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## Civilisation and *sthapatis* of India

C.V. Kand

### Indian civilisation

Civilisation is intimately connected with civil engineering. In India the community which used to handle civil engineering was called *Sthapatis* in Tamilnadu, *Shilpi* in Karnataka and Andhra, *Vishwakarma* or *Karigir* in Rajasthan and *Sompuras* in Gujrath. *Sthapati* was one who created either a house or temple or even made a painting or made statue of God. A creator of things useful for human beings is *Sthapatis*. Books on *Vastushastra* also contain details of painting and sculpture. *Samarangan Sutradhar* written by Raja Bhoj in 11<sup>th</sup> century has chapter on town planning painting and sculpture. There is one common word 'civil' that which is connected with the welfare of citizens. Dictionary meaning of the word civilisation is 'An advanced state of human society in which high level of culture, science, industry and government has been reached, whereas civil engineering means the science and technology to design and maintain public works like roads, buildings, bridges, canals, dams, harbours etc. Thus, it is not possible to separate civilisation from *Sthapatis* since last ten thousand years has seen the connection between the two which becomes more and more clear and confirmed. An effort is made to bring out some important innovations or discoveries in civil engineering which lead to enhancement of civilisation in India in particular upto the end of 19<sup>th</sup> century. *Vastu shastra* was evolved in India from *vedic* period which is more than 7000 years ago. There are about 40 books written on this subject in Sanskrit. The books are not written in the

present scientific style. The style is somewhat *Puranik* i.e. stories indicating benefits when rules are followed, and punishments when these are not followed. These books remained ignored due to being in Sanskrit language and secondly due to lack in easily understood logic. Europe developed science, along with it the mathematics and formulae were also evolved so that findings of the science and technology could be utilised by next generation. In India the approach appeared to be mystic. The rigid criteria for eligibility to learn sciences also restricted its use. However, the hand skill and knowledge of intricate geometry of constructions and sculpture which was acquired by *shilpis* by trial error and then following some rules was transferred from generation to generation. The problem became more than acute after 13<sup>th</sup> century when the country was attacked by invaders from Middle East. Gupta period from 4<sup>th</sup> century to 9<sup>th</sup> century was a period of glory in India and several mighty structures like temples, forts were built in this period. Some of them are in good condition today. It is possible to identify certain discoveries and evolution of concept which took the civilisation several steps ahead and brought out happiness and comfort in the life of people. All these concepts were evolved by *sthapatis*. *Rishis* developed science out of it. The science went in the background yet the skill was preserved and practiced by *Sthapatis*.

In 19<sup>th</sup> century the country came under British Rule. The discoveries and inventions in Europe were implemented in India by the British. A network of roads, bridges

and railways was laid. Survey of the whole country was carried out and buildings on European pattern were constructed. The changes that took place in 19<sup>th</sup> and 20<sup>th</sup> century are phenomenal. Civilisation in India advanced far ahead. After Independence due to planned economy, advancement became faster. Civil Engineering and Architecture was one subject upto the end of 19<sup>th</sup> century and traditional *sthapatis* were the civil engineers and architects of India. These two became separate specialised branches later. That is why the term Architecture which is generally concerned with buildings alone is not used and traditional term *sthapatis* is used in this paper.

### Bricks *Isthika*

In the beginning of civilisation, most easily available material for construction of house was wood from jungles which were all around. Stone was another available material. But stone could be used only by rich people like kings, the *Kshatriya* and *Vaishya*. Common man and even Brahmins used to make their houses and *ashrams* with wood. But this material could catch fire. Miscreants could burn the houses. There are several hymns in *vedas* which pray that please save our house from fire and from miscreants who may fire it. Thus common people were always worried about the safety of the houses.

During *yadnya*, it was noticed that the wet earth which contained fire acquired beautiful and pleasing terracotta colour. The material became harder than wood. It could stand high temperature without damaging. It became harder like stone if over burnt. Then came the idea of using this material for houses. It was easy to dig earth, make shaped cakes of plastic earth and burn these in fire. The *sthapatis* jumped at this idea and then the era of brick houses started. It solved the problem of housing of common man. Later improvements were made in the techniques. The *rishis* who found this material during *yadnya* gave it a name *Ishtika*, that which is useful and that which is auspicious. It is said that the colour of bricks was so attractive that the students and *guruji* in *ashram* made their cloths of this light terracotta saffron colour. It matched with the infrared colour of rising and setting sun. After this invention of bricks, ceramic industries, earthen pot came up and these made the life of people comfortable. The most beautiful and economical light and thin earthen shape and structure is earthen pot (*Kumbha*)

*Taitariya Samhita* elaborates various uses of bricks. The art of making bricks was further advanced upto

*Yajurveda*. *Agnichayan* was a form of platform which used to be made for *Yadnya* called *Somayag*. On this platform various formulations are made with bricks. These shapes are called *Shyena*, *Rathachkra*, *Dron*, *Kank*, *Suparna*. Bihar and Uttar Pradesh developed beautiful brick structures like Nalanda University. It appears the technique spread from India to Middle East and Europe. *Mantras* used to be recited while firing brick kiln. The *Mantra* used to state that " I have tried to follow all rules for making good bricks. Oh god gives me bricks of pleasing colour and good strength from this kiln. That brick will make my house pleasing and durable and give me happiness that is given by the lady of the house. "

This material became so popular that the concept of auspicious deities which should be worshipped at the beginning of any function for its success, came from *Ishtika* Bricks and these deities are called *Isht Devta*. *Ishtika* later was converted into a simple form. Discovery of brick eased the life and brought happiness.

### Lime - *Sudha*

Bricks used to be bound together in mud mortar in the beginning. When certain soils were burnt, to make bricks it was noticed that the colour has become white and soil cakes are disintegrated into white powder. When mixed in water it would generate heat. It was also noticed during fire certain hard stones became white and disintegrated on cooling. The paste of this white powder on drying became as hard and could bind stones or bricks. It had a good binding ability. Then came the idea to use it as a binding material. A combination of brick and lime was almost like a man-made stone and it made houses stronger and economical too. This material was named by *sthapatis* as *Sudha* that which is white and which is as useful and benevolent as nectar "*Amrit*".

Later admixtures were found by the *sthapatis* to enhance the efficacy of binding material. The auspicious and meaningful names given to brick and lime in India establish that evolution of these material advanced the civilisation. Such a recognition of merit is hardly given by any other country to bricks and lime as was given by *sthapatis* in India.

### Shapes of places of worship - Temple, mosque and church

The sages in India recognised five basic elements: The earth, water, fire (sun), wind and space. These create seasons, rains and heat. Trees grow on account of these



Figure 1. Maheshwar Ghat - Madhya Pradesh



Figure 2. 'Sankh' Arch Bridge - Morena, Madhya Pradesh



Figure 4. Khajuraho Temple - Madhya Pradesh

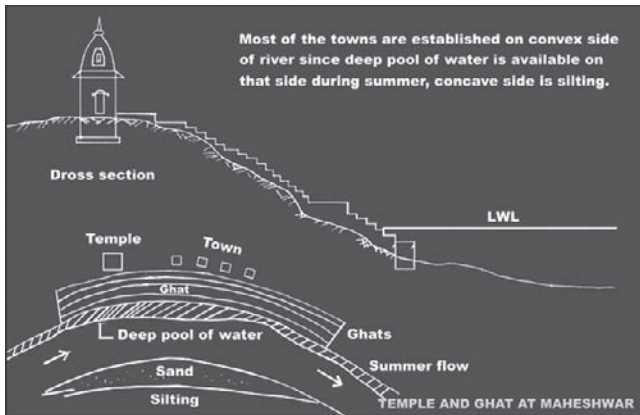


Figure 3. Ghat - Protective apron

elements. It was also recognised that the elements are beneficial as well as these can create destruction. The question which came in the minds of people in all countries was who controls these elements. The answer was not easy to find. This brought the concept of god in all religions. A mere abstract concept could satisfy

the intellectual but this was not adequate for common men. A search for an appropriate form of the god was continued.

Mother Nature has always been the inspiration of men. Particularly two durable shapes attracted attention. One shape was that of tall trees of Pines in Himalayas, having a broad base at bottom and pointed end at top. Second shape was the high mountains of conical shape and a point at top. The trees and mountains existed for several years. They are durable forms inspite of being attacked by rain, wind and earthquake elements. The *sthapatis* of India gave shape to the form of God by a temple and paintings of God and Goddesses. When we remember and pray for God, before our mind comes the paintings of God and Goddesses of Raja Ravivarma or the stratum of Gods created by *sthapatis*. Thus *sthapatis* gave form to the concept of God in the form of temple, mosque and church.

The form of God must be worshipped every day. Therefore, it must be seen every day when one comes out of house. This could be possible only if the form is taller than all buildings in the town. Therefore, the concept of place of worship being taller than all other buildings in the town came. Shapes of pine trees and conical mountains encouraged men to adopt these shapes to the places of worship. They also studied these shapes and noticed three distinct advantages.

1. Conical shapes are stable against wind.
2. They are stable against seismic effects.
3. Rain water would drain out quickly and there would be no leakage.

Temple is not merely treated as an abode of God. It is a form of God. The concept might have been evolved by *Rishis*, but its practical application and evolution of proper form, selection of materials was done by *sthapatis*.

Attention is attracted to the point on top of a place of worship and one will concentrate on the point. This will create concentration of energy in the space between two eyes. The viewer will forget all worries and with an enlightened mind approach the God and pray. The concept of places of worship brought happiness to men. The shapes of *Shikhars* are different according to available construction material and the environment in the region.

The places of worships did not remain as places of prayer alone. The artistic sense of finer elements in man encouraged him to make the places of worship as the most beautiful and something better than what the past generation did. The fine arts like music, dance, painting and sculpture thrived in the vicinity of temples in India. Places of learning were shifted from *ashram* to vicinity of temples. Civilisation became more and more refined. It is significant to note the three principles of places of worship are adopted by all religions.

## Ghats

In India most of the ancient towns developed on the banks of rivers. Water is an essential unavoidable element for human settlement. Therefore, towns have to be established on the banks of rivers or lakes or at places where enough ground water is available. It is

observed that most of the ancient towns are established on concave banks (i.e. along convex flow pattern). It was a common knowledge that even during summer the flow of the river is towards concave bank (convex flow). Convex bank (concave flow) is a silting bank. If you have to draw drinking water from river, it is near concave bank. If the town is established on convex bank, one has to walk through sand to get water. But concave banks are subjected to scouring action during flood. The banks erode and concavity is enhanced. Therefore, these banks need protection. If there is no rock in river bed or it is very deep, concave bank will pose problems of foundation. Therefore a novel multipurpose concept was evolved in India whereby -

1. The scouring banks were protected by constructing Ghats.
2. There was no need to take foundations deeper on account of the protection provided by Ghats.
3. This Ghats could be fruitfully utilised for several useful purposes like bathing, congregations and discourses.

Ghats are used for bathing purpose and washing cloths during the day. In the evening cultural programmes like drama, musical concerts and conferences of learned people were also held on the platforms of ghats particularly during hot seasons. Ghats acted as protective apron. The Ghats of Maheshwar, Wai Banaras and several other places are famous. Fine arts and culture advanced in the temples built along the river in the vicinity of water bodies. Ghats provided premises and platform for these activities. In those days the technique of deep foundation was not known. Ghats also brought out a concept of shallow foundations with protection work.

Structures along river banks became possible with this technique of protection. Even today this technique is employed in waste weirs and bridges. Author has designed several bridges on shallow foundations with this technique of apron and curtain walls. Ghats along rivers besides being protections technically, encouraged art and advanced Indian civilisation several steps ahead.

## Vastupurush

In the process of development of structures one of the most noteworthy contribution was evolution of the



Figure 5. Ambejogai Temple - Maharashtra

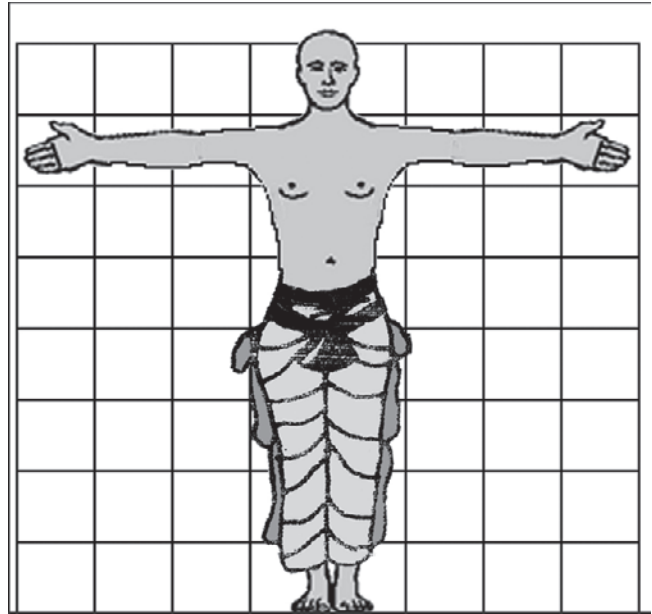


Figure 6. Human Form - Vastu Purush

concept of *vastupurush*. This concept involves some basic aspects.

1. *Vastu* is not considered as inanimate. *Vastu* encloses a part of space in its volume. Space is vibrant. Therefore *Vastu* is vibrant. It is therefore alive like any living creature such as trees etc. The vibrations have a sound. Therefore *Vastu* has a sound of its own (*Nada* in Sanskrit). Thus every *vastu* has its own frequencies of vibration.
2. Human body is the most perfect structure created by God. Every part of it has a purpose. *Vastu* must be designed like a perfect structure of human body where every part is placed at an appropriate place and the human brain synchronises the activities. Similarly every *vastu* has its vital parts. These must be identified. If one stretches both hands horizontally, the distance between end of left hand figures to right hand fingers is found equal to the height of a person. Thus human form is contained in a square grid.



Figure 7. Somnath Temple - Gujarat

3. *Vastushastra* identified a square form with  $8 \times 8 = 64$ ,  $9 \times 9 = 81$  and  $10 \times 10 = 100$  grids. Each house in the grid was assigned definite purpose and any perfect *vastu* was to be designed in the grids.

Many architects of 20<sup>th</sup> century recognised that Human body is a perfect structure and compared *vastu* with that. A woman body was considered as a more refined structure. *Vastushastra* evolved detailed theory of *vastupurush mandal*. In past, towns, villages, palaces and temples were also designed and oriented on the concept of *vastupurush mandal*. Even today Architects adopt it.

The concept of shape was derived from shapes created by nature. Natural shapes of animates have defined life. *Shilpis* observed the process of birth and death

in human beings, creatures, animals and also trees. Certain natural shapes attracted attention particularly those shapes which had long durability. *Vastu* built out of timber could not last long. The structures built from stone lasted longer. The study of shape and durability continued. Even among stones, some shapes and types of stones lasted more than others. The minute study of shapes created by nature and those created by men (*vastu*) brought out following important principles:

1. If the shape designed to last for some definite period, has used optimum quantity of materials, it would be an aesthetically beautiful shape. Example is human body, where nothing is redundant.
2. Durability of a structure depends upon the basic construction material the binding material, an overall shape of the structure, aesthetics and rhythm.
3. Life of a structure depends upon number of joints in it. Joints are affected by heat, humidity and environment. Lesser the quantum of joints, more is the life of the structure.

These principles were intelligently adopted in *Vastupurush Mandal* while planning and orienting structures. Thus the concept of *Vastupurush Mandal* revolutionised the philosophy of durable useful and aesthetically beautiful shapes.

### New ideas from middle east

From 8<sup>th</sup> century onwards invaders after invaders came to India. They were impressed by the tall temples of Hindus and *Buddhist* monuments. Some destroyed the temples, looted the country and went back. Some came with a view to establish and stay in the country from fourteenth century onwards. Some fanatics converted some of the temples into mosques. Yet, there were many rulers having artistic and creative minds. Immediately on establishing their rule they took up construction of massive palaces, mosques and monuments. The main purpose was to create something which will be pleasing to the eye, which will command respect and fear both. They employed *shilpis* of Middle East and Indians to create the structures.

In Hindu temples, the place of main attraction is *Grabhagraha* where deities are kept. Therefore, efforts were to make this part more imposing. Idol worship was not acceptable to Muslims. Yet they strived to create

a suitable form of god in such a manner that devotees would be attracted. The total shape of a mosque would be made in such a manner that it is a pleasing shape which would also command respect.

It is seen that orientation and setting of mosques is such that sufficient open space is left all around and the shape comes to the notice of viewer more and more vividly as he approaches the place. It is possible to have good photo of several mosque structures but this facility is not available in many temples. This brought a new concept of shapes in India. Middle East also evolved the concept of visible shape as distinct from actual shape on paper and in construction. The difference is caused on account of horizontal distance and height. Pleasing shape in view as one looks from distance was given more attention by the *shilpis* from Middle East.

Indian rulers paid little attention to building bridges across rivers. Allauddin was the first invader who built a submersible bridge at Chittodgarh with arch form. Some excellent bridges built by these rulers in 15<sup>th</sup> century at Hyderabad and in 17<sup>th</sup> century at Narwar in MP and Sankh bridge Noarabad in MP are in excellent condition even today. (Purana Pul at Hyderabad is recently closed for traffic).

India had few tall observing towers. One can see close view of distant places and enjoy natural beauty from a tower. Besides, it was useful for observation of enemies' movements. These tall towers were also built by Middle East Rulers. Kutub Minar of Delhi, Charminar of Hyderabad and tower of Aurangabad are in good condition. Thus the arch form, the dome, tall towers and arched bridges advanced the civilisation of India further. These concepts which simplified construction procedures and which removed miseries of travelling people (for want of bridges) thus advanced the civilisation.

### Modern concrete era: Challenge to engineers

Upto almost 1930, monumental buildings such as Palaces offices and places of worship used to be built in stone or brick masonry with thick stone cladding in lime mortar. The roofs were of stone slab or arches and domes. Purely stone buildings and bridges are designed for a life of 500 years. Other were designed to last for 250 years. We have several stone arch bridges in service for more than 300 years. A bridge with corbel type deck built in 11<sup>th</sup> century near Jaganath Puri (Athar Nalla) is still serving



Figure 8. Bahai Temple - New Delhi



Figure 11. Tajul Masjid - Bhopal

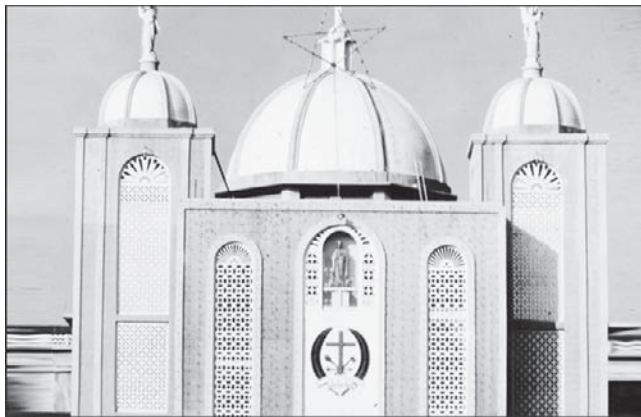


Figure 9. St. Jude's Church, Jhansi - Uttar Pradesh



Figure 12. Corbel Bridge, Athar Nalla - Bhubaneswar (1000 years not out)

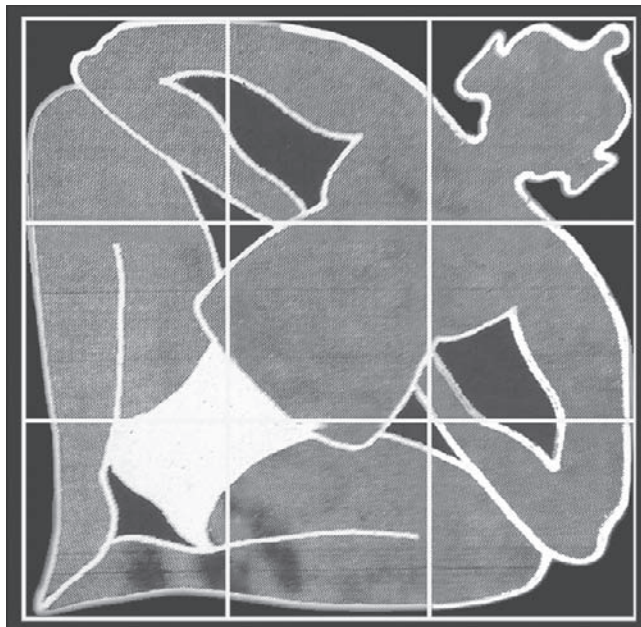


Figure 10. Vastu Purush Mandal

the traffic i.e. 1000 years not out. Palatial buildings are existing for 250 years or more

From 1930 onwards an era of concrete buildings and bridges started. Initially for about 30 years both types of buildings were constructed. But after 1970 generally RCC buildings and bridges are being done. Concrete structures were expected to last for 150 years as per British codes. It is however seen that RCC buildings cannot last for more than 100 years. RCC bridges start deteriorating after 50 years. Multistoreyed building at Marine Drive, Mumbai are 65 years old. Heavy repairs have been carried out recently. In New York, RCC structures of 70 years old bridges deteriorated and are being replaced.

The main reason of deterioration is corrosion of steel inside RCC, which develop cracks and later spalling of concrete. Problem has become more acute due to

introduction of deformed bars. According to some engineers blended cement and deterioration in the quality of cement are also the causes of premature deterioration of concrete.

If concrete structures are compared to stone structure, cost of concrete structures will be half or even less than the cost of stone masonry structures. Moreover, time of construction of concrete structures will be much reduced. In fast track era, concrete has proved to be acceptable.

Every structures must have a minimum life of 100 years. Monumental structures must have at least 250 years life. This can be achieved only by

- Improving quality of cement i.e. make it more durable.
- Make steel corrosion free for 250 years.

Efforts are being made all over the world to achieve these life span targets even if it costs more. This is a challenge to modern *sthapatis* (Engineers). It can be achieved.

## Conclusions

In any society there are men of learning and men of action. Learning and thought is an evolution after a long field experience. One of the assigned duties of *sthapatis* is to find out suitable stone, timber and lime and soil for manufacturing bricks and then evolve appropriate shapes. Invaders of India from Middle East and UK were aware of the community of *sthapatis*. They utilised their skill for building monuments. It looks in later ages *sthapatis* devoted themselves to field work and did not move with the modern era and bother about formal education. They lagged behind and today they are reduced to a status of mere technicians. And yet when a temple is to be built, the modern architect cannot design and build a traditional temple without steel and concrete. We have to call *sthapatis*. In the ritual of *Vastupuja*, *Vishwakarma* (*sthapatis*) is worshipped and honoured by the owner. The role of *sthapatis* in advancing civilisation in India was second to none upto the end of 19<sup>th</sup> century. *Sthapatis* in India and elsewhere gave shape to the concept of God. Place of worship was not treated as abode of God. It is a form of God. In concrete era of 20<sup>th</sup> and 21<sup>st</sup> century, this skill of *sthapatis* can bring out more attractive shapes of places of worship and buildings such as Bahai temple at New Delhi. This RCC temple is designed to last for 250 years.

Hand skill can be mechanised. Mathematical calculations and geometry can be computerised but the inspiration and the occult knowledge derived from generation to generation by *sthapatis* can neither be mechanised nor computerised. *Sthapatis* posses this inspiration and knowledge which needs to be recognised, honoured and preserved. At the same times *sthapatis* must take education in modern science and technology. A marriage of traditional skill and modern technology will advance Indian civilisation far ahead.



**Dr. C.V. Kand** obtained his B.E. (civil) from Pune University, India, MSc (bridges) from Surrey University, UK and PhD from Open International University, Colombo. He is former chief engineer, PWD, Madhya Pradesh and his areas of interest are research development and design, roads, ROB's, aqueducts, flyovers, *vastushastra*, etc. ■

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