

SANSKRIT VĀSTU-WORKS ON SOIL-TESTING

MANABENDU BANERJEE*

(Received 1 November 1995)

Sanskrit treatises on *vāstu* (architecture) consider soil-testing to be the first and foremost requirement for the construction of a building—both residential and temple. Ancient architects determined the fitness of the site, selected for a temple or a house, through several tests. They regarded the earth to be the 'real thing', for the support extended by it to all types of building-architecture. A site was usually chosen after close inspection of the earth's qualities like colour, smell, taste, form, sound etc. White-coloured and square-shaped land, having its sloping towards north, was regarded to be the best. Red-coloured land with sloping towards east has also been praised. The *Vāstu*-works make it clear that a piece of land which rises towards the north or east is good for all types of constructions, for such a land would ensure easy flow of the energy. Land having on it trees like *udumbara* (Fig tree; *Ficus glomerata*), *plākṣa* (Waved-leaf Fig tree; *Ficus infectoris*) and *nyagrodha* (Banyan or Indian Fig tree; *Ficus indica*) has been prescribed for a construction which would last long.

It has been further prescribed that various seeds are to be sprout on the soil by which percolatory nature of the site could be determined. Soil having uniform colour, smoothness, compactness, and which is pleasing to the sight and mind at its touch should be considered to be the fittest. The land meant for constructing buildings should be freed from pebbles, bones, worms, thorn-trees, charcoal, nails, etc.; it should be made even and firm; a site that is situated beside an assembly hall or a temple or a Buddhist *Caitya* or a palace is to be avoided, otherwise the peace of the residents might be hampered.

Circular and triangular land, and that which is narrow or elevated in the centre are to be rejected. A site which is neighboured by a water-course is good, for the latter facilitates irrigation. The *Vāstu*-works contain very clear descriptions of various methods of testing the soil, and these measures were perhaps alternatively employed.

It is very curious to note that in a far remote period, site-selection and soil-testing by Indian architects has to go through several remarkable and practical procedures, and only after then the plan of building was permitted to be drawn. Modern students of Architecture and Civil Engineering have for them in the Sanskrit *Vāstu*-works variegated interesting materials relating to the essential qualities of soil which however need a scientific elaboration by testing in the laboratories.

Key Words: *Agnipurāṇa*, *Bhaviṣyapurāṇa*, *Bhūparikṣā*, *bhūmiparikṣā*, *Mānasāra*, *Mayamata*, *Prāsāda*, *Vāstuśāstra*, *Viṣṇudharmottarapurāṇa*, *Yuktikalpataru*.

The early Sanskrit literature on Architecture (*Vāstuśāstra*) has framed some definite principles for the construction of buildings including temples, residential houses and also of towns. All the constituents of temple architecture have been touched upon and sometimes elaborated by the authors of the *Vāstuśāstra*. For the construction of a building, the first and foremost requirement was considered to be the testing of soils (*bhūparīkṣā*) by which the stability of the site on which a building was to be erected was ascertained. Special emphasis has been given on this aspect by almost all the *Vāstuśāstra*-writers. The *Vāstu*-texts instruct that at the time of building a temple or a house, the owner of the site as well as the architect should chant propitiatory hymns and make offerings by which the destructive entities, which are supposed to be active on the site, will depart to make room for the desired deity whose temple is to be constructed there and for the household deity in the cases of residential houses. To take possession of the site for the abode of a god (i.e., a temple), the following rhythmic formula is recited—

“Let spirits, gods and demons depart and seek other habitations. From now this place belongs to the divinity whose temples will be built here”.¹

Before the construction work is to be started, the fitness of the site selected for the house or temple needs to be examined through several tests prescribed in the *Vāstu*-texts. Measures are also to be taken to purify the soil. The *Mayamatam*, a medieval technical Sanskrit *Vāstu*-text, has given special stress on the testing of the earth on which a building is to be constructed. It says that in the matter of a building-construction, the earth is the principal object (*bhūr eva mukhya-vastu syāt* – Chapter 2, *śloka* 2); the earth (*bhū*) or the ground (*bhūmi*) is the place where buildings (*prāsādas*) of the mortals and Gods, as well as other architectural works are erected. So the earth, being the support of all types of building-architecture, is the real thing. Therefore in all the *Vāstu*-texts as well as in the *Purāṇas* which include a good number of chapters on architecture, examination of site has been treated first. A site is to be chosen after close inspection of the earth’s qualities like colour, smell, taste, form, orientation, sound and palpability. (*Mayamatam*, Chapter 2, *Śloka* 4). The *Matsyapurāṇa* (Chapter 253, *Śloka* 11) says that only after the testing of the soil, the planning of the house (or temple) is to be prepared.

In the principal *Purāṇas* (c. 300-800 AD), the chapters on *Vāstu* (Architecture) prescribe four colours of soils for four classes of people. Thus the *Viṣṇudharmottarapurāṇa* (Chapter 93, *Ślokas* 32-33), *Matsyapurāṇa* (Ch. 253, *Ślokas* 12-13), *Agnipurāṇa* (Ch. 247, *Ślokas* 1-2) and *Bhaviṣyapurāṇa* (Pt. I, Ch. 130, *śloka* 44) state that before laying the foundation of a temple (or a house), it is required to test the nature of the soil. White, yellow, red and black earth are stated to be auspicious for the four *varṇas*, i.e., Brāhmaṇas, Kṣatriyas, Vaiśyas and Śūdras respectively. In taste the soil should be sweet (*madhura*), stringent (*kasaya*), bitter (*tikta*), sour (*āmla*),

salty (*lavaṇa*), and pungent (*kaṭuka*). The tests on the basis of colours and tastes probably indicate that the soil of the proposed land was to be examined to ascertain whether it was suitable for cultivation and whether unpolluted drinking water was procurable near the surface of the land. The *Mayamatam*, a work later than the above-mentioned *Purāṇas*, has elaborated the Purāṇic sūtras.

The *Mayamatam* says (Ch. 2, *ślokas* 10-15): (a) the earth suitable for brāhmins is square (*caturasra*), white-coloured (*śveta*), flawless (*anindita*), embedded with *udumbara* trees, sloping towards north (*uttarapravaṇa*), stringent and sweet-tasting (*kaṣāyamadhura*). Such a land is believed to bestow good fortune on the owner (*sukhaprada*).

(b) The land for the kṣatriyas would be suitable if its length be one-eighth more than its width (*Vyāsaṣṭāmśādhikāyāma*), red-coloured (*rakta*) and tasting bitter (*tiktarasānvīta*); its sloping should be towards east (*prāṇnimna*), and vast in extent; it should be planted with *Aśvattha* trees (*pravisfirṇam aśvatthadrumasamṃyutam*); success is believed to be achieved from such a site.

(c) vaiśyas should select a site the length of which should be one-sixth more than its width (*ṣaḍamśenādhikāyāma*); this earth should be yellow-coloured and tasting sour (*pītam amlarasānvītam*); on this site there should be *plakṣa*-trees; its sloping is to be towards east; the vaiśya-owners would be benefitted by this land.

(d) The length of the site on which the buildings of śūdras are to be constructed should be one fourth more than its width (*catur amśādhikāyāma*); the sloping of this land is towards east (*prākpravaṇānvīta*); it should be black-coloured (*kṛṣṇa*) and pungent in taste (*kaṭukarasa*); it should be planted with *nyagrodha* trees; the śūdras are believed to gain from such a land plenty of riches and crops (*dhanadhānya-samṃddhidā*).

One point is to be noted here that all the sites marked for the building-construction should slope towards north or east. The *Mayamatam* makes it again clear that the site must rise towards the south or west (*dakṣiṇe paścimonnatam*) (3. 1). The *Mānasāra*, another important work on medieval architecture, is of the same view (*dakṣiṇe paścime caīva connataṃ catur aśrakam* – Chapter 4, *śloka* 1).

The directions, given above, are important because of the reason that they pertain to the earth's magnetic field and ensure easy flow of the energy. Though four kinds of trees, allotted in order of sanctity, have been prescribed for planting on lands of four *varṇas*, six varieties of other hardy trees² having more or less pleasing smell of their fruits are also required to be made to grow on all the sites. These are – *bilva*, *nimba*, *nirguṇḍī*, *piṇḍīta*, *saptaparnā* and *sahakāra* (*Mayamatam*, Ch. 3, *śloka* 4).

Various seeds are to be made to sprout on the soil (*sarvavījaprarohiṇī*). The *Viṣṇudharmottarapurāṇa* (Ch. 93, *śloka* 32) prescribes that the ground should be covered with *kāśa*, *śara*, *kuśa* and *dūrvā*. With these empirical procedures, the percolatory nature of the site was determined. The soil's fitness was also outwardly examined by verifying that it was of uniform colour (*ekavarṇā*), compact, smooth, pleasing to sight and mind at its touch (*sukha-saṃsparśānvitā*).

The *Mānasāra* also recommends that a good ground should contain milky trees, full of fruits and flowers, e.g., *khadira*, *kadamba*, *nimba*, *campaka*, *puṣṇāga*, *āmalaka*, *saptaparna* and some other varieties. It should be noted here that of all the trees mentioned in the Purāṇas and the *Vāstu*-texts, some are regarded by Indians as holy by virtue of their medicinal and prophylactic properties.

The different colours of soils for the four castes referred to above do not, however, speak of the qualitative demerit of the soil in the sequence even though temples or residential buildings are permitted to be constructed on all those sites having hue of all the four varieties. B.B. Dutta³ has perhaps furnished the right justification for the allotment of lands of four colours to brāhmaṇas and others. He says, "It is said that people were originally classified into castes according to their complexions (*varṇas*). The complexions of the brāhmaṇas was white, emblematic of purity and holiness; that of the kṣatriyas was red, colours of the blood, symbolic of battle and martial spirit; that of the vaiśyas was yellow, the colour of gold, emblematic of commerce; that of the śūdras was black, the colour of the non-Aryan low caste people, signifying ignorance and dirty habits."⁴

The *Vāstu*-works prescribe that before raising a construction, the ground is to be made even by freeing it from pot-sherds (*niṣkapāla*), pebbles, bones, worms etc. The soil may be mixed with little sand (*tanuvālukāsaṃyutā*) and there should be no hole there (*na suśira*). Charcoal, stumps and every kind of pointed objects must be removed from the site (*aṅgārair vṛkṣamulaiśca śūlaiścapi pṛthag-vidhaiḥ*). Slush, ashes or husks are not to be allowed to be mixed with the soil (*śarkarābhir ayuktāyā bhaṣmādyais tu tuṣair api*).⁵ The *Matsyapurāṇa* (Ch. 253, *ślokas* 49-50) states that at the time of the commencement of the construction of a building, if the owner feels an itching sensation on his body, it is apprehended that there are nails or some foreign particles under the ground. The owner of the land should take steps to remove those nails etc. from the site, for it is believed that a plot of land containing such elements is always dangerous. The *Bhaviṣyapurāṇa* (I. 130. 43) states that the site which contains coal, hair, stone, bones, etc. is unfit for the erection of a temple (*śarkarā-tuṣa-keśāsthikṣārāṅgāravivarjitā*).

The *Viṣṇudharmottarapurāṇa* emphasizes that after taking out the nail-like objects (*śalya*) from the ground, the latter is to be properly prepared and made levelled. Even

a small particle of nail should be removed and in this respect assistance from an expert is to be sought.⁶ Even a work like the *Śatapatha Brāhmaṇa* of the pre-Christian era states (8. 5. 2. 16) that the site, the earth, should be made even and firm, for 'it is the starting point of the ascent'. A late tantrik work, called *Īśāna-śiva-gurudeva-paddhati* (Pt. III, Ch. 36, *śloka* 79) says that the ground should be made even all over, like a mirror. The *Vāstuśāstra*-authors are unanimous in that after being finally levelled, the ground is to be made ready for "the drawing of the *Vāstupurusamaṇḍala*, the metaphysical plan and forecast of the temple."⁷ Only after then the architect will think of beginning the construction. Though many of the above descriptions may appear to be magical, some may be of scientific in character.

Houses are generally advised not to be constructed on a site which is situated in the vicinity of an assembly hall, Buddhist caitya, palace or a temple⁸ may hamper the peace of the residents, because of the noise likely to emerge from the congregation of people. The *Mayamatam* rejects a site which is embedded with thorny trees (*Kaṇṭakidrumasamṃyutā*), which is circular or triangular or shaped non-uniformly or like a *vajra* (i.e. narrow in the centre) and the site which is raised in the centre like a tortoise (*vr̥tta-triṅga-vaṣamā vajrābhā kacchaponnatā*) (Ch. 4, *śloka* 12). For a temple or for the buildings of brāhmaṇas, the *Mayamatam* recommends a rectangular site (*catur aśrīyatāḥ śrūtāḥ*). A site which may be entered through several passages (*bahupraveśamārgā*) and which is crossed by a road (*mārgaviddhā*) is also rejected. It is good if a site is neighboured by a water course which, when the site rises to the south, runs to the north and when the site has the west-ward elevation, it flows towards the east. The principal profession of ancient Indians being agriculture, a small canal-like water course near the site was insisted upon. According to Śukrācārya, an ancient author on politics, when a town was to be set up, attention was given on the maintenance or creation of a network of rivers and waterways to facilitate irrigation as well as navigation by means of boats.⁹

A land elevated in the centre has been rejected by both the *Mayamatam* and the *Mānasāra*, though the actual reason for this objection is not clear to understand. Again, while in the opinion of the majority of the *Vāstuśāstra*-authors, the land is to be levelled and should have the proclivity towards the east or north. Bhoja, the king of Dhārā (11th century AD) in his *Yuktikalpataru* (*ślokas* 156-157) has expressed his view that the site meant either for a house or a town should be elevated in the centre and sloping towards the east or north-east. According to Bhoja, "a southern declivity is responsible for all kinds of insanitation and for causing diseases; a declivity towards the north is conducive to wealth, while a westward slope destroys peace and prosperity; a depression of the ground in the middle conveys poverty while a depression on the borders brings the happiness."¹⁰ When almost all the *Vāstuśāstra*-texts are unanimous in hailing the easterly slanting of a ground, they evidently guarantee the complete benefit of the morning sun. But the northerly declivity recommended by a majority

of the *Vāstu*-authors is unintelligible and cannot be properly justified. India's existence is to the north of the equator, so the proneness of the site towards the north will not only lessen the opportunity of getting the sunlight, but also will "expose any building to the chill winds of the winter". So the *Vāstuśāstra*-writers were expected to describe that the site should be slanting towards the south. But that has not been done and this cannot be satisfactorily accounted for. B.B. Dutta however forwarded a justification which is interesting but seems to be not much convincing. He says, "In a hot country like India, too much exposure to the sun's rays, such as a southerly declivity would bring about, cannot be desirable, for it would make the buildings too hot and the soil too dry. The prevailing winds and rains in India are from the south and west. If the ground slopes towards these directions, the house would be dangerously exposed to every storm and shower".¹¹ According to the *Vāstu* texts westerly proclivity of a land for a house, temple or town was to be avoided, perhaps, for the reason that Indian tradition believes in that the west represents Varuṇa, the god of rain and water, who can make the frontal atmosphere gloomy. Likewise, prohibition to select southerly sloping land might have been conceived from the notion that the south appears to be particularly inauspicious because it represents Yama, the god of Death. On the other hand, the Himalaya mountain, which is believed to be the abode of gods, being situated at the northern end of the Indian territory has been recommended for building temples, houses or towns on lands having northerly declivity for the purpose of paying homage to gods. Merits, if any, of a north-sloping land is based mainly on superstition and expert architects and civil engineers can say whether this has any sound scientific background.

The examination of the ground in respect of its colour and taste having been made and having ascertained its outward appearance, such as, the growth of trees and shrubs, elevation, depression, etc., the quality of the soil was further tested in some peculiar ways. In this regard, the *Purāṇas* contain very clear descriptions. Architects could apply any of these according to their choice.

(A) On the ground selected for building-construction, a hole measuring one and a half square foot is to be dug and it should be smeared with cow-dung. In the pit, an earthen pot full of ghee along with four lit wicks is to be put, pointing the wicks to four cardinal directions. If the wicks remain there bright for some time, the site is considered auspicious for a temple or a house.¹²

(B) On the ground, one and a quarter cubit of land is to be excavated. The pit is to be filled up with the excavated earth. If there is more earth left after filling the hole, the construction on that ground is considered excellent (*adhike śriyam āpnoti*), for it is to be understood that the ground is of rich compactness. If the pit is not entirely filled up with the excavated earth, the site is to be rejected (*nyūne hānim*), and lastly if the pit is exactly filled up by the excavated earth, it is to be considered

as of medium quality (*same samam*).¹³ The *Mayamatam* (Ch. 4, ślokas 17-18) records the same method of soil testing. The *Bhaviṣyapurāṇa* provides us also with almost the same method of test. — “A pit be dug and filled with earth dug from it. If the pit is filled completely and some earth is left over, it is of good quality; if the pit is filled with the earth that has been excavated from it, it is said to be of medium quality; if the pit remains unfilled with the same earth, then it is of inferior quality.”¹⁴

(C) The *Viṣṇudharmottarapurāṇa* (Ch. 93, ślokas 42-43) regards it to be the best type of ground which explicitly sends out good smell and pleasant sound (*sā praśastā mahī jñeyā sugandhā susvanā tathā*); which is sloping to the north (*prāg udak-pravaṇā*); which is shiny and stable (*snigdhā ca sudṛḍhā tathā*); which after being dug out cannot only be refilled with the excavated earth, but also the latter remains in excess (*khāte dhikaṃ ca mṛdyatra pūryamāne tathā bhavet*); in whose pit a burning lamp does not faint and a garland of flowers, if placed in it, does not wear out (*dīpaṃ na mlāyate yatra nyastam ca kusumaṃ tathā*); and water poured into whose pit stay for a long time (*toyam satiṣṭhate khāte yatra kālāntaram bahu*).

(D) Another type of the soil testing has been suggested by the *Matsyapurāṇa* (Ch. 253, śloka 18). It says that the land is to be ploughed and various kinds of seeds are to be scattered there. (*phālakṛṣṭe 'thavā deśe sarvavījāni vāpayet*). Thereafter it should be looked out how much the seeds have grown within three, five or seven days; if they grow tall within these days, the land is regarded good; if the growth is moderate, the land is to be uprightly rejected.¹⁵ Thus the fertility and fitness of the land are to be ascertained and a fertile ground is considered to be good for laying the foundation of a construction.

(E) The *Agnipurāṇa* (Ch. 39, śloka 18) is in favour of ploughing the land, marked for the building, only with cows (*halena vāhayitvā gām gobhiś caivāvadārayet*) and the *Mānasāra* (Ch. 5, śloka 85) says that ploughing should be made for several rounds. The latter further states that the architect himself after offering *pūjā* to the deities, will drive oxen across the ground and remove therefrom grass and weeds. Thereafter the ground is to be ploughed by a pair of strong and blemishless oxen. Then all kinds of seeds (like sesamum seeds, pulse, etc.) mixed with cowdung are to be sown on the ploughed ground. “When the crops have matured and flowers are in bloom, the cows, generally the cattle of the community, together with oxen and calves, are put to graze on them and they are allowed to remain there for one or two nights: for the ground is purified by the grazing of the cattle, consecrated by their exhalations, purged of impurity by the hilarious belowing of the oxen, cleansed and sanctified by froth flowing from the mouths of the calves, laved by bovine urine, besmeared with their ordure and chequered with slipped cud and their foot-marks. The foregoing procedures of selecting and sanctifying the ground were followed in all cases of a village, a ward, a fortress and the like.¹⁶

(F) The *Mayamatam* (Ch. 4. *ślokas* 5-8) prescribes almost the same procedure of purifying the ground with bovine substances. It further adds (Ch. 4, *ślokas* 10-15) a novel method of soil examination. It is stated that at the centre of the site a square piece of land should be dug out to the depth of one cubit (*aratni*).¹⁷ The pit should be dug out faultlessly so that it is not too narrow or too deep (*asambhrāntam-asamkṣiptasamucchrayam*). The pit is to be consecrated with water washed from all jewels, mixed with sandal and thrashed rice (*candanākṣatamiśreṇa sarvaratnodakena ca*). Thereafter the architect will fill the pit with water at nightfall and lie down on the ground beside the pit. Next morning if he find a remanant of water in the pit, then the ground is to be treated as the precursor of prosperity (*sāvaśeṣam jalam drṣṭvā tad grāhyam sarvasampade*). If the ground is found damp and muddy, the construction on it would be ruined (*klinne vāstuvināsāya*) and if the water is completely dried up, the ground signifies loss of harvests and riches (*śuṣke dhānyadhanakṣayaḥ*).

Sūtradhāra Maṇḍana, in his work on architecture, namely, *Rājavallabha*, slightly amends the above method of soil testing. he says, "Sink a pit one cubit deep, fill it up with water, walk away a hundred paces from it, and then come back and see. If the water stands slightly below the brim, then it is best; if the pit is empty by one quarter, then it is middling; if the pit is found only half-full, then it is the worst."¹⁸

All the above-mentioned measures, were perhaps, alternatively used to be taken by ancient Indian architects to ascertain the durability, solidity and fertility of the soil. It is interesting to note that a very long time back from now the site selection and soil-testing had to go through several remarkable and practical procedures after which the plan on the ground (i.e. the building site) was drawn. At present in India soil testing is considered essential for multistorey buildings only. Calcutta Municipal Corporation has made soil testing compulsory for buildings above 11 m. in height only after the devastation of some high rise buildings during the recent past. No testing is generally required for one to three storeyed buildings. But we have references in the Purāṇas and other works on architecture to multistoreyed buildings including tall temples, and the *Vāstu*-texts have made it compulsory to test soil for all types of buildings and also for establishing a town.

The proponents of the *Vāstuśāstras* have taken all steps – both magical and scientific – to strengthen the foundation on which a structure along with its other forces is to stand. In fact the *Vāstuśāstras* started to be formulated in India in about 2000 BC, i.e. during the Vedic times and highly flourished from 300 AD onwards. According to some modern civil engineers, the principles laid down in those works can be used even now-a-days for at least one or two storey buildings.

The *Vāstuśāstra*-authors had certainly some idea about the significant properties of soils, i.e., permeability, consolidation and compressibility, and shear strength which

are at present being studied as part of Soil Mechanics. What were in very germinal forms in the *Vāstu*-texts are now being developed quantitatively by experts in the Soil Mechanics.

The classification of soil on the basis of its colour i.e., white, red, yellow and black has a scientific basis, but their association with the four *varṇas*, i.e., *brāhmaṇas* and others is doubtful.

In conclusion, it may be stated that a student of the history of Indian Architecture and Civil Engineering will certainly find interesting materials in the *Vāstuśāstras* including the *Purāṇas*, which though remain in somewhat rudimentary forms, can be treated as the germs of soil-properties and this should be one of the subjects of research in recent time. The descriptions of soils in the *Vāstuśāstras* need a scientific elaboration by testing in the modern laboratories and corroboration by new findings.

ACKNOWLEDGEMENT

I am indebted to Professor S.R. Bhattacharya, Department of Civil Engineering, Jadavpur University, Calcutta, for furnishing me with some valuable suggestions and information.

REFERENCES & NOTES

1. *apakrāmantu bhūtāni devatāśca sarākṣasāḥ/
vāsāntaram vrajantvasmāt kuryāṃ bhūmiparigraham//*
*rākṣasāśca piśāśca ye'swiṃ stīṣṭhanī bhūtale'/
sarve te vāpaḡacchantu sthānaṃ kuryāmaham hareḥ"//*
– Mayamatam, IV. 3;
Agnipurāṇa, 39. 17; Brhatsamhitā, 58. 2.
2. Thus the spirits having been asked to leave, possession is to be taken of the site.
2. The botanical or english names of the Sanskrit terms for the plants mentioned in the article are – *Āmalaka* = Emblic myrobalan; *Nimba* = Neem tree, *Azadirachta indica*; *Bilva* = Wood-Apple tree; *Nirguṇḍi* = *Vitex negundo*; *Piṇḍiā* = A species of Date tree; *Tabernaemontana coronaria*; *Sāptaparnī* = *Alstonia scholaris*; *Sahakāra* = Mango tree; *Udumbara* = Fig tree, *Ficus glomerata*; *Aśvattha* = *Thespesia populneoides*; *Nyagrodha* = Banyan or Indian Fig tree; *Ficus indica*; *Plakṣa* = Waved-leaf Fig tree, *Ficus infectoris*; *Kuśa* = A grass with long pointed stalks, *Poa cynosuroides*; *Kāśa* = *Saccharum spontaneum* – used for mats, roof etc.; *Sara* = A sort of Reed or Grass, *Saccharum Śara* – used for arrows; *Dūrvā* = Durb grass, *Panicum dactylon*; *Khadīra* = *Anacia catechu*; *Kadamba* = *Nauclia cadamba*; *Campaka* = *Michelia campaka*; *Pumṇāga* = *Rottleria tinctoria*. (Monier William's *Sanskrit-English Dictionary*).
3. Dutta B.B., *Town-Planning in Ancient India*, p. 49.
4. *Ibid.*, p. 57.
5. *Mayamatam*, Ch. 4, *śloka*s 7-9).

6. *aśalyayā mṛttikayā purayed sudr̥ḍham punaḥ*
ḥṛtvā tu pūritam deśam sudr̥ḍham suśamaḥ tataḥ
susūkṣmaśalyajñānārthaḥ Kuryāc chalyapaikṣaṇam
 – *Viṣṇu Dh. Pur.*, Ch. 94, Śloka 7-8.
7. Kramrisch S., *Hindu Temple*, I, p. 16.
8. *Mayamatam*, Ch. 4, śloka 11).
9. *Śukranītisāra*, Ch. 1, śloka 214.
10. Dutta, *op. cit.* p. 52.
11. *Ibid.*, pp. 53-54.
12. *Matsyapurāṇa*, Ch. 253, śloka 12-13.
13. *Op. cit.*, Ch. 253, śloka 15-16.
14. *Same samaguna jñeyā hīne hīnaguṇā bhavet*
vardhamane tu vai pāṃsor bhaved vrdhikarīkṣitih
 – *Bhav. Purāṇa*, Pt. I, Ch. 130. śl. 47.
15. *tri-pāñca-sapta-rātre ca yatrārohanti tāny api*
jyeṣṭhottamā kaniṣṭhā bhūr varjanīyatarā sadā
 – *Mat. Purāṇa*, Ch. 253, śloka 18.
16. Dutta, *op. cit.* pp. 61-62.
17. *vastumadhya tatas tasmin khānayed vasudhātalam*
aratnimātragambhīram catur aśrasamanvitam
 – *Mayamatam*, Ch. 4, śloka 5-8.
18. Dutta, *op. cit.* p. 58.

BIBLIOGRAPHY

- Acharya, P.K., *Architecture of Mānasāra*, Munshiram Manoharlal, New Delhi, 1980.
- Acharya, P.K., *Hindu Architecture in India and Abroad*, New Delhi, 1979.
- Agor, R., *Civil Engineering*, Delhi 1992.
- Bhat, M. Ramkrishna (ed.) – *Bṛhatsaṃhitā*, Motilal Banarsidass, Delhi, Varanasi and Patna, 1981.
- Dagens, B., *Mayamatam* (in two Volumes) – translated and edited, Indira Gandhi National Centre for the Arts, New Delhi, 1994.
- Datta, M.N. (Translated), *Agnipurāṇa* (in two Volumes), Varanasi, 1967.
- Meister, Michael W. (ed.), *Ananda K Coomarswami: Essays in Early Indian Architecture*, Indira Gandhi National Centre for the Arts, New Delhi, 1992.
- Shah, Priyabala (ed.), *Viṣṇudharmottarapurāṇa* (Part – III) in two Volumes, Oriental Institute, Baroda, 1958 & 1960.
- Sastri, T. Ganapati (ed.), *Śilparatna*, Part-I, Trivandrum, 1922.
- Sastri, T. Ganapati, *Īśāna-śiva-gurudeva-paddhati*, Trivandrum, 1925.
- Sarkar, Binoy Kumar (ed. & trans.), *Sukranīti*, New Delhi, 1975.
- Taluqdar, A. (trans.), *The Matsyapurāṇa*, New Delhi, 1987.