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Vastushastra System - Measurements and Proportions

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I. INTRODUCTION

Vastushastra (traditional Indian architecture) edicts are based on the principle that microcosm (manmade build environment) must be in unanisom with macrocosm (cosmos) as its integral part. As such no interruption of microcosm should be contrary to the laws of cosmology both at gross and subtle level. The western concept of science ends at meeting materialistic or utilitarian end. Vastushastra goes beyond and believes that ignoring the order at subtle level may damage the environment and thereby the quality of life. In cosmos everything is perfect and in order at its minutest level, so it has to be in microcosm. By definition, the perfection has two attributes (a) the mathematics (number, formulas) and (b) the geometry (two or three-dimensional). It is a scientific fact that even an atom is the miniature of the gross level and has the same order as that of cosmos. All the elements are formed out of pentadic primordial elements (space, air, energy, water and matter) and vibrating element called time causes the phenomenon. The sages tried to establish the same order through Vastushastra norms so that microcosm is a replica of macrocosm. The similarities establish the resonance which may be through numbers, mathematics and / or the geometry. The cosmos vibrates with the energy so also the animate things vibrate with energy. The mutual co-ordination establishes the resonance resulting in balance, harmony and rhythm.

II. PHENOMENON OF TIME AND SPACE, SPACE AND RHYTHM

The science and technology of Vastushastra and hinged on the concept of time and space rhythm and form. The space is filled with countless particles of energy which vibrate. The vibration of space is realized as time (kaal). Every animate thing follows rhythm tic vibration or rhythm for its material growth, which is called spatial form. Time is directly proportional to this tri-dimensional space e.g. a seed / sperm grows into matured tree / human form over period of time. Time is imminent in the primal space which is its manifest form. Thus, the space which otherwise is measured in linear units can be defined in terms of time. Time emerging as vibration is quantifiable numerically which is a number.

A. Resonance And Rhythm

The energy particles in the vast space cause threads or strings of energy called wave which can be straight or curved lines. These wave patterns caused by the pulsation are found to have another significant property called by the modern scientists as resonance - two frequencies of vibration responding to each other- just like a phenomenon of magnetic poles attracting or repulsing each other of when three or four veenas (stringed instruments) put to particular pitch resonate with one another when one is activised. This is sympathetic vibration as per modern physics and the response is called resonance. In other words the frequency of vibration (rhythm) is one and same in the group of veenas.

Form this phenomenon a theory has been deduced in Vastushastra (traditional Indian architecture) that identical number resonates with each other. For example number 4 will resonate with another 4 causing harmony and also with multiples of four or fractions there of i.e. 4 will resonate with 4,8,16,32,64 etc. Similarly the resonance of equal wavelengths creates a symphony. When the numbers resonate with each other, it is obvious that corresponding derivates of resonating linear measure such as perimeter, area, and volume would also resonate with each other.

The modern “force field theory” and “wave mechanics” corresponds to the traditional geometric - harmonic theory of universal orders as being interwoven configuration of patterns. This phenomenon is interpreted as spatial resonance or spatial harmony i.e. spaces harmonize or resonate with each other provided they are caused by one and the same frequencies or of multiples or fractions thereof. The resonance is noticeable in the sound frequencies of seven + one eight notes (Sa. Re. Ga. Ga. Ma. Pa. Dha. Ni. Sa) resonating with upper Sa and so on. It must be realized now that phenomenon of resonance is universal to all the energy spaces of light sound, magnetic, heat etc., and is extended to vibrations related resonance of material spaces in single, two and tri-dimensional forms also.

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III. VASTUSHASTRA THEME / THOUGHT

Microcosm, to be an integral part and not at loggerheads with macrocosm, must have omnipresent perfection and order as that of universe. That is why Vastushastra emphasizes the inter and intra dimensional co-relationship in two and three dimensional forms with utmost importance to the choice of proportionate measurements, since there is perfection in the macrocosm so has to be in microcosm. Thus man-made environment has to be sympathetic replica of universe in its spatial context, contents and arrangements in all respects. That is why the adherence to the measurements is imperative in all creative activities particularly in architecture. The perfect measurements and proportions ensures the harmonic resonate environment. According to Sumarangan Sutradhar, every creative activity such as architecture and sculpture must be "MEYA"- complete in measures.

IV. MEASURE AND MEASUREMENTS

The units of measurement and the system evolved out of them are of paramount significance in vastushastra. Vastu mathematics which numerical at subtle level but geometrical at application level has its source in the concept of time as unit of measure converted into space measure. Since the basic theme of Vastushastra is that it recognizes the amorphic quality of the space and also the intrinsic nature of space vibrating into numerical measure, the smallest particle called parmanu was identified. Parmanu is described as the minute aerosol particle of dust seen in the sun light beam creeping in the dark room. The octal multiplication is done till it could be equated to choice of befitting grain. The spatial form of words is the result of vibration of syllabic sound energy and this time measure is known as taal. The foot beats in dance or metrical structure in poems or sonic meter in music are easy to understand. All these are examples of space vibration and time measures measured numerically. Table - 1 shows the octal multiplications of basic unit equated to time units.

A. Measurement Units Based on Human Body

Human body (form) is in a state of constant vibration due to which by itself is an element that is an element that is in constant symphonic resonance. The resonatory body must have resonant measures. This was reckoned and the measurement system was derived based on the proportions of the human body. In modern times the anthoropometric data has been used to decide the functional spaces but the measurement units have not been deducted from it.

It is but natural that each person perceives the size of element in his surrounding environment in his surrounding environment in relation to one's own mortal frame, own size or stature, which becomes ready measure for linear dimensions. Even now in India the term purusha (man i.e. height) is used as approx measure for the fathom of well, height of height of building etc. The foremost advantage of body measurement units is that when the vastu (building) is constructed with the human scale will be in resonance with the human. The perfect measure of a man is such that the stature or height (kaya) is equal to the span or armstretch (vyama). Different ethenic races may have different stature but conform to this ideal proportion. This has been substantiated by modern anthropometrical studies. Further, the human body is enclosed in a perfect square, which is similar to embodied form of the circular earth known as vastu Purusha Mandala.

The smallest unit of human scale is angula which is the length of middle phalanx of the middle finger is related to the largest unit of grain scale with octave multiplication to achieve the integration of two systems viz grain the human body. Subsequent octave multiples of angula yield pada to vyama / kaya. The octal subdivision of vyama / kaya yields 1 pada or 1 taal of time unit (Table – I). Pada is equal to 24 cm in length or 1 face length (from hair line of skull to chin) (fig.1).

The unification of time units, grain and body measurements units have been shown in the Table-1 and Fig. 1. The proportions of human body are such that the single pace of walk matches with arm length (from shoulder to tip of middle finger) and this unit is designated as hasta (arm).

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Table - 1

TIME UNITS	SPACE UNITS DERIVED FROM GRAIN
8 Ganam= 1 Lavam	8 Parmanu = 1Car Dust (000916mm)
8 Lavam = 1 Kashta	8 Car Dust = 1 Liksha (0.007328mm)
8 Kashta= Nimish	8 Liksha = 1 Yuka (0.058624mm)
4 Nimish = 1 Tudi	8 Yuka = 1 Tila (Seasame seed – 0.468992mm acceptable least dimension)
8 Tudi = 1 Kuru	8 Tila= 1 Yava (3.751936 mm, say 3.75mm unhusked paddy grain)
	8 Yava = 1 Angula (30mm measurement of body dimension)
	8 Angula = 1 Pada (24 cm)
8 Tall = 1 VYAM	8 Pada = 1VYAM (192 cm)
	3 Angula = 1 Parva (9 cm)
	8 Parva = 1 Hasta (72 cm) = 24 Angula = 3 Pada
	12 Angula = 1 Vishti (36 cm)
	4 Hasta = 1 Danda (288 cm)
	8 Danda = 1 Rajju (2304 cm)
60 Ghatika = 1 Ahoratra	1000 Danda = 1 Ghatika (1/60 of day = 24 minutes)(2.88km)
= 24 hours	2000 Danda = 1 Krosa (5760 m = 5.7 km)
2 ½ Ghatika = 1 hour	8000 Danda = 1 Yojana (2304 m =23 km)
	8 Ghatika = 1 Yojana (1000 Rajju = 23 km)

Integration of space and time unit indicating 1 tall = 1 pada

Source : Ganapati (2001) pp. 182.209

It Measures 8 parva, 3 pada or 3/8 of vyama. The unit of hasta was standardized to measure linear length of building. Three consecutive doubling of parva leads to hasta and its division in three parts yields to 1 pada of 8 angula each.

V. IMPORTANCE OF OCTAVE SCALE

As explained before, the dimensional resonant co-ordination the number eight has assumed a very significant status of quality of unitary measure. Thus, any dimension (multiple or division) will automatically establish the numeric resonance. It is believed that the number eight has been chosen because of its cosmic or otherwise attribute including the following:

A. The location / orientation of any vastu (building) on the earth can be with reference to 8 directions (4 cardinal + 4 sub-cardinal).
B. The earth's upper crest is 1/8 of its diameter.
C. The height of human body is 8 times the face length / Pada or Taal.
D. In music the octave of seven notes and pause note totaling eight create a one rhythm or order. The time measure of this is known as taal or laya which is equated to face measure i.e. 1 taal= face length = 1 pada. This is unique contribution of vastushastra where time measure and spatial measure has been equated. The human form is found to convulse into basic units of musical octave.
E. The total alphabets (of Devnagari script) have been divided into eight groups as per the style of pronunciation by one articulation resulting in different sound frequencies.

Thus, the number eight appears to be common denominator in cosmos, time and human form (body) with common order or rhythm. The vastu (building) which encloses a part of vibrating cosmic space is also a living organism. It is oblivious that the vibrations of human and building must have unity of order. The measures are derived from the vibrations of the cosmic space thus attributing divine (cosmic) origin for all creations of the earth.

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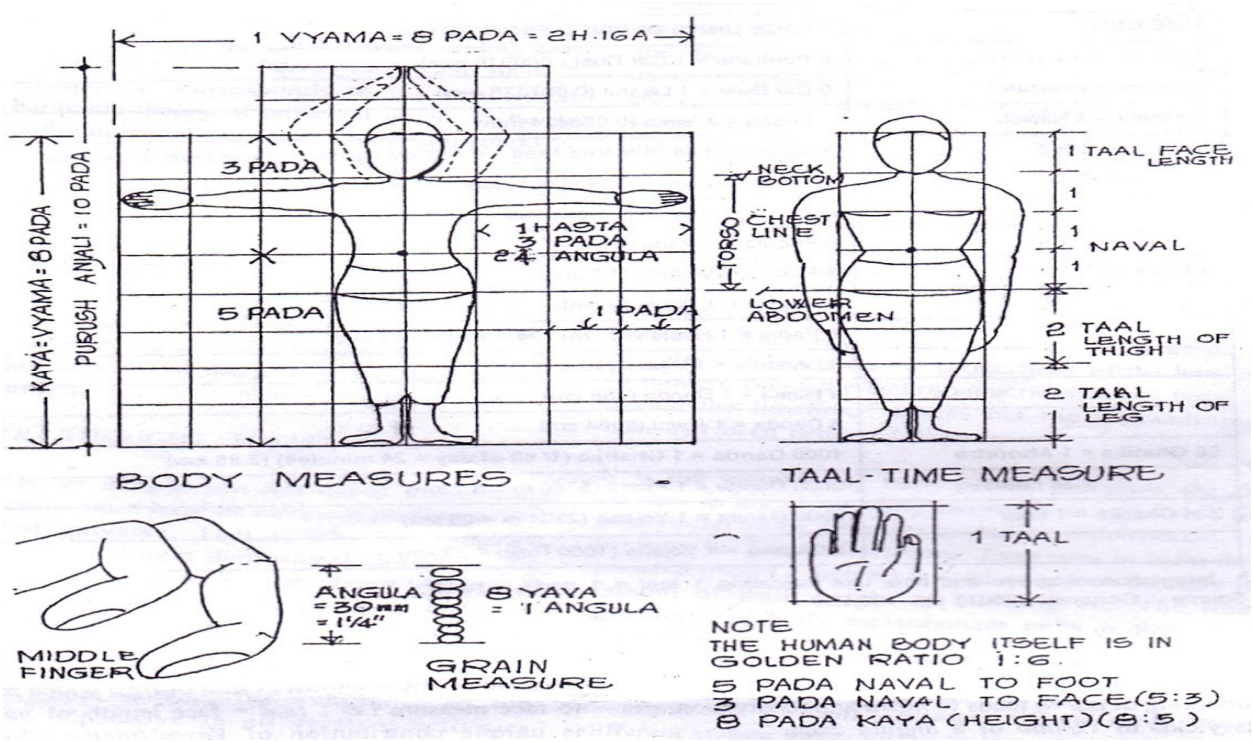


Fig.1 Integration Of Measurement System

VI.APPLICATION

Pertinently it implies that there will be as many scales as individuals which is not practicable proposition. If the height of an individual does not match to the standards it means the individual's rhythm is short of cosmic rhythm and has only two solutions:

1) The individual must elevate personal rhythm to universal rhythm through yogic practices etc; and

2) The designer limits himself in creating a space to individual psyche with standardized cosmic rhythm.

This is achieved through matching the designed cosmic or astronomical attributes of vastu (building or living spaces) to that of abstracted attributes of an individual by using ayadi shadvarga (the formulas related to aya). Ayadi is a set of six formulas aya (aya (income, vyaya (expenditure), Nakshtra (star group) Yoni (Virgina / organ), Vara (Solar day) and Tithy (Lunar Day). The ayadi shadvarga is an architectural device to find out appropriate and proportionate measurements, location, and orientation of building. Broadly the chosen dimensions appropriate to plot (length, width, height, area, volume, perimeter etc.) are checked by multiplying the co-efficient and divided by the divisor to find out the reminder. The co-efficient / divisor are chosen number of cosmic order such as (a) number of directions – 8 or 10, (b) 12 months (time period of one orbit of earth), (c) solar days – 7, (d) lunar days – 30, (e) star group – 27, and (f) Seasons- 3.

Table: 2

Yoni number (Reminder)	Yoni Name	Position with respect to focal point Location and orientation	Notes: The location/orientation in the odd reminders is preferred being in the cardinal direction. ii) The vastu be located in the respective zone and should face the respective direction as indicated by reminder. iii) The even yonis are used for elements other than building.
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Source: Achuttan and Problem (1998) P. 108

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It can be noticed that the chosen numbers depict the time period causal to the solar attributes, thereby establishing the cosmic resonating relationship. The deciding factor is the reminder, which a number and qualitative name. Although the formulas are different in different texts the contents and context remains the same.

A. Reminder

The reminder has attained the significance in Hindu way life. Firstly, the nil reminder denotes the end or death of procreation and hence no continuum. For example if any animate thing (tree, cattle, species) does not have reminder (seeds, baby cattle or species) it will extinguish. Secondly, finding out the reminder is most common in Hindu astronomical calculations. The quotient indicates the traversed part of the planet in the cosmic order and the reminder denotes the part in which it is at that particular time.

B. Yoni

Of all the formulas, the Yoni formula with inbuilt choice of prime dimensions is used to decide the correct location and orientation of building in the vastu Purusha Mandala superimposed over the plot with respect to centre of gravity (CG) of plot (focal point) the vastu can take any of 8 positions (4 each in the cardinal and sub-cardinal zones) these positions or direction is taken as a birth place of the vastu in the cosmos and denoted by its Yoni. The reminder number and the qualitative is name as in the table 2.

This method is analogues to the method according to which the place of any particular planet or celestial body at a particular time is found in the zodiac circle of Nakshtras (groups of stars) (27 number in 360° i.e. 13º.20' or 800 minutes for each Nakshtra). According to "suryapradnapti" the longitude of planed expressed in minutes is divided by 800. The quotient shows the number of Nakshtra through which the planet has already passed and the reminder traversed part of the Nakshtra in which it is at the time. In a similar way the location and orientation of vastu is ascertained in the cosmos. For desired suitable position of the vastu, the perimeter is altered by changing proportions of length and width. The wrong perimeter and reminder will provide disorder as the vastu will obstruct the course and order of cosmos and thereby the resonance.

The prime dimension of perimeter of vastu for Yoni computation should be in befitting units (Angula – Pada- Hasta) in whold number facilitating the division by eight and getting the integer as reminder. Thus a perimeter of 9 pada (3 hasta) if divided by 8 gives a reminder 1 i.e. Dwaja Yoni meaning the vastu be located in east zone of the plot facing east (Table 2). If the perimeter is successively increased by one Pada (P=10, 11, 12….16) will give a reminder of 2, 3, 4,…… giving successive directions in clockwise starting from East. Thus the system of perimeter yielding same Yoni can be seen along the eight radial vectors (with 8 Pada pitch) of an Archimedean spiral with an initial diameter of 9 pada (3 Hasta) and spiral opening in clockwise directions. (Fig – 2 yoni) spiral). (The respective location and orientation of vastu as per YONI number has been shown in Fig. 2-A).

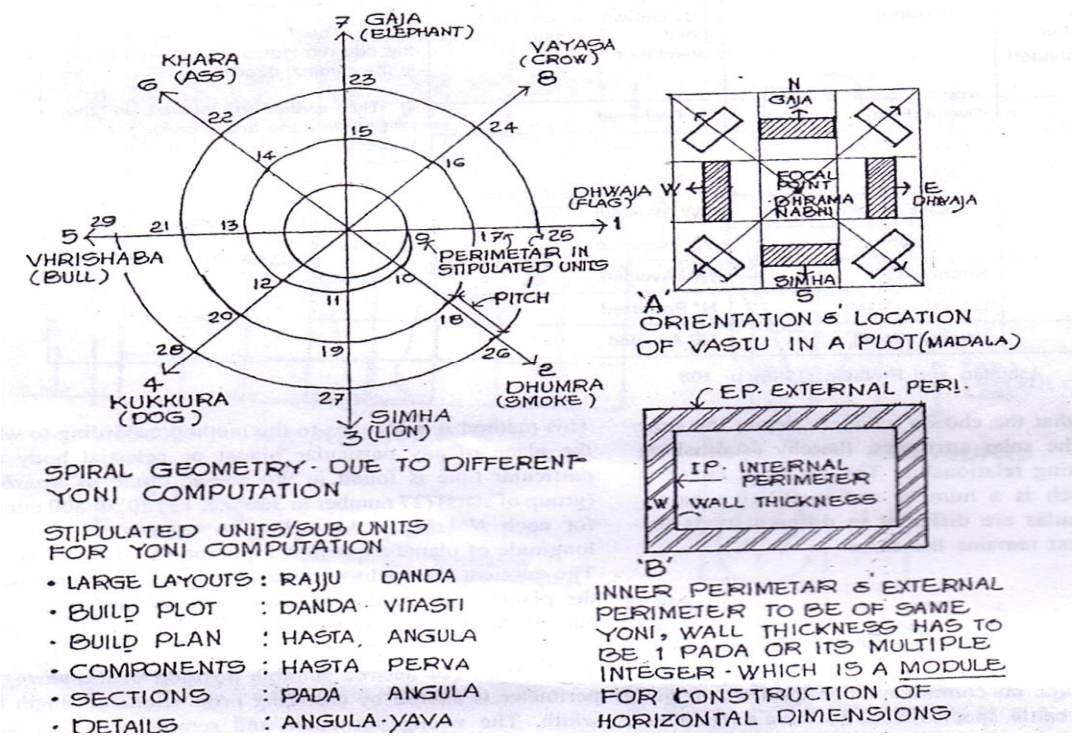


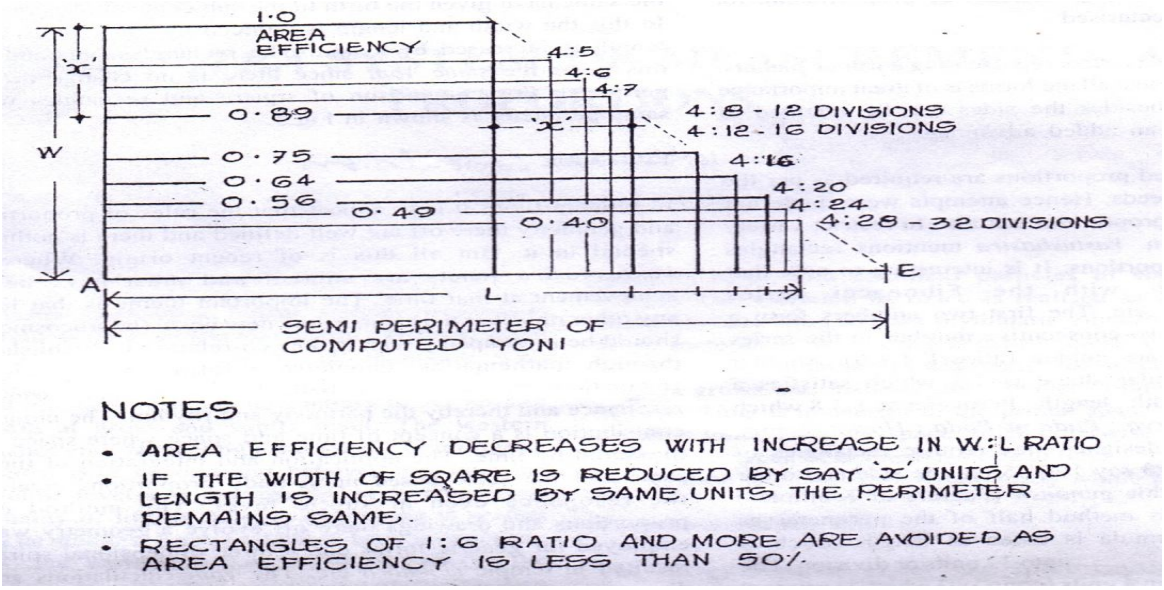
FIG. 2 YONI SPIRAL

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TABLE - C GROUP OF RATIOS (W:L)

SAMATAT	PADADHIKA	ARDHADHIKA	PADONA	SAMATAT
4:4 (1:1)	4:5 (1:1.25)	4:6 (1:1.5)	4:7 (1:1.75)	4:8 (1:2)
4:8 (1:2)	4:9 (1:2.25)	4:10 (1:2.5)	4:11(1:2.75)	4:12 (1:3)
4:12 (1:3)	4:13 (1:3.25)	4:14 (1:3.5)	4:15(1:3.75)	4:16 (1:4)
4:16 (1:4)	4:17 (4:4.25)	4:18 (1:4.5)	4:19(1:4.75)	4:20 (1:5)
4:20 (1:5)	4:21(1:5.25)	4:22 (1:5.5)	4:23(1:5.75)	4:24 (1:6)
4:24 (1:6)	4:25 (1:6.25)	4:26 (1:6.5)	4:27(1:6.75)	4:28 (1:7)

Source from Achuttan and Problem (1998) pp. 133-185



VII. MODULAR CO-ORDINATION

The perimeter can be measured expounded inside and outside (additionally it can be at centre line also). The Vastushastra texts recommend that ideally both inside and outside perimeter should yield the same Yoni number. This is possible only if the wall thickness is equal to 1 pada which becomes the module for construction or design (fig. 2-B). For smaller components such as door / window frames the unit of measurement is Parva (Parva= 3 Angula= 1/9 Hasta). Again the starting point is the inside perimeter may be 9 parva to get Dwajyoni. If the outer and inner perimeter has to have same Dwajyoni the thickness of frame will have to be 1 parva (3 Angula = 9 cm) or its integer multiples. Thus a module of 3 A (9cm) is used for vertical measure of elements such as door / window height, Masonry joint, sill lintel, beam depth etc. Incidentally the brick size in ancient times in South India was IP x 1/2P x 3/8 P i.e. 8 A x 4 A x 3 A i.e. 24 cm L x 12 cm W X 9 cm H (where P = pada and A = angula).

VIII. PRESCRIBED UNIT

It must be noted that the prime dimensions must be taken in prescribed basic units and sub-units as per Vastrushastra which otherwise may give paradoxical results. For example a rectangle of 3 Hasta perimeters will give dwajayoni in pada unit but vayasa Yoni in Parva and angula units. It also means that Yoni computations cannot be done in any units least of all in modern units such as foot / meter etc.

IX. PROPORTIONS AND FORM

Several attempts have been made to define, what proportion on the basis of mathematics or geometries is? Similarly in vedic times (ancient Indian) also efforts were made to evolve perfect and proportionate form. The three dimensional form grows out of plan composition. Any geometrical plan shape defined by perimeter is termed as mandala. However, the search was directed to the ideal proportions of rectangular spaces as obvious choice. The application of Yoni formula decides the location / orientation of the vastu on the basis of its perimeter, but vastu to be aesthetically pleasing to look at must be proportionate for which it is further sectarised.

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The embodied form of a circle, representing earth or planets, is a square evolving almost all the forms is of great importance as per vastushastra, besides the sides can be oriented to cardinal directions is an added advantage.

The rectangles of varied proportions are required as per the functional or design needs. Hence attempts were made not only to define perfect proportions but also to restrict variety through standardization. Vastushastra mentions rectangles of 1:2, 2:3 and 3:5 proportions. It is interesting to note that these ratios match with Fibonacci series 1, 1, 2, 3, 5, 8……etc. The first two numbers form a square. The ratios of two consecutive numbers in the series such as 3:5, 5:8 etc. are golden ratios (1:1.6). Another proportion for rectangular shape is 1:3 which satisfies a condition relating to width : length : Perimeter as 1:3:8 which represents Angula : Parva : Pada or Pada : Hasta : Vyama. In actual practice the designer may require rectangles of proportion more than 1: 3 say 1:4, 1:5 on one side and other small ratios also. For this gunansh (Factors of Multiples) concept is used. In this method half of the perimeter as deduced from Yoni formula is taken as length which is divided in 8, 9, 10, 11 ……. up to 32 units or division. The width of rectangle is taken 4 units (constant) which is original value symbolizing the four main cardinal directions and the length is remaining units. Thus rectangles of proportions of width to length equal to 4:4 (square), 4:5 (1:1:1.25), 4:6 (1:50), 4:7 (1:1:75) ……..to 4:28 (1:7) are obtained. The twenty-four shapes i.e. 24 ratios excluding the square cover the whole range of rectangular mandala which has been grouped in class is (a) W : L both integers (b) 1 W : 1.25 L. (c) I W: 1.5 L (d) 1 W : 1.75 L. The integer proportions are named SAMTAT and always to be preferred. Others are shown in the Table – 3 Group of ratios.

Padona ratios (1:1.75) are to be avoided as per the Vastushastra norms. In all the above cases if the area enclosed is calculated and the area efficiency is computed from the ratio of compared to that of square having same perimeter goes on decreasing. If the efficiency of a square in taken as one then the efficiency of a 1:7 rectangle is less that 50% i.e. 0.40. As it is from purely economic reasons and proportion the rectangles greater than 1:6 (i.e. 32 divisions of a perimeter) may not be acceptable. That is why the table does not have ratios more than 1 : 7 (4 : 28).

This method of developing different proportions of rectangle with perimeter remaining the same and hence Yoni remaining the same have given the birth to the sub concept of pandyoni. In this width and length is reduced by say x units and length is increased by x unit. The rectangles obtained by this gives the same Yoni since there is no change in the perimeter. For comparison of square and rectangles with same perimeter is shown in Fig.3.

X. CONCLUSION

In modern times it may appear that the rules of proportion and geometry ther off are well defined and there is nothing special in it. But all this is of recent origin. Where - as, Vastushastra tenets are ancient. They must have been achievements at that time. The important theme is that like any other object in the cosmos, the new vastu (microcosmos) should be in sympathy with it. The co-relation is established through mathematics, geometrical forms, astronomical calculations etc., which it is believed has the same cosmic resonance and thereby the harmony and rhythm. The unique contribution is a concept of time and space where space is measured by time. The application and integration of time scale and the scale based upon body proportions creates the resonance even at subtle level. The method of proportions and drawings there off evolve a geometry was employed for generic forms e.g. a three dimensional spiral resulted in temple shikhara etc. The Yoni calculations are dimensions arrived at by using other formulas gives divinity to vastu unlike in present day architecture, which is an assemblage of conveniences and utility along with other factors. But is far away from the vastu concept that it has to resonate with cosmic order.

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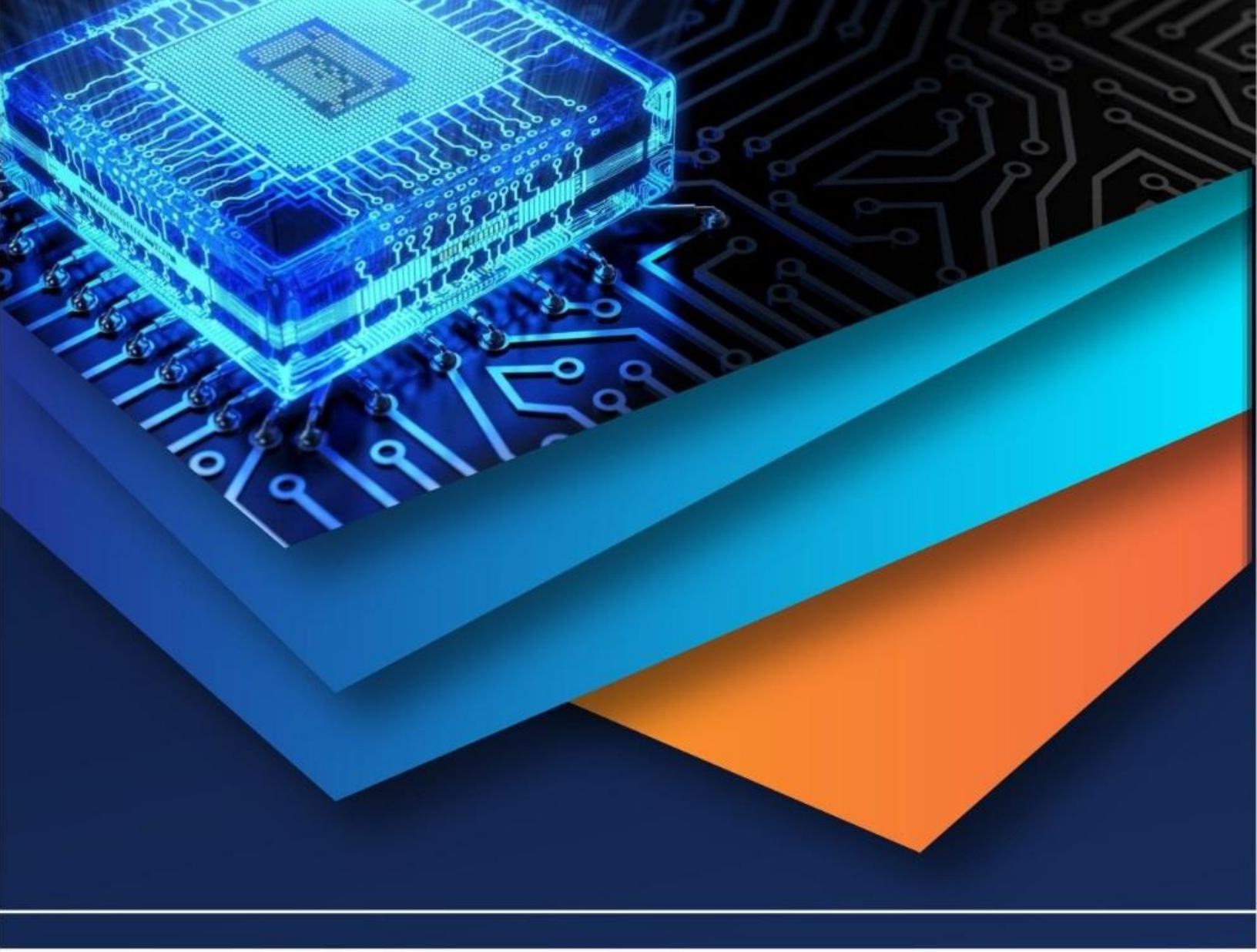
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Source: Achuttan and Problem (1998) P. 108

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