाक्रान्तकाष्ठा-
निष्ठो द्वेष्टा सुराणां स तु युधि पतितो विद्धगात्रो धरित्र्याम् ।
व्याप्तः सर्वत्र पश्चाद् बहुतरपरिवृत्त्यैव पृथ्वीं विमथ्नन्
मर्त्या दुःस्था मुनीन्द्रास्त्वपि च मग्नभुजस्तावदेवं बभूवुः ॥

सर्वव्याप्तेऽप्यमुष्मिन्नतनु तनुघटाभ्यन्तरे व्योम यद्वत्
तद्वन्नित्यं विशेषान्नगरपुरमहीक्षेत्रखण्डाङ्गणादौ ।
उत्ताने नैर्ऋताशाविनिहितचरणे यावदीशात्तशीर्षे
जाते तावन्निषेदुः स्थिरमिह विबुधास्तस्य देहे क्षणेन ॥

मूर्ध्नीशोऽस्य तु संस्थितो नयनयोः पर्जन्यकश्चादिति-
श्चापस्तद्वदने तथा गलतले तस्यापवत्साह्वयः ।
वामश्रोत्रगतो जयन्त इतरश्चास्यादितिः संस्थिता
वामांसे स्थितवानथार्यमपतिरप्यंसेऽर्गलो दक्षिणे ॥ २९ ॥

अर्कादयो वामभुजस्थिताः स्युश्चन्द्रादयो दक्षिणहस्तगाश्च ।
वामप्रकोष्ठे सविता च सावित्रोऽन्यत्र रुद्रः शिवजित् प्रकोष्ठे ॥

महीधरार्यौ कुचयोर्विवस्वान् मित्रश्च कुक्षौ द्रुहिणोऽथ नाभौ ।
इन्द्रोऽस्य मेढ्रेऽण्डयुगे तु तज्जित् पादद्वये तस्य परे प्रविष्टाः ॥

१. 'विठिवञ्छकं च च' ग. पाठः. २. 'यः' ख. ग. पाठः.

ता देवता वास्तुशरीरसंस्थाः सन्तर्पितास्त्विष्टफलप्रदाः स्युः ।
ताश्चेदनिष्टा विपरीतदाः स्युस्तस्माद् विदध्यादिह वास्तुपूजाम् ॥

इति मनुष्यालयचन्द्रिकायां दिङ्निर्णयादिशुभवीथी-
परिग्रहवास्तुदेवतानिर्णयो नाम
द्वितीयोऽध्यायः ।

अथ तृतीयोऽध्यायः ।

शिखिः साष्टतिलैर्यवोदरमिति प्राहुस्तदष्टोन्मितं
मात्राख्याङ्गुलमङ्गुलैरिनमितैः प्रोक्ता वितस्तिस्ततः ।
तद्द्वन्द्वं करकिष्कुरत्निभुजदोर्मुष्ट्यादिसंज्ञं तत-
स्त्वेकैकाङ्गुलवृद्धितोऽङ्गुलत्रिशपादप्यथो भिद्यते ॥ १ ॥

मात्राख्याङ्गुलिपञ्चविंशतिमितं मानं विमाने स्मृतं
प्राजापत्यकसंज्ञितं सुरगृहे तेनापि मेयं क्वचित् ।
एतैरेव वराङ्गुलैः परिमितं षड्विंशतिप्रोन्मितै-
र्मानं क्वापि समस्तधाम्नि विहितं नाम्ना धनुर्मुष्टिकम् ॥

सम्प्रोक्ताङ्गुलिसप्तविंशतिमितं मानं यदुक्तं बुधै-
र्नाम्ना तत्तु धनुर्ग्रहं यदमुना ग्रामादिकं मीयते ।
रथ्याध्वोपवनादिसम्मितिविधौ वापीतटाकादिके
चेष्टं तत्र धनुर्ग्रहं त्वथ धनुर्मुष्टिश्च तत्रेष्यते ॥ ३ ॥

अष्टाविंशतिसंमिताङ्गुलिमितं प्राच्याख्यमानं भवेद्
वैदेहं नवविंशतिप्रतिमितैर्मात्राङ्गुलैः सम्मितम् ।

१, २. 'नुग्रहं' क. ख. पाठः.

स्याद् त्रिंशत्प्रवराङ्गुलीपरिमितं वैपुल्यमेकाङ्गुली-
युक्तं तत्तु भवेत् प्रकीर्णमिति दोर्मानप्रभेदोऽष्टधा ॥ ४ ॥

भूसुरकार्ये निलये धनुर्ग्रहं च प्रकीर्णं च ।
वैपुल्यधनुर्मुष्टी भूपानां मानसाधने योज्ये ॥ ५ ॥

प्राजापत्यं च वैदेहं वैश्यानां सम्मतं भवेत् ।
किष्कुः प्राच्यं च शूद्राणां किष्कुः सर्वत्र संमतः ॥ ६ ॥

स्वस्वोक्तमानादुपरि प्रदिष्टं सर्वं न चेष्टं क्षितिपादिकानाम् ।
अधरस्थमानं सकलं क्रमेण वैश्यक्षितीशद्विजवर्णयोग्यम् ॥७॥

सुरालये समस्तान्यप्यभीष्टानि यथेप्सितम् ।
मानानि श्रेष्ठमध्याधमाङ्गुलोत्थानि च क्वचित् ॥ ८ ॥

यवोदरैरष्टभिरुन्मितं यन्मात्राङ्गुलं तत् कथितं वरिष्ठम् ।
क्रमेण सप्तांशयवोदरैर्यत् तन्मध्यमं चाधमसंज्ञितं च ॥ ९ ॥

षाष्टिकशाल्युदरैरप्यष्टाद्यैर्वैराङ्गुलाद्यं वा ।
तच्छाल्यायतजलधिः सार्धत्रितयं त्रिसंमितैर्वापि ॥ १० ॥

नवधेत्युदिताङ्गुलिप्रभेदा नवधा तत्र कराः स्युरुत्तमाद्याः ।
अथ तेऽङ्गुलिवृद्धितोऽष्टधोक्तैः करभेदैः सहिता द्विसप्ततिः स्युः॥
आदौ चतुर्विंशतिसंमितैर्यो मात्राङ्गुलैरुक्तकरः स एव ।
सर्वत्र पूज्यो मतभेदतोऽन्ये सर्वेऽपि च क्वापि यथार्हमिष्टाः ॥
हस्तेनैव गृहाद्यमुक्तमुदितं कुत्रापि मात्राङ्गुलै-
स्त्यावश्यकतो यवैरपि परीणाहं च गत्यादि च ।

१. 'नुग्रहं' क. ख. पाठः.

मानुष्येषु तु बाह्यगेहगतिनिष्ठादौ चतुर्हस्तको
दण्डो यष्टिरिति स्मृतोऽष्टगुणितो दण्डोऽत्र रज्जुर्भवेत् ॥१३॥

तालाद्यैः प्रतिमादिकं खलु यवैर्मेयं च भूपादिकं
वस्त्रप्रावरणांशुकादि परिमेयं स्याद् वितस्त्या तथा ।

शस्त्राद्यं तदनामिकाङ्गुलियुगेनैवं च तद्व्यासतो
मुष्ट्या याज्ञिकभाजनादि यजमानस्यान्यदङ्घ्र्यादिना(म् ?)॥

द्विजभवनादिबहुत्वाद् ग्रामाद्याः सम्भवन्ति बहुभेदाः ।
उत्तममध्याधमतो मानविशेषैश्च सम्भवेदेषाम् ॥ १५ ॥

योजनमितचतुरश्रं भूभागं ग्राममुत्तमं प्राहुः ।
मध्यममर्धप्रमितं *प्रायशोऽधमं ग्रामम् ॥ १६ ॥

नगरस्य सहस्रादि द्विसहस्रान्तं च दण्डमानं स्यात् ।
पत्तनसंज्ञं तद्वत् पोतान्वितवारि(नि)धितटोपेतम् ॥ १७ ॥

पुरमिति नरवरभवनप्रधानमाहुर्वणिग्जनादियुतम् ।
नगरं राजवरालयसकलजनागारमण्डितं विदितम् ॥ १८ ॥

एकविप्रवरागारतत्कुटुम्बसमन्वितम् ।
एकभोगं भवेद् ग्रामं तद्भृत्यायतनावृतम् ॥ १९ ॥

ग्रामाद्यखिलं द्विजभवनादिबहुत्वादनेकधा ज्ञेयम् ।
मानविशेषैरुत्तममध्याधमसंज्ञितं च सम्भवति ॥ २० ॥

उत्तरयुगबाह्यान्तो मन्दिरविस्तार एव देवगृहे ।
श्रेष्ठो दण्डस्तद्वज्जगति प्रान्तावसानिको मध्यः ॥ २१ ॥

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* इह 'तदर्धकम्' इत्यपेक्षितं भाति ।

पादुकयुगलावधिको दण्डः प्रोक्तोऽधमः सुरागारे ।
प्रासादाद् बहिरेतैर्मर्यादाः पञ्च तत्र कल्प्याः स्युः ॥ २२ ॥

यानाङ्गादिषु केतुरेव विहितः सर्वत्र शस्तो ध्वयं
पर्यङ्कादिषु कुञ्जरो मृगपतिः पीठासनादौ हितः ।
भाण्डे कूपतटाकपञ्जरविधौ योनिर्वृषो वा ध्वजो-
ऽथाश्वत्थादिसमस्तकुट्टिमविधौ केतुर्विधेयः सदा ॥ २३ ॥

अन्तर्योनिर्मानपात्रादिवापीकूपादीनामङ्गणे गर्भगेहे ।
तुर्यश्चागारोत्तरव्यासमध्ये कुत्राप्युक्तोऽन्यत्र सर्वत्र बाह्ये ॥

इष्टातानवितानमाननिचये त्रिघ्नेऽष्टभिर्भाजिते
शेषो योनिरिह व्ययो गुणियुजाथायोऽष्टनिघ्नेऽर्कणैः ।
ऋक्षं वह्निसमाहते तु नवभिः शेषं तिथिस्त्रिंशता
वारो भूमिधरैर्निधिप्रगुणिते धर्माहृते वा व्ययः ॥ २५ ॥

ध्वजधूमसिंहकुक्कुरवृषखरगजवायसाः क्रमेण स्युः ।
प्रागादियोनयोऽष्टौ तेष्वयुजः सम्पदे युजो विपदे ॥

केतुयोनिरभिवाञ्छितार्थदः
सात्त्विकोऽमरगुरुर्द्विजो भवेत ।
पूर्वदिक्ष्वभिहितोऽपि सर्वदा
सर्वदिक्ष्वविहितो विशेषतः ॥ २७ ॥

सिंहो दक्षिणदिक्स्थितः क्षितिसुतो लक्ष्मीप्रदस्तामसो
भूपोऽथो वणिगुत्तरे शुभकरो दन्ती बुधो राजसः ।

शूद्रः पश्चिमदिक्स्थितोऽर्कतनयो धान्यप्रदस्तामसः
सम्प्रोक्तोऽथ विदिक्षु ये निगदितास्तत्रापि ते निन्दिताः॥

उद्वेगः स्याद् धूमे शुनि कलहश्चपलता खरे भवति।
ध्वाङ्क्षे कुलहानिः स्यात् सर्वविदिग्योनयस्ततो निन्द्याः॥२९॥

प्राच्यां केतुर्विधेयः स तु भवति विधानेषु सर्वत्र नित्यं
शालायां दक्षिणस्यां मृगपतिरुदितः केतुयोनिश्च योग्यः।
मातङ्गः केतुसिंहावपि च वनपतौ पश्चिमे स्याद् वृषोऽन्ये
केतुः सिंहो गजश्चापि च निजनिजकोणालयेऽप्येवमेव॥

योनिः प्राणा एव धाम्नां यदस्माद्
ग्राह्यस्तत्तद्योग्ययोनिप्रभेदः।
मृत्युर्वर्ज्यः सर्वगेहेष्ववश्यं
सर्वव्यापत् प्राप्यतेऽस्मिन् गृहीते॥ ३१॥

आयाधिक्यं व्ययतः समाप्य गर्भादयथापत्तिः।
नक्षत्रादिशुभत्वं ज्योतिःशास्त्रादिभिः सुविज्ञेयम्॥ ३२॥

बालत्वं कौमारं यौवनमथ वार्द्धकं च निधनं च।
पञ्च वयांस्येष्वन्त्यं नेष्टं शिष्टानि वास्तुनीष्टानि॥३३॥

द्वेधा योनिश्चतुर्धा व्ययविधिरुदितश्च द्विधायो वयश्चा-
प्यृक्षं विप्रादिवर्णास्तिथेरपि च तथा राशयो द्विप्रकाराः।
त्रेधा वारो ध्रुवादिस्त्रिविध इति विकल्पेन योन्यादयः स्युः
प्रोक्तेष्वेतेषु पूर्वोदितमखिलमतं कार्यमावश्यकेऽन्यत्॥३४॥

सामान्यं परिणाहतः सुविहिता योन्यादयो दीर्घतो
विस्तारेण च पादमानचरणाधिष्ठानतुङ्गैरपि।

केवलनाहेऽद्रिहते त्रिघ्ने नाहे च शिष्यते वा [illegible]

द्विघ्ने वा त्रिघ्ने वा नाहे नृपभाजिते ध्रुवाद्याः स्युः ॥ ४१ ॥

क्षेत्रफले व्ययुक्ते नृपभक्ते वा ध्रुवादयः शिष्टाः ।

ध्रुवधान्यजयविनाशाः खरकान्तमनःप्रसादसुमुखत्वम् ॥ ४२ ॥

सौमुख्यासौम्यत्वे विरोधवित्तोरुक्षयाक्रन्दाः ।

वृद्धिजयौ च क्रमशः संज्ञातुल्यं फलं भवेदेषाम् ॥ ४३ ॥

इति मनुष्यालयचन्द्रिकायां मानभेदयो-

न्यायव्ययादिनिर्णयो नाम

तृतीयोऽध्यायः ।

अथ चतुर्थोऽध्यायः ।

स्वाभीष्टालयदीर्घमङ्गणविधिं तेषां पृथङ् नाहतो

योन्यायर्क्षवयोव्ययादि शुभदं सर्वप्रकारादपि ।

सम्पाद्याथ गृहेऽष्टदीर्घगुणविस्तारादिभेदान् पृथग्

दीर्घव्यासमितिं करोतु च यथात्राल्पान्तरालं सुधीः ॥ १ ॥

इष्टाद् दीर्घात् सर्वधाम्नां च नाहो

विस्तारोऽस्माद् विस्तृतेः पादमानम् ।

तस्मान्मासूरं च तच्छेषतः स्यात्

स्तम्भः स्तम्भाद् विस्तृतिश्चोत्तराणाम् ॥ २ ॥

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१. 'वधनधा' ख. पाठः.

तत्तदुत्तरविस्ताराल्लुपानीप्रादिविस्तृतिः ।
उत्तरादेर्घनं तत्तद्विस्तारादेव कल्प्यते ॥ ३ ॥

षड्हस्तादिनिजेष्टदीर्घकरसङ्ख्यानेऽष्टनिघ्ने स्वदिग्-
योन्याढ्ये सति तत्त्रिभाग इह तद्गेहस्य नाहो भवेत् ।
व्यत्यासक्रियया भवेदपि च तद्दीर्घोऽथ नाहेऽर्धिते
दीर्घोने परिशिष्यतेऽत्र विततिः सर्वत्र मर्त्यालये ॥ ४ ॥

स्वाभीष्टदीर्घहस्ते द्विघ्ने सति तत्त्रिभागसंयुक्ते ।
स्वाभीष्टयोनिसङ्ख्याष्टांशयुते नाह इति च सम्भवति ॥ ५ ॥

नाहाङ्घ्र्यंशेन दीर्घो विततिरपि भवेत् तुल्यवेदाश्रगेहे
नाहार्धे नन्दभक्ते विततिरुदधिभागैश्च दीर्घो विशिष्टैः ।
स स्यात् पादाधिकोऽर्धाधिक इह परिणाहेऽर्धिते दिग्विभक्ते
षड्भिर्दीर्घश्चतुर्भिर्विततिरिति सुरागारयोग्यास्त्वमीऽसौ ॥ ६ ॥

पादाधिको मनुजसद्मनि गृह्यते त-
त्रावश्यके समततायतिकोऽपि कैश्चित् ।
अर्धाधिकोऽत्र न हितो मुनिभिः समस्त-
पादोनतापि कथिताखिलनाशिनीति ॥ ७ ॥

नाहार्धे द्वादशाद्यैस्त्रिभिरपि च विभक्तेऽथवा षोडशाद्यै-
र्विंशत्याद्यैश्च तत्त्वादिभिरपि मनुयुग्मादिभिर्दन्तसङ्ख्यैः ।
तत्तत्तुर्यप्रहीणैरथ विततिरुदध्यंशतः शेषभागै-
र्दीर्घो वस्वङ्कपङ्क्त्यादिभिरपि गुणविस्तारमाहुर्मुनीन्द्राः ॥ ८ ॥

नाहार्धे शिवभक्ते विततिस्त्रिभिरष्टभिश्च दीर्घो वा ।
दीर्घोर्धादधिकतरं व्यासं नेच्छन्ति गर्गदक्षाद्याः ॥ ९ ॥

चत्वारोऽत्र तु दिग्गृहाः पृथगथो कोणालयाश्चैवमि-
त्यष्टावेव नृणां गृहा मुनिमताः संस्थानभिन्नास्ततः ।
भिद्यन्ते नवधोत्तरस्य गतिभिर्मानेन नामादिभि-
श्चैतेषां द्वितलादिलक्षणविधौ मानानि तान्येव च ॥ १० ॥

भिन्नाभिन्नवशाद् द्विधैव विदिता शालात्र भिन्ना पृथग्
दिक्स्था स्वाङ्गविशेषपूर्णविभवा कोणालयासम्भवात् ।
अन्तर्बाह्यभवोत्तराभिमिलनादेकीभवेत् कोणगे-
हापर्यन्ततलसङ्कुचो भवति यत्राभिन्नशालैव सा ॥ ११ ॥

शालास्त्वन्योन्यभिन्ना निजविहितगतिव्याससयोन्यादियुक्ताः
पर्युद्यत्पत्रमानावधिनिहिततलसत्पादुकाभिन्नशालाः ।
सर्वार्हास्ता विशेषादवनिसुरहिताः कोणवेश्मप्रहीणा-
स्तत्रापि प्राङ्गणं केतुजमिति विदिता भिन्नशाला विशुद्धाः ॥

मित्रे दक्षिणपश्चिमे पुनरुदक्प्राच्ये च गेहे मिथ-
स्तस्मात् तद्युगलोत्थकोणनिलयः शेषो विधेयोऽपि च ।
अन्यत् कोणयुगं तथैकमथवा न श्लेषयेत् सूतिका-
शूद्राद्यागमनिष्क्रमार्थमुदितो मार्गोऽयमेवात्र तु ॥ १३ ॥

एकद्वित्रिककोणश्लेषवशाच्छिष्टभिन्नशाला स्यात् ।
धरणीदेवहिता साप्यखिलार्हा भिन्नमिश्रभावेन ॥ १४ ॥

दिग्गेहोत्तरपृष्ठसंहितविदिग्गेहोत्तराणि क्रमा-
न्नन्द्यावर्तपदप्रदक्षिणगतीन्यातस्य संयोजयेत् ।
अन्तःस्थोत्तरयोगनाहमिह सर्वत्रापि केतूर्ध्वं
बाह्यस्थं च तथैव चेदतिशुभं संश्लिष्टभिन्ना त्वियम् ॥

१. "श्च" क. ग. पाठः.

सर्वत्रापि च कोणगेहपरिणाहाप्त्यै स्वदिग्योनिरे-
वोक्तस्तत्र विदिग्गृहास्तु सकला जन्या भवन्त्येव हि ।
दिक्शालाजनका भवन्ति च ततः केतुर्भवेदीश्वरे
सिंहोऽग्नौ निर्ऋतौ वृषः करिवरो वायौ नृणां धामनि ॥ १६ ॥

एवं संश्लिष्टभिन्नालयविधिवदथाकल्प्य सर्वोत्तराणि
स्वोक्तैर्दिग्योनिभिश्चैव च परिधिमुपादाय कोणालयानाम् ।
दिग्गेहान्तान्तराले पृथगपि च महाद्वारमध्यं विनान्य-
त्रादध्यात् कोणगेहोत्तरमपरिमितिश्लिष्टभिन्नाष्टशाला ॥

कोणगृहोत्तरयोगः सन्धिगृते दिग्गृहोत्तरान्तेषु ।
यत्र स्यात् तत्र भवेद् भिन्नत्वं तद्गृहाश्चतुर्धेति ॥ १८ ॥

दीर्घव्यासाद्यभावे पृथगथ विधिवत् सन्ति कर्मोक्तनीत्या
सन्धायाकोणगेहावधि बहिरुदितान्युत्तराण्यत्र धीमान् ।
आधारीकृत्य पूर्वोपरनिलयबहिष्ठोत्तरस्याग्रमूला-
वाधेयत्वेन चान्यद् द्वितयमिति चतुष्कोणसन्धि विधाय ॥

नाहं केतुजमेवमत्र बहिरप्यन्तश्च कृत्वा विदिग्-
गेहान्तर्विहितोत्तरैर्विरहितं त्वन्तःस्थकोणेष्वपि ।
सन्दध्याद् बहिरुत्तरोक्तवदिदं स्यान्मिश्रभिन्नं चतुः-
शालं दिङ्निलयाः स्वयोनिगतिभिर्युक्ताः समस्ता अपि ॥

कोणेषु सर्वनिलयोत्तरयोगभेदा-
न्मिश्रत्वमत्र तु विदिग्गृहहीनभावान् ।

दिङ्मन्दिराणि निजयोनिगतिप्रभेदै- [illegible]
युक्तान्यमूनि यदतोऽपि च भिन्नतात्र ॥ २१ ॥

पर्यन्तध्वजमादधीत बहिरप्यन्तश्च तत्पत्रमा-
नान्तश्चाङ्गणनाहमप्यथ बहिर्नाहं च दिग्धामसु ।
कोणागारगतोत्तरान्तरुदितं नाहं च केतूरवं
युक्त्या तूत्तरविस्तृतिं च जनयेत् संमिश्रभिन्नालये ॥

मानाद् बाह्यान्निजेष्टाद् रहयतु मितिमाभ्यन्तरीं शेषमानात्
कोणाभ्यश्चोदरोद्यत्कुजमपि शितधीरष्टनिघ्नं विजह्यात् ।
तच्छेषादुत्तराणामपि जनयतु विष्कम्भमष्टयंशतोऽमू-
न्यापर्यन्तायतान्याकलयतु च चतुर्दिक्षु बाह्यान्तराणि ॥

प्राग्वत् प्राङ्गणपत्रमानबहिरन्तर्नाहकोणालयाः
केतूत्था हि दिगालयास्तु निजयोन्याढ्याः सगर्भान्विताः ।
राजार्हं तदपीह मिश्रकचतुःशालं नृगेहं विदु-
र्दिक्शाला निजयोनिजा यदखिलार्हं तद् द्विजेष्टं न वा ॥

तुल्यातानवितानताङ्गणविधौ गत्वा विनान्तर्बहि-
र्योगे तूत्तरपत्रमानपरिणाहोऽप्यस्तु केतूद्भवः ।
केतूत्था अपि दिग्विदिङ्निलयनान्तर्बाह्यनाहाः स्वम-
ध्योद्यद्द्वारपदा भवन्ति च चतुःशालं गृहं भूभुजाम् ॥

कश्चिच्चतुःशालगृहे समस्ते सर्वोत्तराणामपि मध्यसूत्रे ।
नाहो विधेयो यदि तत्तु मध्यप्ररूढमानं भवनं वदन्ति ॥

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१. 'त्था' क. पाठः.

एकं स्याद् यदि दक्षिणं गृहमुभे चेत् तच्च पाश्चात्त्यकं
ते सौम्यं च गृहत्रिके गृहचतुष्के प्राच्यमेतानि च ।
वाञ्छन्ति क्वचिदेकमेव भवनं यद्यत्र पाश्चात्त्यकं
चेष्टं गेहयुगादिनिर्मितिविधौ प्रागुक्तवत् कल्प्यताम् ॥

प्राक्शालारहितं गृहत्रिकमथो सुक्षेत्रमत्यृद्धिदं
चुल्लीदक्षिणमन्दिरेण रहितं तद् वित्तहानिप्रदम् ।
ध्वंसः पश्चिमशालया विरहितं पुत्रक्षयारिप्रदं
सौम्योनं तु हिरण्यनाभमिति तद् वित्तप्रदं सर्वदा ॥

प्राक्पाश्चात्त्यविहीनके कलहमुद्वेगं च कौचाभिधे
याम्योदग्रहितेऽर्थसिद्धिरुदिता सिद्धार्थकाख्ये द्विके ।
प्रागादिद्वितयोनिते क्रमवशान्मृत्युं भयं विक्रमं
चार्थासिं प्रवदन्त्यतः क्रमवशाद् याम्यादिकं कल्पयेत ॥

इति मनुष्यालयचन्द्रिकायां गृहाणामिष्टदीर्घपरिणाहदीर्घ-
विस्तारशालाभेदादिनिर्णयो नाम
चतुर्थोऽध्यायः ॥

अथ पञ्चमोऽध्यायः ।

कुर्याद् गृहाय कृतवास्तुपदं समस्तं
मातङ्गभारकरनृपाङ्गुलमात्रतुङ्गम् ।
बाह्यान्तराङ्गणगतान् गमनाय मध्य-
निम्नत्वदोपविरहाय च मृच्छिलाद्यैः ॥ १ ॥

१. 'नाभिरिति' क. ख. पाठः. २. 'कोपाभि' ग. पाठः.

रक्षाशोभोच्छ्रयार्थं सकलनिलयमारूरतोऽधः समन्तात्
कुर्यादेकद्विहस्तप्रविततमुपपीठं गजाद्यङ्गुलाढ्यम् ।
अन्तर्भागे तु गर्ताङ्गणमथ वृषजं केतुजं वायताढ्यं
दिश्यैशान्यामथोदङ्मुखमपि रचयेत् प्राङ्मुखं वाम्बुमार्गम् ॥

गेहाधिष्ठानोच्चतुल्यो रसाग्र-
ष्टाङ्गांशांशैरूनितो वा यथेष्टम् ।
मर्त्यागारस्योपपीठोच्छ्रयः स्यात्
तत्तद्भागैः पादुकाद्यं विधेयम् ॥ ३ ॥

गर्तप्राङ्गणतारतोऽधिककृतायामार्धमप्युत्तरे
निक्षिप्यार्धमवाक् च मध्यचतुरश्रेष्टाष्टकोष्ठात्मके ।
मल्लीकुट्टिममापसंज्ञपदयोः कुर्यात् पदे दक्षिणे
यद्वा तत्पुनरापवत्सपदयोश्चोदक्पदेऽन्तर्वृतौ ॥ ४ ॥

केतूत्थं तुल्यताराततिजलनिधिकोणं च वस्वष्टिकोणं
वृत्तं वा सोपपीठाद्यवयवसहितं कैरवाद्यन्वितं वा ।
गेहाधिष्ठानतुङ्गं कुहचिदपि तदूर्म्यादिरुद्रान्तभागै-
र्हीनं वा रज्जुवेधाद्यपगतमुदितं मल्लिकाकुट्टिमं तत् ॥ ५ ॥

उपपीठोच्चसमोच्चा मासूरोपानहं करोतु दृढम् ।
तदुपरि परितः पादुकमथ कुर्यादुक्तपत्रमानान्ता ॥ ६ ॥

सर्वत्रोत्तरबाह्यपार्श्वविहिताल्लम्बाद् बहिः कुट्टिम-
स्याष्टाष्टाङ्गुलनिष्क्रमो य उदितस्तत् पत्रमानं विदुः ।

१. 'न्तर्विंतौ' ग. पाठः.

यद्वा तद्द्विगुणं च तत्त्रिगुणितं वा तद्विधेयं तथे-
वान्याद्युत्तरयोः षडङ्गुलमदो द्वन्द्वं प्रतीच्यां क्वचित् ॥ ७ ॥

तत्पत्रमानमसमं च समं च बाह्ये-
ऽप्यन्तश्च तद्विहितयोनिकनाहयुक्तम् ।
मर्त्यालयेषु विहितं सुरमन्दिरान्त-
हाराप्रदीपनिलयेषु च गोपुरेषु ॥ ८ ॥

प्राहुर्गेहचतुष्कपादुकबहिर्भागं बुधाः प्राङ्गणं
याम्योदग्विहितायतं च चतुरश्रं केतुयोन्यन्वितम् ।
भूम्यश्वाम्बुधिनागरन्ध्रदिननाथाष्टद्विसङ्ख्याङ्गुलै-
रेकद्वित्रिकरैस्तथैव गुणविस्ताराादिभिर्वायतिः ॥ ९ ॥

सूत्रैः प्राङ्गणगेहमध्यविहितैरन्योन्यविद्धैर्भवेत्
तद्गेहस्थितपुत्रपौत्रविलयस्तस्माद् गृहाणां क्रमात् ।
कर्तव्यं गमनं प्रदक्षिणतया प्रागादितो वह्नि-
न्ध्राद्रीष्वङ्गुलकैः स्वयोनिजनकैरावश्यके वा यवैः ॥

गत्यङ्गुलानि निजदिग्विहितानि यानि
तान्यष्टतद्द्विगुणितत्रिगुणाङ्गुलैश्च ।
युक्तानि तद्दिगुचितानि भवन्ति यत् त-
दल्पान्तरालनिलयादिषु तानि युञ्ज्यात् ॥ ११ ॥

दिक्कोणालयभेदकृन्ति च भवन्त्यष्टान्तरालानि तद्-
बाहुल्यं तु धनक्षयाय हि भवेदत्यल्पता व्याधये ।
मृत्युर्भित्तिविरोधनेऽन्तरविहीनत्वादतः प्रायशो
नेष्टं गेहरसांशतोऽधिकतरं द्व्यङ्गुलोचोनितम् ॥ १२ ॥

नर्णं धामनि पादमानमुदितं स्वस्वोचरोपानहो-
मध्यं साङ्घ्रिकरात्रिकोन्मितमिदं त्वल्पालये दृश्यते।
गेहव्याससमं तदर्धसहितं व्यासाब्धिषट्सप्तव-
स्वङ्काशांशयुतं च तैर्विरहितं चैवं मुनीन्द्रा जगुः ॥ १३ ॥

भक्तेऽस्मिन् पादमाने गुणचतुरिषुषट्सप्तनागाङ्कदिग्भि-
स्तेष्वेकांशो भवेत् कुट्टिममपि च तथेध्मांशिते वा रसांशः।
नन्दद्वन्द्वैः शरांशो दिनकरयुगभक्तेऽद्रिभागो मुनीन्द्रै-
र्द्वयंशं तिथ्यंशिते स्याज्जलधिपरिमितो विश्वभक्तेऽपि चैवम् ॥

मासूरमानानि चतुर्दशैवं भवन्ति तेभ्यः पृथगूनिताश्चेत्।
रसाद्रिनागाङ्कदशेशभागाश्चतुर्युताशीतिमितानि सन्ति ॥ १५ ॥

इष्टाधिष्ठानमाने नवभिरथ विभक्ते त्रिभिः पादुकोच्चं
षड्भिः कुर्याज्जगत्युच्छ्रयमथ नयनाग्न्यंशकैर्वा क्रमेण।
द्वेधैवं मञ्चकं स्यात् प्रतिगलरहितं सर्वतः पादुकस्य
स्वोच्चाङ्घ्रयूनार्धवद्व्यंशत इह शरभक्ते त्रिभिर्निष्क्रमो वा ॥

रसांशिते वाञ्छितकुट्टिमोच्चे प्रकल्पयेत् पादुकमेकतोऽथ।
त्रिभिर्जगत्युच्छ्रयमेकतस्तद्गलं प्रतिं तद्वदिहैकतोऽपि ॥१७॥

सायकांशिनि तु कुट्टिमोच्छ्रये पादुकोच्छ्रयमिहैकभागतः।
द्व्यंशतोऽथ जगतीं गलं प्रतिं चैकतो विरचयेद्यथेति वा॥

देवेन्द्रांशिनि कुट्टिमे द्वितयतः सम्पादयेत् पादुकं
षड्भागैर्जगतीगलाङ्घ्रिमिलया कुर्यादधो वाजनम्।
अब्धिस्थां गलमूर्ध्ववाजनमथान्यंशेन नेत्रांशतः
प्रत्युच्चं गलमञ्चकाभिधमिदं सद्वाजनं भूतिकृत् ॥ १९ ॥

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१. 'मञ्चका' ख. पाठः.

एवं त्रिधोक्तं गलमञ्चकाख्यं प्रतिजगत्या समनिष्कमेव ।
तेषां गलान्तर्गमनं गलोत्सेधाङ्घ्र्यंशतः स्याद् गलमञ्चकानाम्

कृत्वाधिष्ठानमेवं दृढतरमथ तच्छेषितं पादमानं
विद्यादङ्घ्र्युच्चमस्मिन्नृतुतुरगभुजङ्गाङ्कपङ्क्तीशभक्ते ।
एकांशेनान्वितं वा विरहितमथवेतीप्सिताच्चाङ्घ्रिदीर्घा-
दोमासंज्ञाङ्घ्रिपीठोच्चयमपनयता पोतिकाया घनं च ॥२१॥

विन्यस्येत् पादपीठं सुदृढतरशिलासारदारुप्रक्लृप्तं
मासूरोपर्यथाब्ध्यश्रकवसुनृपकोणं क्वचिद् वर्तुलं वा ।
स्तम्भाधोभागकर्णोन्मितविततदूर्ध्वोच्छ्रयं वा तदङ्घ्र्य-
न्यर्धांशोनं च पद्मोपममपि कुहचिद् राजनाद्यन्वितं च ॥

स्तम्भाः स्वविस्तारहुताशभागप्रक्लृप्तमूलाग्रविस्तारसमेताः ।
स्थाप्या यथार्हं निजपीठिकोर्ध्वे [illegible] समन्ताः ॥

स्तम्भोच्चाब्धीषुषड्भूधरवसुनवभिर्भक्तभागैकतः स्यात्
स्तम्भाधोविस्तृतिस्तैर्वसुनवदशरुद्रांशहीनोऽग्रतारः ।
दण्डोऽप्यश्रायमेतेन च कुहचिदथो मीयते दारुक्लृप्तौ
कुड्यस्तम्भाग्रतारोऽप्यथ तदवयवाकल्पने दण्डसंज्ञः ॥

स्तम्भास्तन्मूलतारश्रुतिमितचतुरश्रोर्ध्वभागाः समस्ता
मूलेऽप्यर्धाग्निवेदाशुगरसततिकर्णोन्मिताष्टाश्ररूपाः ।
मध्ये व्यासश्रुतिप्रोन्मितकृतचतुरश्रास्तदूर्ध्वाग्रगेयद्-
वस्वश्राः सर्वतो वर्तुलनृपवसुकोणाश्च यद्वा विधेयाः ॥ २५ ॥

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१. 'पत्यर्धा' ख. ग. पाठः. २. 'ण्डाद्यश्रा' क. पाठः. ३. 'वा स' ख. ग. पाठः.

वृत्तादयस्ते चरणास्त्रयोऽमी मध्यादधस्ताच्चतुरश्रका वा ।
यद्वा वितानश्रवणोपकॢप्तचतुर्थश्रमूलाश्च तथा विधेयाः ॥ २६ ॥

अत्युच्चेऽङ्घ्रौ तु तत्तत्यधिचरणदलद्विघ्नविस्तारमासू-
रेखोच्चाध्यर्धतुङ्गं रचयतु चरणं कुत्रचिन्मध्यतोऽधः ।
कुर्यादेवं शिलाभिः प्रणिगदितसुधाभेदसंमेलिताभि-
र्यद्वा सारिष्टकाभिः क्वचिदखिलसमुत्सेधमर्धोच्छ्रयं वा ॥

एकं वाजनमुत्तरस्य यदि तत् स्तम्भान्तराभ्यश्रकं
नेष्टं संमतमल्पवाजनयुते पत्रान्विते चोत्तरे ।
स्तम्भा मौक्तिकदामशुण्डवलयाद्याढ्यास्तथेष्टास्तयो-
र्गेहाङ्गं च समस्तमुत्तरवशादूर्ध्वाधरस्थं भवेत् ॥ २८ ॥

स्तम्भाग्रोत्तरतारयोगदलविस्तारं तथा स्तम्भम-
ध्योद्यद्व्यासततां च तद्दलघनां रूपोत्तरं पोतिकाम् ।
स्तम्भाग्रोदितदण्डवह्नियुगदीर्घां वाणाथाभिर्वा वोत्तर-
व्यासत्रिघ्नसमायतां कलयतु स्तम्भे लसद्वाजनाम् ॥ २९ ॥

पत्रोत्तरे चेद् विततांऽघ्रिहीनतीव्रा विधेया खलु पोतिकेयम् ।
खण्डोत्तरे तुल्यवितानतीव्रा सर्वाश्च सर्वेषु यथोपशोभम् ॥ ३० ॥

स्तम्भाधस्तारभेदप्रकथनविधिनैवोत्तराणां च तारं
स्वाभीष्टं कल्पयेद् वा वसुवसुयुगलार्कोर्मिसङ्ख्याङ्गुलैर्वा ।
श्रेष्ठं खण्डोत्तरं तद्विततिसमघनं मध्यमं पत्रसंज्ञं
पादोनोच्चं कनिष्ठं विततिदलघनं तत्तु रूपोत्तराख्यम् ॥

१. 'रुद्र' क. ख. पाठः

उत्तरविस्तारघने न्यस्यापि प्रकल्पयेत् क्कापि ।
तत्र तु चूलीति मता तस्यामेवार्पयेत लुपाः ॥ ३२ ॥

एक एव यदि वाजनं भवत्युत्तरस्य शरभाजिते घने ।
उच्चमंशयुगलेन निष्क्रमोऽप्यस्य पट्टमवशिष्टभागतः ॥ ३३ ॥

अल्पवाजनयुतोत्तरे घने नागभागिनि महत् त्रिभागतः ।
एकतोऽल्पमुभयोश्च निष्क्रमः स्वोच्चतो भवति पट्टमब्धिभिः ॥

बाणांशिन्यखिलोत्तरस्य तु घने द्वाभ्यां महद् वाजनं
    चैकेनाल्पमथातनोतु महितं पट्टं च शिष्टांशतः ।
अब्ध्यादीश्वरपश्चिमांशिनि घने सर्वोत्तरस्यैकतो
    युक्त्या वाजनयोश्च निष्क्रममथान्यत्रापि चैवं विधिः ॥

स्तम्भमूर्धनि निधाय पोतिकामुत्तरं तदुपरि प्रकल्पयेत् ।
पोतिकाविवरतः समुद्गतस्तम्भमस्तकशिखाहितावटम् ॥ ३६ ॥

अथोत्तरोच्चोच्चतदर्धतारां क्षुद्रोत्तराख्योत्तरपट्टिकां च ।
सङ्कीलयेदुत्तरबाह्यपश्चादूर्ध्वं दृढैः स्वोचितदारुकीलैः ॥ ३७ ॥

कीलास्ते कूटसूत्रेष्वखिलनिलयमध्येऽपि च द्वारमध्ये
कर्तव्यास्ते समस्ता यवमितगतिभिः सूत्रतोऽतीतमध्याः ।
युक्त्या पङ्क्तिं लुपानां सममपि परिकल्प्याथ मध्ये च तासां
कार्याः कीलास्त्वयुग्माः खलु सकललुपायुग्मसङ्ख्या विधेयाः ॥

एकाङ्घ्रयूनादिदण्डोच्छ्रयमुपरि- निधायोत्तरे वाजनं प्राक्
    तिर्यग्दण्डोच्छ्रयाङ्घ्रयूनितबहलतुलास्तासु वंशानुवृत्त्या ।

१. 'हे त्रि' ग. पाठः. २. 'त' क. पाठः.

स्वाधोक्रान्ता जयन्ती तदुपरि सुसमीकृत्य कृत्वानुवंशं
निश्छिद्रं छादयेत् स्वोचितघनफलकाप्रस्तरेणोर्ध्वभागम् ॥

यद्वा कपोतवलभीविलसत्तुलोलु-
पोद्यत्पिधानफलकादितुलाविशेषैः ।
युक्तं च खण्डफलकादिविचित्रचित्र-
मूर्तिप्रभेदसहितं महितं विदध्यात् ॥ ४० ॥

इति मनुष्यालयचन्द्रिकायां
पञ्चमोऽध्यायः ।

अथ षष्ठोऽध्यायः ।

अल्पे धामनि बाह्यमेव महति त्वारूढमप्युत्तरं
विष्कम्भे तनुयात् स्वगेहविहितैर्योन्यादिभिः संयुतम् ।
वस्वृष्यर्कयुगाङ्गुलादिगतिरन्तः स्यादलिन्दं तु तत्
तावत् स्वोच्छ्रयमस्य कर्णसदृशी विष्कम्भपादायतिः ॥ १ ॥

विष्कम्भपादं तु तदङ्गभेदैर्युक्तं तथा कल्पलतादिचित्रैः ।
महातरङ्गान्तरुदीर्णचूचुक(प्र ?)सूनसंशोभितमातनोतु ॥ २ ॥

कुर्यादुत्तरपट्टतोऽखिललुपालम्बं तदौचित्यतः
स्तम्भोच्चे शरभाजिते द्वितयतो यद्वाङ्कभक्तेऽब्धिभिः ।
अद्र्यंशिन्युरगांशिते च हुतभुग्भागैस्तथाङ्घ्र्युच्छ्रय-
त्र्यंशार्धांशत एव वाभिलषितं पोढोदितेष्वेषु तु ॥ ३ ॥

लम्बोऽयं विहितादधःस्थचरणोच्चेऽङ्गादिरुद्रान्तिमै-
र्भक्ते तेष्विलया युतो विरहितो वाङ्घ्रयुच्चविध्यध्वना ।
यद्वा चन्द्रदिगग्निवारिधिशरोर्म्यद्रयङ्गुलैरूनितो
लम्बोऽसौ क्वचिदन्वितोऽप्युभयतस्तुल्योऽप्यतुल्योऽथवा ॥

विस्तारेण घनेन वापि न लुपालम्बो भवेदुत्तर-
स्यैकेनाधिदलद्वयत्रयचतुर्बाणोर्मिशैलोन्मितैः ।
योगे सत्यपरालयैरपि लुपाच्छेद्याश्च नीप्रादयो
गेहाङ्गेष्वखिलेषु चोत्तममतो नच्छेदयेदुत्तरम् ॥ ५ ॥

ऋजुमञ्चाख्यास्तुल्याः प्रकृतिलुपाः पार्श्वसंस्थिताः सर्वाः ।
कोटयुपकोट्याद्याः स्युर्विकृतिलुपास्तास्त्वतुल्यदीर्घतताः ॥

कार्या लुपाश्चोत्तरपट्टिकोर्ध्वे कूटाहिताग्रा विकृताः समस्ताः ।
पार्श्वाहितास्ताः खलु निर्विकारा निवेशिताग्राः पुनरग्रधान्याम् ॥

पार्श्वप्रान्तलुपाप्रयोगवशतो वंशाख्यया साग्रया
युक्त्वा चोत्तरतारपादरहितव्यासोच्छ्रयं चाथवा ।
अद्र्यूर्म्यङ्गुलतारतीव्रसहिता पत्रैर्लुपातीव्रव-
द्व्यर्ध्यंशप्रमितैर्लुपापदगतैर्युक्ता लसद्वाजना ॥ ८ ॥

कूटः कोटिलुपाग्रकल्पितशिखासम्प्राप्तपार्श्वोवटः
पार्श्वाक्रान्तलुपाग्ररन्ध्रनिहितायःकीलसङ्कीलितः ।
आधारोऽस्य लुपाग्रकल्पितशिखा तस्मादधो मूल ए-
वोक्तोऽसौ विकृता लुपाश्च सकला गेहे समाब्ध्यश्रके ॥

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१. 'दन्वितो' ख. पाठः. २. 'प्रच' क. ख. पाठः.

धुर्धूरप्रसवोपमोऽष्टनृपकोणो वा तथा वर्तुलः

सम्फुल्लाब्जयुतोऽथवाथ गुलिकारूपः स्वमध्यादधः ।

विस्तारद्विगुणायतस्तदुरगांशोनदीर्घोऽथवा

कूटोऽब्ध्यादियवोत्थपत्रविलसन्मध्यप्रदेशो भवेत् ॥१०॥

प्रायः सर्वलुपाघनोन्मितपरीणाहं करोतूत्तर-

व्यासप्रायततं तथाङ्गुलकृतैर्योन्यादिभिः संयुतम् ।

पट्टं कोटिलुपावितानसदृशायामं लुपासङ्गम-

स्थानं पत्रपदोर्ध्वमित्थमुदितं कूटस्वरूपादिकम् ॥ ११ ॥

आयतचतुरश्रगृहे विकृतिलुपा वंशबद्धकूटगताः ।

वंशस्थाग्रास्त्वन्याः प्रकृतिलुपाः कीलिता ह्ययःकीलैः ॥१२॥

वंशाग्रमूलशिखया यदि कूटपार्श्व-

रन्ध्रप्रवेशकृतसन्धिरिहाजयुक्तः ।

आधारभेदकृतसन्धिवशेन कूट-

स्याधोगतं भवति मूलमिहापि नित्यम् ॥ १३ ॥

मुखसहितायतभवने मुखपर्यन्तायतो भवेद् वंशः ।

गेहवदेव मुखानामुत्तरमूलाग्रयोगविधिनियमः ॥ १४ ॥

मूलप्रदेशविलसत्कदलीसुलग्न-

वंशाग्रमूलपरिकीलितदारुकीलः ।

वंशावलम्बितवशादयमूर्ध्वमूलः

कूटो यथोर्ध्वमवलम्बितबालकूटः ॥ १५ ॥

सर्वत्रेष्टाभ्यश्रे तिर्यगधः कल्पितात्र रेखा या ।

सा हि भुजाथोर्ध्वाग्रा कोटिः स्यात् कोणगामिनी कर्णः ॥

सुश्लक्ष्णे फलकातले क्षितितले वा गेहताराधमा-
नाभ्यश्रं तदधोभुजापरिमिलत्क्षुद्रोत्तरोच्चोन्मितम् ।
तस्याधो घनमुत्तरस्य च लुपालम्बं च तिर्यग्गतैः
सूत्रैः कल्पयतूत्तरोपरि लुपापङ्क्तिं च युक्त्या ततः ॥ १७ ॥

सङ्ख्याः कोटयुपकोटिकादिविकृतानां या लुपानां तत-
स्ताः सङ्ख्या द्विगुणैकसङ्ख्यरहिताः कल्प्यास्तु सर्वत्र च ।
द्वे द्वे कोटयुपकोटिकादिविकृतानामन्तराले पृथक्
तत्रैका गृहतारमध्यनिकटेऽप्येवं विभागो मतः ॥ १८ ॥

इति विकृतिलुपानां पङ्क्तिमाकल्प्य तत्त-
न्मितिनियमकृताङ्को यत्तदाक्रान्तकर्णम् ।
नियतकृतलुपालम्बादथाकूटपार्श्वं
भवति पृथगमीषां दीर्घमानं लुपानाम् ॥ १९ ॥

सर्वत्रोत्तरतारतुल्यमृजुमञ्चानां लुपानां ततं
तद्वस्वद्रिरसांशुगाभ्यनलभागैकोनितं वान्वितम् ।
द्विघ्नं चोत्तरतारतोऽङ्घ्रिरहितद्विघ्नं च सार्धं पुनः
कार्यं तद्धनमङ्गुलेन यववृद्ध्या यावदत्वङ्गुलम् ॥ २० ॥

अभ्यश्रं मञ्चकस्य प्रततिमितमथाकल्प्य तत्कर्णमर्धी-
कृत्य न्यस्येद् भुजायामथ विकृतिलुपापङ्क्तिमत्रैव कुर्यात् ।
तत्तत्कर्णप्रमाणं खलु विकृतिलुपानां पृथग् विस्तृतिः स्यात्
पार्श्वे कार्यं ध्वजादित्रयमपि च वितानं च लम्बं च सूत्रम् ॥

व्यासेऽङ्कांशिन्यधोऽब्धिप्रमितमुपरि बाणोन्मितं कल्पयित्वा
मध्ये सूत्रध्वजाख्यं विरचयतु लुपापार्श्वयुग्मे समन्तात् ।

अष्टांशिन्यप्यधस्तादनलमितमुदध्युन्मितं चोर्ध्वभागं
यद्वा बाणांशितेऽग्निममितमुपरि दस्रोन्मितं चाप्यधस्तात्॥
ध्वजसूत्रस्योभयतो द्व्यङ्गुलमानेन कल्पयेत् सूत्रम्।
तदधस्तादप्यूर्ध्वे तत्तद्विस्तारमाननियमः स्यात्॥ २३॥
कृत्वा वेदाङ्गुलाभ्यश्रकमखिललुपापार्श्वयोर्मध्यसूत्रे
तद्वेदाश्रोत्थकर्णद्वितयमिह वितानं च लम्बं च विद्यात
सर्वत्रैतद् विधेयं द्वयमपि वलयस्थानकूटावसान-
स्थानेष्वप्युत्तराद्यर्पणनियमपदे नीप्रलम्बान्ततोऽपि॥ २४

इति मनुष्यालयचन्द्रिकायां
षष्ठोऽध्यायः।

अथ सप्तमोऽध्यायः।

चूली वा क्वचिदल्पमन्दिरविधौ तत्रापि युग्माः स्मृता
विष्कम्भाश्च तदर्धसम्मिततदङ्घ्य्रग्रेषु वंशोऽपि च।
तस्मादङ्घ्रिसमुच्छ्रयात् त्यजतु वा क्षाप्याद्रिनागाङ्कदिग्-
रुद्रांशं त्विह चूलिकोपरि लुपाश्च स्वाग्रधान्यान्विताः॥ १॥
विस्तारे पुनरुत्तरस्य दशधा भक्ते रसाद्यष्टदिग्-
भागैर्वोत्तरतारतोऽङ्घ्रिरहितं वाष्टांशितेऽग्न्यंशकैः।
विस्तारं प्रकरोतु नीप्रफलकस्यैतत्त्रिभागं घनं
विस्तारे शरभाजितेऽपि च घनं द्वाभ्यां प्रकुर्यात् क्वचित्॥
नीप्रन्यासे शरांशिन्यथ तदुभयतस्तूर्ध्वपट्टं तलं च
द्वाभ्यामेकेन पट्टं चरममपि विधेयं तथा षड्भिभक्ते।

द्वाभ्यां तस्योर्ध्वपट्टं त्रिभिरपि च तलं स्यादधः पट्टमेके-
नैवं वा नागभक्ते ज्वलननिगमभूम्यंशतः कल्पनीयाः ॥
नीप्रव्यासे विभक्ते शरगिरिनवभिः सर्वतो बाह्यभागं
नीप्रस्थानाद् वितानादुपरि तदुचितं कोटिकर्णाध्वनात्र ।
नीत्वा नीप्रं लुपासु स्वयमिह विधिना धूलिकारोधयोग्यं
कृत्वा वायव्यहोमाद्यवहिततहृदयः कारुभिः कल्पयेत् तत् ॥
मनुयवचतुरश्रं द्व्यङ्गुलं तत्र तु द्वि-
द्वययवपरिवृद्ध्या त्र्यङ्गुलान्तं क्रमेण ।
वलयमिति मुनीन्द्रैः षड्विधं दर्शितं ते-
ष्विह विहितलुपौचित्येन तत् कल्पनीयम् ॥ ५ ॥
तत्र सप्तदशाभिर्यवैः स्मृता पट्टिकाविततिरङ्कसम्मितैः ।
तद्घनं घनपदोनमन्तरं सन्दधीत च लुपासु कीलकैः ॥ ६ ॥
लोष्टैराच्छाद्यते चेदखिलनिलयने पट्टिकाप्रस्तरः स्यात्
तत्स्थाने क्वापि कार्योऽपि च घनफलकाप्रस्तरो बद्धकीलः ।
लोष्टाधाराय किञ्चित् तलमपि च खनेच्चञ्चुसन्धारणार्थं
ताम्रैराच्छाद्यते चेन्न तु तलरचना देवगेहादिकेषु ॥ ७ ॥
शिरःप्रदेशस्त्वभिधानमुक्तं वेश्माख्यपुंसस्तदधोमुखं स्यात् ।
मासूरतुङ्गार्धपदोनितं तद्विस्तारमाद्यङ्गघनाद् घनं च ॥ ८ ॥
द्वाराण्यङ्गणगेहमध्यसिरयोर्मध्यस्थमध्यान्यथो
कुर्यादङ्गुलकल्पितागमवयोयोनीनि पूर्वादितः ।

१. 'रे' ख. पाठः.

योगावुत्तरतारतुल्यविततौ विरतारतुल्याङ्घ्रि-
द्व्यर्धांशोनघनौ भुवङ्गमपतङ्गाढ्यौ लसद्राजनौ ॥ ९ ॥

योगादङ्घ्र्यग्निभागाधिकघनयुतनिर्वाजनाधः पटी स्या-
दूर्ध्वस्थाने तु तुल्योत्तरमिलितनिजाग्रौ च योगौ विधेयौ ।
योगान्तर्भागनाहो निजदिगुचितयोन्यायवृद्ध्यादियुक्त-
स्वेष्टायामोननाहार्धत इह विततिः स्याद् गुणव्यासतो वा ॥
द्वारोर्ध्वपट्यूर्ध्वमथो गणेशपद्मालयायादनमूर्तिभेदान् ।
यथेष्टमापाद्य विचित्रपत्रिप्रभेदयुक्तां फलकां विदध्यात् ॥ ११ ॥
कुड्ये भूयिष्ठविस्तारिणि दिवराकरैर्भाजितेऽन्तर्बहिश्चा-
प्यर्द्धाप्यंशान् विधायान्तरविहितसिगलभ्रमध्यौ च योगौ ।
कृत्वा क्वाप्येतयोर्मूर्धनि सुदृढतरामूर्ध्वपट्टीं तदूर्ध्वं
भित्त्यङ्गादीनि कुर्याद् दृढतरशिलया सत्सुधायोगभेदैः ॥
अन्तर्नाहजमन्दिरे घनतरे कार्ये च कुड्ये क्वचिद्
गेहप्राङ्गणपादुकावधि करोतु स्वांशकुड्यं घनम् ।
तच्चत्प्राङ्गणगेहसूत्रमनुसृत्यैवेष्टकुड्यप्रथा-
निष्ठं पृष्ठत एव नेयमुदितद्वारोत्तरादीनि च ॥ १३ ॥
कवाटयुग्मं निजतीव्रयुक्तद्वारप्रथार्धप्रततं विधेयम् ।
मात्राङ्गुलैर्नेत्रहुताशसङ्ख्यैः सार्धैश्च यद्वाभिमितैर्घनं च ॥

ऊर्ध्वाधरभ्रमणकार्गलसन्धिपाल-
प्रक्षेपणीयवलयान्यपि पत्रकाणि ।
तिर्यञ्च्युदञ्चि पुलकार्नवकुड्मलानि
सश्रीमुखेन्दुशकलानि कवाटयोः स्युः ॥ १५ ॥

द्वारव्यासाब्धिबाणोर्म्यवनिधरभुजङ्गांशितैकांशतीव्र-
व्यासा व्यासार्धपादोनितबहलमिता द्वारतुल्यायतिश्च ।
कर्तव्या सूत्रपट्टी ज्वलनशरमहीभ्रादिबीजरत्नाढ्या
मुक्तादामादिपद्मस्थितमहितरमाकृष्णविघ्नेशयुक्ता ॥

माता वामगता कवाटफलका सा सूत्रपट्ट्याश्रया
पुत्री दक्षिणगामिनीति सकलद्वारेषु सम्प्रेक्ष्यताम् ।
द्वारोच्चानलवेदबाणरसभागोच्चां तदुच्चाब्धिबा-
णोर्म्यद्र्यंशघनप्रतानसहितामाकल्पयेतारमाम् ॥ १७ ॥

द्वारव्यासपयोधिबाणरससप्तादंशकाद्यायतं
कुर्यादर्गलमायतोर्मिगिरिमातङ्गांशतारान्वितम् ।
विस्तारार्धघनं घनोन्मितलसत्खण्डद्वयं चारमा-
मूलाग्रान्तिकसम्प्रक्लृप्तकवलीसम्प्राप्तखण्डान्तरम् ॥

अधोर्गलं मातृकवाटसंस्थं पुत्रीगतं चार्गलमूर्ध्वसङ्गि ।
अथारमामध्यमतीत्य मध्यात् सुकीलयेताथ कवाटपृष्ठे ॥

एकजातितरुभिः प्रकल्पितं द्वारपादफलकादिकं शुभम् ।
अन्यथा यदि वधूकुशीलता सम्भवेदिति वदन्ति केचन ॥

एकं कवाटं यदि वामभागे मध्याद्धो वोपरि वारमा स्यात् ।
तदर्गलं वर्तुलमष्टकोणं वेदाश्रकं वा दृढशृङ्खला वा ॥ २१ ॥

आशाभास्करसूत्रभेदिनि गृहे पृष्ठेऽथवा सप्तमे
सूत्रे द्वारमथापरं क्रमवशात् पृष्ठे निजेष्टं पुनः ।

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१. 'जि' ग. पाठः.

सन्यार्धे भवनस्य कार्यमुचितयौन्यादिभिः संयुतं
नैकैवेच्छति चेत् कवाटफलका वामे भवेन्निष्क्रमे ॥ २२ ॥
कुर्यात् प्राङ्गणतो गमागमकृते द्वारं महत् पादुके
तद्बाह्ये पथि पादुकोपरि गतं त्यक्त्वा मसूरोच्छ्रयम् ।
मार्गव्यासचतुर्गुणेन परिधिः स्वामीष्टयोनिर्यथा
तद्व्यासं तु तथा करोतु च विदिग्धामास्ति चेत् कुट्टिमम् ॥
दण्डात् प्राङ्गणमध्यतोऽब्धिशरषट्सप्तादिसङ्ख्यान् व्यती-
त्यादध्यादथ पौष्पदन्तिकपदे द्वारं प्रचारोदितम् ।
भल्लाटेन्द्रगृहक्षतेष्वपि महाद्वाराण्युपद्वारका-
ण्यष्टाप्युन्नतभूतले द्वितलतद्वक्त्रादियुक्तानि वा ॥ २४ ॥
पर्जन्यकोष्ठे च भृशे च पूष्णि भृङ्गेऽपि च द्वारपशोषयोश्च ।
नागेऽप्यदित्युक्तपदेऽपि चेच्छन्त्यष्टेत्युपद्वारगृहाणि नृणाम् ॥
स्तम्भाधस्तारतो वोच्छ्रयस्तुरगांऽशांशतो वा प्रतेर-
प्युत्सेधेनात्र सार्धत्रिनियुगलहुताशांऽभिभितैश्चात्र वेदी ।
कर्तव्या कुट्टिमोर्ध्वे तदुपरि चरणैर्युग्मसङ्ख्यैश्च दारु-
स्तम्भार्धाङ्घ्र्यूनतुल्यप्रततिभिरभितः स्वोत्तराद्यैश्च भित्तिम् ॥
पत्रमानवशतोऽङ्गुलवृद्ध्या वेदिकाविहितनिष्क्रमणं स्यात् ।
सार्धयुग्मदहनादिमितैस्तैरङ्गुलैर्विहितमुत्तरलम्बात् ॥ २७ ॥
स्वद्रव्यैरेव वेदीरिह कतिचिदुशन्तीष्टकामृच्छिलाद्यै-
र्वृक्षैर्वा भिन्नजात्यैरपि च विरचिता दृश्यते सर्वगेहे ।
अन्तर्नाहेन योन्यन्वितभवनविधौ गर्भगेहोक्तनीत्या
द्वारं तत्पादुकोर्ध्वे न्यसतु पुनरधस्तात् प्रतेर्गर्तगेहे ॥

युग्मास्तुलाः स्तम्भलुपादर्धैः स्युः
सर्वास्त्वयुग्माः खलु पङ्क्तयस्ताः[1]।
नृगेहनिर्दिष्टकराधिकाश्चेद्
विनाशदास्ताः खलु पङ्क्तयः स्युः ॥ २९ ॥

प्राचीनेऽग्निसमर्चनादिकमुदीचीने कुटुम्बादिकं
व्यत्यस्य प्रकरोतु वा द्वयमिदं याम्येऽतिथिप्रीणनम् ।
पाश्चात्ये धनसन्निधापनमदो द्वन्द्वं विपर्यस्य वा
शेषार्धे तु तयोस्तथा शयनविद्याभ्यासनाद्यं चरेत् ॥

कृत्वा दिङ्नवनागवर्गपदभिन्ने क्षेत्रकेऽन्तर्गतै-
रष्टयङ्काब्धिमितैर्विधातृपदयुक्तं प्राङ्गणं मध्यत ।
शालाः पङ्क्तियुगायिकादिकजुपरतद्वाह्यतस्तद्वहि-
र्गोष्ठोलूखलवेश्मकादिविलसत्पङ्क्त्यावृतं कल्पयेत् ॥ ३१ ॥

कार्तान्त्यां खलसद्म धान्यभवनं तत्रापि वा नैर्ऋते
कुर्वीताथ धनालयं धनपतौ प्राच्यां तथापांपतौ ।
सिंहे वालितुलाकुलीरभवने धान्यालयोक्तेषु वा
धान्यागारविधिर्धनोदितपदे कुत्रापि चावश्यके ॥ ३२ ॥

गोशालेन्द्रजलेशयोर्वितथपूषाभ्यन्तराले मता
पर्जन्यैन्द्रिपदे तथा कुसुमदन्तद्वारपालान्तरे ।
भृङ्गे शोषपदेऽथवात्र महिषागारं यमेऽप्युक्षशा-
लास्मिन् क्वाप्यथवास्तु मर्मविलसच्छूलं समस्तं त्यजेत् ॥

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१. 'यः' क. पाठः.

क्षेत्रस्य कोणगतरज्जुमतीत्य यानं
नेच्छन्ति केचन गवामखिलेषु दिक्षु ।
मुख्यं वृषं न मृगराट्करणेषु सिंह-
व्याघ्रौ स्थिरं च करणं शुनि गर्दभाद्याः ॥ ३४ ॥

पर्जन्ये पचनालयं शिखिनि वा मेषे वृषे वानिले
तत्रैवापि च भुक्तिसद्म मकरे चापांपतौ नेष्यते ।
कुम्भे सौख्यगृहं तथैव मकरे वायौ तदावश्यके
कर्तव्यं वृषमेषयोरिदमथो वायौ तथोलूखलम् ॥ ३५ ॥

मीने कूपमतीव मुख्यमुदितं सर्वार्थपुष्टिप्रदं
मेषे चापि घटे च भूतिकृदिदं नक्रे वृषेऽर्थप्रदम् ।
आपे कूपमथापवत्सकपदे मुख्यं तथैवेन्द्रजि-
त्कोष्ठे दृष्टमपांपतौ तु शुभदं नागेऽसं मारुते ॥ ३६ ॥

कूपं शोभनमन्तरिक्षपदकेऽप्येवं तटाकं हितं
माहेन्द्रे च महीधरे च वरुणे सोमे शिवे मेषभे ।
वायौ वा निर्ऋतौ च दृष्टमथवा स्नानादिपानादिषु
प्रायो नैकजलं(हितं ?) नदीजलभृतेऽत्रान्यत् पृथक् कल्पयेत् ॥

आग्नेय्यां भवनस्य कूपखननं पूर्वं कृतं वा तथा
वापी दाहभयादिकं प्रकुरुते तद्वत् फलं दक्षिणे ।
ग्रामादेरपि दीर्घिकादि कतिचिन्नेच्छन्ति याम्ये तथै-
वारामो गृहसन्निधौ फणभृतां वासोऽपि नैवेष्यते ॥ ३८ ॥

राज्ञां धामनि भूसुरस्थितिगृहं नित्यार्चनायाङ्गणे
शर्वेन्द्राग्निजलेशदिक्षु कुलदैवार्चाप्रतिष्ठादि च ।
प्रासादादिविधानमीशसुरनाथाग्न्यन्तकाशागतं
केतूत्थं नृपजं करोतु च निर्ऋत्यादौ क्रमाच्छ्रेयसे ॥ ३९ ॥

सेवितकुलदैवतधामेशनिर्ऋत्यादिके तु नृपजं स्यात् ।
गृहपुरपत्तननगरग्रामादावभिमुखा भवन्ति तदा ॥ ४० ॥

निरङ्गसाङ्गादिविभिन्नगेहप्रतिष्ठिता याः प्रतिमास्तु तासाम् ।
चलाचलत्वोभयभेदतस्तत्क्रियावशाच्चापि भवेद् विशेषः ॥

सौख्यार्थं धरणीभृतां मणिगृहं मित्रे विहारोऽनिले
व्यायामोऽर्गलके तथैव निर्ऋतौ स्नानादि पर्जन्यके ।
इन्द्रे तोयपतौ च भुक्तिनिलयं नृत्तादि गान्धर्वके
शस्त्राद्यं निर्ऋतौ गृहक्षतपदे प्राग्ये च शय्यागृहम् ॥ ४२ ॥

दण्डान्तं समतील वप्रमुदितं मृद्भिः शिलाद्यैस्तथा
श्रेष्ठं तत् परिखा तु मध्यममतं शाखावृतिश्चाधमम् ।
तत्पानादिषु कण्टकिद्रुमलता प्राखाश्च वेण्वादयः
कुर्याद् द्रव्यवशादिहैकमुदितान् वृक्षांश्च दिक्षु क्रमात् ॥

एवं निर्माप्य गेहं प्रथममिह वृतस्तन्त्रिवर्यस्तदन्ते
तत्कर्तॄन् शिल्पिनस्तान् वलयमणिलसत्कुण्डलाद्यैर्यथेष्टम् ।
सन्तोष्यापाद्य चैतत् स्वयमपि यजमानेन सम्यङ्मुहूर्ते
गत्वा तद्वास्तुपूजाद्यखिलशुभविधिं साधु कुर्वीत तस्मिन् ॥४४॥

कर्ता चाथ क्रियान्ते महितगुरुवरं भोजयित्वा यथेष्टं
गोभूम्याद्यैश्च दत्त्वा विधिवदवहितो दक्षिणां मुख्यरूपाम् ।
आज्ञामादाय तस्मान्निखिलमपि जनं प्रीणयन् भूरिदानैः
स्वीयैः सार्धं स्वगेहे सुचिरमधिवसेत् पूर्णकामः सुखेन ॥ ४५ ॥

इति मनुष्यालयचन्द्रिकायां बाह्यगेहकूपतटाकादिविधानं नाम
सप्तमोऽध्यायः ॥

समाप्ता मनुष्यालयचन्द्रिका ॥

शुभं भूयात् ।

BIBLIOGRAPHY

1 Āchārya. P.K. (Tr) "Architecture of Mānasāra", The Oxford University Press, 1934.

2 Adoor K.K. Ramachandran Nair (Editor), "Gazeteer of India", Kerala State Gazeteer Vol.II, Kerala Gazeteers, Trivandrum, First Edition, 1986.

3 Ananda. K. Coomaraswamy, "History of Indian and Indonesian Art", Munshiram Manoharlal, New Delhi, 1972.

4 Andrews. G.E., "Number Theory", Hindustan Publishing Corporation (INDIA) Delhi, 1984.

5 Balakrishnanasari. S, "Thachusastram Bhasha", (Mal), K.U.O.R.I.M. Library, Trivandrum, 1982.

6 Banerjee. G.N., "Hellenism in Ancient India, Munshiram Manoharlal, New Delhi, 1961.

7 Banerjee Manabandu, "Sanskrit Vastu Works on Soil-testing", Indian Journal of History of Science Vol.31(3), 1996, Indian National Science Academy, New Delhi.

8 Bhanumurthy. T.S., "A Modern Introduction to Ancient Indian Mathematics", Wiley Eastern Limited, New Delhi-2, 1992.

9 Bhārati Kṛṣna Tīrthaji, "Vedic Mathematics", Motilal Banarsidas, Delhi-7, 1988.

10 Bhōja, "Samarānkaṇa Sūtradhāra", Edited by T. Ganapathi Sastri, M.S. University of Baroda, 1966.

11 Boner Alice, Śarma. S.R., Baurau. B., "Vāstusûtra Upaniṣad", of Pippalada, (tr and summary), Motilal Banarsidas, Delhi.

12 Boyer. C.B., "The History of Mathematics", Wiley, New York, 1968.

13 Chandrasekhara Pillai. V. and Balakrishnanasari. S. (Ed) "Vastuvidya", (Mal), Kerala Univeristy Oriental Research Institute and Manuscript Library, Trivandrum, 1979.

14 Chandrika. B.T., "Dravidasilpakala", (Mal), Kerala Bhasha Institute, Trivandrum, April 1974.

15 Cheriya Anujan Bhattathirippad. K.P., "Tantrasamuchayam" (Mal) of Chennas Narayanan Namboothirippad, Parts I, II & III, Panchangam Pustakasala, Kunnamkulam, 1989.

16 Damodaran Namboothirippad. K., "Tantrasamuchayam" (Śilpabhagam) (Mal), Panchangam Pustakasala, Kunnamkulam, 1988.

17 Datta. B. & A.N. Singh, "History of Hindu Mathematics", A Source Book, Part I & II, Asia Publishing House, Bombay, 1962.

18 Dietz Albert. G.H., "Dwelling House Construction", The MIT Press, Cambridge, 1979.

19 Fergussan James, "History of India and Eastern Architecture", Vol.I, Edinburg Press, London, 1910.

20 Ganapathi Śastri. T. (Ed) "Mayamata of Mayamuni", (SKT), Trivandrum, Sanskrit Series No.LXV, Government Press, Trivandrum, 1919.

21 Ganapathi Śastri. T. (Ed), "Silparatna of Srikumara", (SKT), Trivandrum, Sanskrit Series No.LXXV, Trivandrum, 1922.

22 Ganitānand, "A few remarks concerning certain values of π in Ancient India", Ganita Bharati, Vol.12, Nos.1-2, (1990).

23 Ghurye. G.S., "Vedic India", Popular Prakashan, Bombay, 1979.

24 Gupta. R.C., "On the value of π from the Bible", Gaṇita Bhārati, Vol.10, Nos. 1-4 (1988).

25 Gupta. R.C., "South Indian Achievements in Medieval Mathematics", Ganita Bharati, Vol.9, Nos. 1-4 (1987).

26 Gupta. R.C., "Lindemanns discovery of the Transcendence of ¶. A century tribute, Ganita Bharati, Vol.4, Nos. 3-4 (1982).

27 Heath. T.L., "A History of Greek Mathematics", Vol.II, Dover, New York.

28 Heath. T.L., "The Thirteen Books of the elements", Second Edition, Vol.III, Books X-XIII and Appendix, Dover, New York.

29 Jatavedan Namboothiri, "Kattil Mutal Kavilvare" (Mal), Mathrubhumi Weekly, Book 59, Vol.44, Page 6, 1982.

30 Kapila Vatsyayan, "The Art of Kerala Khetram", Edited by Prof. K.G. Paulose, S.R.V. Govt. Sanskrit College Committee, Trippunithura, 1989.

31 Kapur. J.N., "Review on Geometry in Ancient and Medieval India", by T.A. Saraswati Amma, Indian Journal of History of Sciences, Vol.24(1), 1989.

32 Kay. K.R., "The Bakhshali Manuscript", A study in Medieval Mathematics, Part I & II, Cosmo Publications, New Delhi, 1981.

33 Kayalad. K.P., "Vastuvidyayute Aksharamala" (Mal), Desabhimani Weekly, Book Nos. 28 and 29, Vols. 29 to 34, 1996 & 1997.

34 Kesavachari. N., Payyannur, Balaramam (Silpasastram), (Mal), Vidyarambam Publications, Alappuzha, 1989.

35 Kesavachari. N., Payyannur, "Ganitaratnakaram", (Mal), Vidyarambam Publications, Alappuzha, 1989.

36 Kesavachari. N. Payyannur, "Manushyalayasopanam" (Mal), Acharyagranthalayam, Payyannur, 1956.

37 Koyithatta. N., "Manushyalayachandrika", (Mal), Alied Publications, Talasseri, 1989.

38 Kramrisch Stella, "The Hindu Temple", Vol.I & II, Motilal Banarsidass, Delhi, 1976.

39 Krishnan. T.V. (Tr) "Logante Malabar Manuel" (Mal) of William Logan, Mathrubhumi, Calicut, 1985.

40 Krishnanasari Vazhappilli, "Silpakala Vastuvidyabhyasam" (Mal), Santha Book Stall, Guruvayur, 1992.

41 Krishnanasari Vazhappilli, "Thachusastram" (Mal), Santha Bookstall, Guruvayoor, 1992.

42 Krishnan Namboothiri Kanuppayyur; and Dr. A. Achyuthan (Ed), "Readings in Vastusastra (Traditional Architecture)", Vastuvidyapratistanam, Kozhikode, 1995.

43 Krishna Warrier, Parakkal, "Grahanirmanapadhati" (Mal), Panchangam Bookstall, Kunnamkulam, 1990.

44 Lockwood Michael, Gift Siromoney, P. Dayanandan; "Mahabalipuram Studies", C.L.S., Madras, 1974.

45 Madhavaji, "Kshetrachaitanyarahasyam", (Mal), Kerala Kshetrasamrakshana Samiti, Kozhikode, 1988.

46 Madhavan. S., "Origin of Katapayadi System of Numerals", S.R.V. Samskrita grantavali (Jl), Govt. Sanskrit College Committee, Tripunithura, Vol. XVII, 1991.

47 Maheswaran Bhattathirippad, Kuzhikkat, "Kuzhikkat Paccha" (Tantragrantham) (Mal), Panchangam Bookstall, Kunnamkulam, 1991.

48 Mallayya. N.V., "Studies on Sanskrit Texts on Temple Architecture with special reference to the Tantrasamuccaya", The Journal of the Annamalai University, Vol.X, No.1 & 2.

49 March. L. & Philip Steadman, "The Geometry of Environment", MIT Press, Cambridge, 1974.

50 Moosad. C.K., "Prachinaganitam Malayalathil" (Mal), Kerala Bhasha Institute, Trivandrum, 1980.

51 Narayanan Kattumatam, "Naveekaranakalasam" (Mal), Mathrubhumi Weekly, Book 69, Vol.51, Page 33, February 1992.

52 Narayana Pisharoti. K.P., "Malayalathile Samkhyasabdangal" (Mal), Mathrubhumi Weekly, Book 69, Vol.2, Page 18, March 1991.

53 Nath. R., "Agra and its Monumental Glory", Taraporevala Sons & Co. (P) Ltd., 1977.

54 Neelakandanasari. K., "Manushyalayamahachandrika" (with commentary) (Mal), S.T. Redyar & Sons, Kollam, 1987.

55 Neelakandanasari. K., "Manushyalayavidhi" (Mal), Devi Bookstall, Kodungallur, 1981.

56 Parameswaran. K. (Ed), "Manushyalayachandrika" (Thachusastram) (Mal), Kochi Malayalabhasha Pariskarana Committee, 2nd edition, (1125 ME).

57 Prabhu Balagopal. T.S., "Vastuvidyadarsanam" (Mal), Vastuvidyapratistanam, Kozhikode, 1994.

58 Prabhu Balagopal. T.S.; & Dr. A. Achyuthan, "A Text Book of Vastuvidya", Vastuvidyapratistanam, Calicut.

59 Prabhu Balagopal. T.S., (Ed), "Vastuvidya 95", Selected Papers of National Conference on Vastuvidya, Calicut, 1995.

60 Prabhu Balagopal. T.S. & Dr. A. Achyuthan, "Keralathinte Thachusastram", Mathrubhumi Weekly, Book 63, Vol.8, Page 26, May 1985.

61 Pramar. V.S., "Design Fundamentals in Architecture", Somaiya Publications, Bombay.

62 Purushothaman Namboothiri. P.S., "Brhalsamhita or Varahisamhita" (commentary), (Mal), Sriramavilasam Press, Kollam, 1935.

63 Purushothama Sarma. C.S., "Yantrasamuccayam", (Mal), Devi Bookstall, Kodungallur, 1997.

64 Raghava Varrier. M.R., "Kodungalloorinte Patanam", (Mal), Mathrubhumi Weekly, Book 65, Vol.52, Page 26, March 1988.

65 Ramachandra Menon. P., "Bharateeyaganitam" (Mal), Kerala Bhasha Institute, Trivandrum, 1989.

66 Ramavarma (Maru) Thamburan & A.R. Akhileswara Iyer, "Yuktibhasha" (Mal), Mangalodayam Ltd., Trichur, 1948.

67 Ramesh. R.K., "Veedukalo Kongreetukootukalo?" (Mal), Mathrubhumi Weekly, Book 68, Vol.11, Page 30, May 1990.

68 Rao Balachandran. S., "Indian Mathematics and Astronomy", Jnanadeep Publications, Bangalore 10, 1994.

69 Rao Muralidhar, "Vaastu Shilpa Saastra", S.B.S. Publications, Bangalore, January 1995.

70 Sankaran Namboothirippad, Kanippayyur, "Manushyalayachandrika", (Mal), Panchangam Bookstall, Kunnamkulam, (1162 ME).

71 Sankaran Namboothirippad, Kanippayyur, "Kaikanakkum Atamkal Pattikayum", (Mal), Panchangam Bookstall, Kunnamkulam, (1166 ME).

72 Sankaran Namboothirippad, Kanippayyur, "Muhurthapadavi", (Mal), Panchangam Bookstall, Kunnamkulam, (1168 ME).

73 Sarada Srinivasan, "Mensuration in Ancient India", Ajanta Publications, Delhi, 1979.

74 Sarbhai. S.C., "Review on Aryabhata I and his Contributions to Mathematics" by Parameswar Sha, GB, Vol.12, No.1-2, (1990).

75 Śarma. K.V., "A History of the Kerala School of Hindu Astronomy", Vishveshvaranand Institute, Hoshiarpur, 1972.

76 Śarma. K.V., (Ed), "Tantrasangraha of Nilakantha Somayaji with Yuktidipika and Laghuvivrti of Śankara", V.V.B.I. of Sanskrit and Idological Studies, Punjab University, Hoshiarpur, 1977.

77 Sarmak. V. and S. Hariharan, "Yuktibhasa of Jyestadeva", Indian Journal of History of Sciences, Vol.26, No.2, 1991.

78 Śarma. K.V., "Leelavati of Bhaskaracarya", (SKT), V.V.R.I. Hoshiarpur, 1975.

79 Śarma. V.S., "Vastu Sutra Upanishad", (Mal), Bhaktapriya, Book 1, Vol.6, Page 54, Guruvayur, June 1986.

80 Sasibhushan. M.G., "Chuvarukal; Chitrangal", (Mal), Mathrubhumi Weekly, Book 59, Vali 44, PP 5, January 1982.

81 Sasirupan, "Chatussalakalku oru charamakkurippu", (Mal), Mathrubhumi Weekly, Book 68, Vol.21, PP 8, July 1990.

82 Shukla. A.K., "Mathematics of Aesthetics", Enkey Publisher Pvt. Ltd., New Delhi - 21, 1987.

83 Soundara Rajan. K.V., "Indian Temple Styles", Munshiram Manoharlal, New Delhi, 1972.

84 Srinivasan. K.R., "Temples of South India", National Book Trust India, New Delhi, 1972.

85 Srinivasan. P.R., "Beginnings of the Tradition of South Indian Temple Architecture", a Bulletin of the Madras Govt. Museum, New Series, Vol.VII, No.4, 1959.

86 Vamanan. K.K., "Sreechakram", (Mal), Mathrubhumi Weekly, Book 67, Vol.32, PP 43, October 1989.

87 Varahamihira, "Brhat Samhita", (Tr) by V. Subrahmanya Sastri and Ramakrishna Bhat, Published by V.B. Soobbiah & Sons, Bangalore, 1947.

88 Vasuachari, Tannirmukkam, "Silpibalaprabodhini", (Mal), Vidyarambam Publishers, Alappuzha, 1992.

89 Vasuachari, Tannirmukkam, "Grhachitravali (Silpa Sastram)", (Mal), Vidyarambam Publishers, Alappuzha, 1990.

90 Vasuachari, Tannirmukkam, "Vastukaumudi", (Mal), Vidyarambam Publishers, Alappuzha, 1992.

91 Vasudeva Sastri & N.B. Gadre, (Ed), "Viswakarma Vastu Sastram" (text and commentary), T.M.S.S.M. Library, Tanjore, 1958.

92 Waerden. B.L., "Geometry and Algebra in Ancient Civilizations", Springer - Verlag, Berlin, 1983.

GLOSSARY

Adhiṣṭhāna: Basement of a vimāna, maṇḍapa, or similar structure, forming a distinct architectural feature, supporting walls and pillars, and consisting of distinct moulded tiers.

Ādhāraśila: Foundation stone generally used to denote the lowest part of the support system of the idol.

Aliṇda: Corridor, varanta, passage.

Alpaprāsāda: Small temple with the perimeter of the Prāsāda (Srīkovil) not exceeding 16 hasta and of single storey.

Angula: Linear measurement equal to 1/64 of vyāma; also equal to 8 yava. 1 angula is 3 cm.

Ankaṇa: Courtyard

Ankaṇasūtras: Axes passing through the centre of the courtyard.

Antahāra: Secondary boundary of temple from prāsāda.

Āntara bhitti: Inner wall of multiple walled prāsāda or sanctum.

Antarmandala: The innermost prākāra around the sanctum usually at a distance of half the width of the prāsāda.

Ara: Room; chamber, the traditional architectural construction of Kerala in which the walls of the rooms are constructed in wood is called 'ara' and 'nira'.

Ardha-maṇḍapa: Pillared hall immediately in front of the principal shrine or distal half of a mandapa with two seriate pillars, as in rockcut cave-temple.

Arddhādhika: Ratios of length to width which are obtained by adding ½ to integers.

Ārūdhōthara (Ārūḍham): Additional horizontal support for the rafters between wallplate and ridge; elevated uttara.

Asiddha: Temple sites in settlements.

Astavarga: 8 x 8 grid; maṇḍūka maṇḍala.

Āyāma: Elongation; the frontal elongation is called mukhāyāma.

Āyatacaturasra: Rectangle.

Bāhya-bhitti: Outermost wall of a multiple-walled sanctum.

Bāhya-hāra: Fourth boundary of the temple from the prāsāda.

Balivattam: Envelope containing the offering stones (balikkal).

Bhadra: Land located at the side of sea, river or lake with good resource of water and facilities for cultivation.

Brahmanābhi: Focal point of a vāstumaṇḍala, where the two sūtras intersect.

Brahmasūtra: The west-east axis of a maṇḍala.

Chitra-pōtika: Corbels with embossed carving or painting of creepers, flowers etc.

Cuttampalam: The covered corridor enclosing the shrine-room located 1 dandu away from the shrine-room; also called nalampalam.

Daṇḍu: Linear measurement equal to 4 hasta (96 angula), the unit in the proportional system of measurement.

Dhūmra: This is an inferior variety of arid site.

Eaves: The lowest part of the roof. It is the section formed by the rafter ends, plate, and cornice.

Gable: The gable roof consists of two inclined planes which meet in a peak over the centre line of the house and slope down to two opposite roof plates. At the two ends are triangular sections of wall called "gables" or "gable-ends", hence the name gable roof.

Gajapṛṣṭha: Combination of square and semi-circle; the rear side of an elephant.

Garbhagṛha: Shrine-cell or cellar.

Grhavāstu: Architecture of residential buildings.

Gala, grīva: Neck, usually the clerestory raising up the roof with light and air openings (Nāsikas) on its sides.

Hasta: Ānthropometric linear measurement equal to length of arm; the standard and most commonly used hasta is 24 angula and is called kiṣku; 8 types of hastas varying from 24 angula to 31 angula with variation of 1 angula are known by different names; the names for hasta are kara, bhuja, aratni, kol.

Hip: When the roof slopes down in four inclined planes to four plates, it is called a hip roof.

Īśānakhaṇḍa: The sector of Īśa, the north-east sector; also called manuṣyakhaṇḍa.

Īṣṭadīrgha: Desired length, selected length.

Kadalakâkarna: Successive inward offsetting or corbelling of the roofing slabs or brick courses over walls to reduce the space to be roofed over to an ultimate small opening top that can be covered by a slab overlapping like a banana bunch.

Kalaśa: The pot of the lower portion of the finial.

Karṇasūtra: Diagonal axis of a maṇḍala.

Katapayadi notation: A system of representation of numbers. In this system the consonants (vyanjanas) beginning with ka, ta, pa and ya represent the digits from 1. Pa to ma stand for 1 to 5 and ya to ha represent digits 1 to 8. m and n denote 0. In the case of conjunct consonants, the number denoted only by the last consonant is taken and the vowels following consonants have no value. The vowels not preceded by consonants represent 0. The letter l represents 9. In this system the arrangement of the digits is from right to left (ankanam vamato gati).

Kāvu: Sacred grove, for the worship of gods like Kāli, Ayyappan, Serpents etc.

Khaṇḍōttara: Uttara having equal width and thickness is called khaṇḍōttara.

Kila: Wedge.

Kṣētravāstu: Architecture of temple.

Kūṭa: Pendant; solid wooden piece to which tip of all the rafters of a koṣta type of roof or the top ends of slanting rafters and the end of ridge of a sabha type of roof are connected.

Kuthampalam: Temple theatre for performing arts.

Madhyama: Medium.

Madhyahara: Third boundary of a temple comprising the dīpamāla.

Mahāmarma: Sensitive node when 4 sūtras intersect in a maṇḍala.

Maṇḍala: Demarcated area; region, generally circular.

Maṇḍapa: Open or closed pillared or astylar hall.

Manuṣyālaya: House for human beings.

Manuṣyāpramāṇa: Measurement system based on the size and proportions of human body.

Marmavēdha: Intersections with vulnerable points.

Maryāda: Fifth boundary of a temple; outermost prākāra.

Mātra: Module of measurement.

Miśra: Mixed.

Namaskāramaṇḍapa: Pavilion in front of the prasada used for namaskāra.

Nātyasāla: Halls for performing arts.

Navavarga: 9 x 9 grid, paramaśāyikamaṇḍala.

Nēpathya: Makeup room, aṇiyara.

Ōma: Basal pīṭha of pillar or pilaster.

Pada: Linear measurement equal to 8 angula; pillar.

Padma: Lotus, capital-member below the phalaka.

Parivāra dēvatas: Subsidiary deities in a temple.

Patrōttara: Uttara having thickness 3/4 of the width is called Patrottara.

Patta: Plain or decorated band.

Pattika: Projected top slab of the platform or adhiṣtāna, or wooden reaper.

Pādādhika: Ratios of length to width which are obtained by adding ¼ to integers.

Pādōna: Ratios of length to width which are obtained by subtracting ¼ from integers greater than 1.

Pāduka: Ground course, the lowest part of the adhiṣṭāna.

Phalaka: Abacus, moulded capital of pillar supporting the corbel, or potika.

Pinjara: Wooden roof-frame.

Poorna: These types of sites are located on top of plateaus or in the mountain valleys.

Pōtika: Corbel bracket over pillar.

Praṇāḷa: Spout projected to discharge water.

Prāsāda: Sreekovil or vimāna.

Prastara: Entablature, consisting of mouldings over walls and pillars, viz, the uttara (beam).

Pitch: The 'pitch' of a roof is its slope.

Pūja: Adoration; sacrifice to the deity, offerings and other rites.

Rafters: These are the structural members of the roof. Common rafters or straight rafters run from ridge to plate at right angles to the wall. The hip rafters run from the exterior corners of the plate to the ends of the ridge. Framing into the hips are shorter rafters, running from plate to hip rafter, called jack rafters.

Rajju: Linear measurement equal to 8 dandu, literally means rope; also, the diagonal sūtra in a mandala.

Ridge: The peak of the roof. The ridge board or ridge pole is the member against which the rafters bear. It forms the lateral tie which holds them together at that point. In a square house the ridge vanishes to a point or kootam.

Rūpōttara: Uttara having thickness ½ of the width is called Rupōttara.

Sāla: Rectangular hall with gable roof, in some cases it represent a courtyard house.

Samatatam: A rectangle with length equal to an integer multiple of its width.

Śikhara: Roof of the prāsāda, domical, 4 sided with a single finial, vaulted with many finials on the ridge, or apsidal with many finials.

Śliṣta- Bhinnasala: Catussala with partially separated and partially combined halls (houses).

Sōpana: Flight of steps.

Srīkovil: Used to denote vimāna or prāsāda, the sacred structure.

Sthapati: One of the four silpins who is the relevent person in all types of construction, must be a 'samaśtakriyāpatu'.

Stūpika: (Stûpi) Finial.

Supadma: It is a land located in the plains, suitable for human habitation and temples.

Sūtragrāhi: He must be wellversed in all sâstras, constructions etc. a student of Sthapati or his son. Another silpin of the 4 silpins.

Takṣaka: The third silpin in the construction of houses.

Tala: Storey of the temple, gopura.

Tāla: A proportionate measure, palm of the hand, modular unit of dimension in iconography in terms of face length.

Taranga: Wave.

Upapīṭha: Additional moulded platform or sub-base below the adhiṣṭāna.

Vardhaki: The fourth silpin in the construction of building.

Vilakkumadam: The structure with several rows of oil lamps at the Madhyahara.

Vimāna: Prāsāda, Srīkovil.

Vyāla: Leonine figure.

Yōni: Architectural formula for orientation, place of origin.

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