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Construction Techniques of Indian Temples

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***Abstract*—India is a country of temples. Indian temples, which are standing with an unmatched beauty and grandeur in the wake of time against the forces of nature, are the living evidences of structural efficiency and technological skill of Indian craftsman and master builders. Every style of building construction reflects a clearly distinctive basic principle that represents a particular culture and era. In this context the Indian Hindu temple architecture are not only the abode of God and place of worship, but they are also the cradle of knowledge, art, architecture and culture. The research paper describes the analysis of intrinsic qualities, constructional and technological aspects of Indian Temples from any natural calamities. The analytical research highlights architectural form and proportion of Indian Temple, which proved its commendatory result in good seismic performance.**

***Index Terms*— Dravidian style, Indian architecture, Indian temples, Nagara style,**

I. Introduction

Indian temples has its own significance in today's a well as early era. The temple defines beauty through its arts forms and construction techniques. The construction techniques so used and developed has been mentioned in Hindu mythology as Purna Vastu or a perfect building is that which is properly oriented and constructed with carefully laid out norms to protect it from the evil forces of the nature, which include floods, storms, hurricanes and earthquakes.

A. Symmetry and Proportion

Fig. 1. Show the Symmetry and proportion in different plan of Indian temples.

It is a geometrical property of a building configuration. The selection of symmetrical plan shapes and layouts is of great importance in seismic design, because symmetry about the elevational axis is of less dynamic significance than plan symmetry. In Indian architecture the use of square as the basic unit and of triangle as the principle governing the layout resulted in strictly symmetrical plans and layouts along one or two principle axis, which in turn resulted in simple structural systems and an increased structural strength against seismic forces. The Indian doctrine of proportions is designed not only to correlate the various parts of building in an aesthetically pleasing manner but also to bring the entire building into a magical harmony with the space.

B. Strutural Plan Density

Structural plan density defined as the total area of all vertical structural members divided by the gross floor area. The size and density of structural elements is very great in the Indian temples as compared to the today's buildings. For a R.C.C. framed building it is generally 3, but in Indian this can go as high as 47% as it is in the case of the Surya temple Konark.

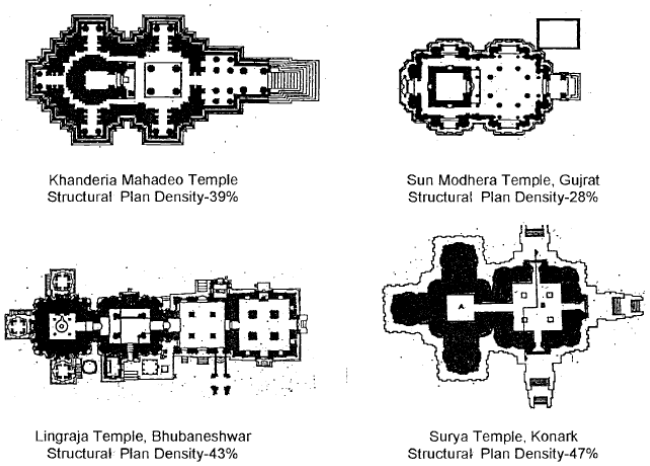

Fig. 2. Structure plan density of Indian temples

II. The Hindu Temples

The Hindu temples commonly known as Mandir in Hindi and derived from the Sanskrit word Mandira, are identified by several names in different parts of India.

A. Elements of Hindu Temple

1. The sanctuary as whole is known as the "Vimana" that consists of two parts. The upper part of the Vimana is called as the "Sikhara"
2. The lower portion inside the Vimana is called as the "Garbhagriha" (cella or inner chamber).
3. Pradakshina patha: meaning the ambulatory passageway for circumambulation.

4. Mandapa: is the pillared hall in front of the garbhagriha.
5. Antarala: meaning the vestibule or the intermediate chamber.
6. Ardhamandapa: meaning the front porch or the main entrance of the temple leading to the mandapa.
7. Gopurams: meaning the ornate tower at the entrance of the temple complex specially found in south India.
8. Pitha: the plinth or the platform of the temple.
9. Toranas: the typical gateway of the temple mostly found in north Indian temple.
10. The Amalaka: the fluted disc like stone placed at the apex of the sikhara.

B. Different Types of Architectural Styles

Hindu temples have been classified into three different orders; the Nagara or 'northern' style, the Dravidian or 'southern 'style, and the Vesara or hybrid style which is seen in the Deccan between the other two.

C. Distinct Features of 'Northern style' and 'Southern style'

The major and distinct features between the north Indian temple and the south Indian temple are their superstructures.In the north the beehive shaped tower called as the sikhara .The gateways are in the north and they are plain, simple and small. Temples are based on square but the walls are sometimes broken at so many places that it gives an impression of temple being circular in plan. The tower is made up of miniature sikhara creating an amazing visual effect resembling mountain.

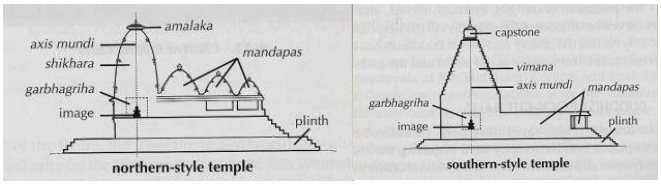

Fig. 3. North and South Style Temple

III. Construction Temples of Hindu Temples

The construction of temple is an art, a science and a complicated creative study with a blend of mathematics, logic, geography, geology, science, ecology, art, sculpting, music, light and sound, religion, social sciences and astrology.

A. Selection of the Site

The gods always play where groves, rivers, mountains and springs are near, and in towns with pleasure gardens. hus, most of the ancient surviving temples were built on the mountain peaks, lush valleys, grooves, near the water body, the essential necessity is the existence of water.

B. Inspection, Insemination and Levelling of the site

After the inspection of the site for its consistency it is important to check the condition of the soil. This can be determined by performing some simple test on the site. In this a pit is dug on the site and the soil which has been taken out is put back again and checked whether the level of the packed soil is higher, same or lower. The land with the higher and the same level of packed soil are selected for the construction. Secondly, the pit is filled with the water and left overnight; the quality of the soil is evaluated according to the quantity of water remaining in the pit. Finally, the fertility of the soil must be tested. This is tested by sowing a seed at the chosen site on a auspicious day and the germination is observed. If the growth of the plant is satisfactory the land is considered suitable for the construction of temple.

C. Orientation, Measurements and Layout

The nature of the main deity greatly influences the orientation of the temple. According to the orientation of the plan the placement of the idol is decided. The specific directions of the deity are as such: East facing-any and all gods and goddess, because it's the best orientation. West facing-is According to the orientation of the plan the placement of the idol is decided. The specific directions of the deity are as such: East facing-any and all gods and goddess, because it's the best orientation. West facing-is for the Shiva family of the Hindu pantheon such as Shiva, Ganesh, Linga, etc. South facing-is for the monkey god Hanuman, and other aggressive gods and goddess, Yama or the god of death etc.

D. Selection of Material

In a class of Hindu society use of stone for all kind of temples. The stone is considered as the most sacred building material. The temple made in brick is hundred times more worthy than wood and the temple constructed in stone is ten thousand times more worthy than in brick. The temples of male deity are generally made of stone and brick, the female deity temples are usually made of brick and wood, and temple with all the materials are considered neutral. The stones are used in temple construction according to the availability and climate of the region such as granite in the south, marble in the west, sandstone in the central and limestone in the coastal areas, sandstone is never used in coastal areas and generally locally available stone is preferred. The hard and even stones are used for the plinth, columns, beams and slabs. The supple stones are used for the construction of sculptures, idols, carvings etc.

E. Process of Temple Building

1) Laying the Foundation

The foundation of the temple is 2 meter deep pit. The pit is dug throughout the base and is wider than the base of the temple. The stones are laid one above the other without mortar towards the structure boundary. At the base of the foundation on the exact centre of the garbha griha a hollow duct is placed running from the foundation base to the base of the main idol of the temple, for performing the ritual called as garbhadhana.

2) Assembly of Elements

The final and the most important stage for the construction of the temple is the assembly of all the parts together. After carving of the individual pieces is completed, the different levels of the temple with its different parts are pre-assembled to check the accuracy of the joints and to avoid any mismatch and

misfit during the time of placing the part at its actual position in the temple.

3) Joinery system

The stone construction the architectural elements and the decorative details of the temple continued to follow the timber construction details for centuries in one form or another even though the original purpose and the context was lost.

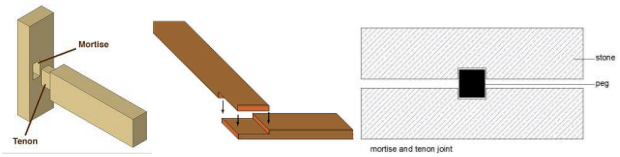

Fig. 4. The mortise and Tenon joint with a peg

The major joining systems used were different types of mortise and Tenon joint and the lap joint. The mortise and Tenon joints were mostly used for the horizontal assembly and the lap joints were used in the vertical assembly. Another kind of joint is a kind of mortise and Tenon joint i.e. a peg is fixed between the two mortises cut out in two different stones, this joint is usually used between the two courses of masonry to avoid the movement of the stones due to lateral forces. In the past natural binders were used to unite the joints together. In the present days cement acts as the binding agent between the joints. In the past the use of steel was strictly prohibited as steel gets rusted and reduces the age of the temple. But temples constructed during the 13th and 14th century shows the use of iron clamps and wedges, with ends sealed in molten lead.

4) Plinth

The plinth stones placed above the foundation stones act as the retaining wall for the rubble compacted earth Above this compacted rubble are laid stone slabs for the flooring of approximately 200 mm to 300 mm. The stones of the plinth are place one above the other and they are made stable with the self-weight. The number of courses of stones at the plinth varies according to the size of the temple from 3 to 10 numbers. On the stone floor of the temple, where exactly the vertical components were raised, was marked with chisel marks (mason marks) and grooves for the pillar bases without lines for raising walls and entrances.

5) Wall

The main structural masonry walls are constructed as a stone composite masonry with stone, brick with lime or mud as the masonry core. The thickness of the stones varies from 300 to 4500 mm. The average thickness of the masonry wall varies from 800mm–1200mm.Large stone act as ties and thus strengthen the walls. The joints are very fine either without any mortar or with fine lime mortar. Over the wall are the stone beams.

6) Column and beams

The columns are monolithic structure. They are made up of 5 parts and all are interlocked by the mortise and Tenon joints. The five parts consists of two parts of the base one part as the shaft and two as the capital of the column. The top of the column have the brackets which provide a good bearing for the beams and reduce the spans. The beams were placed over the column structure which further supports the roofing system of the temple.

7) Mandapa

The mandapa of the temple may be flat roofed in the south and have pyramidical superstructure in the north. The mandapa ceiling is built with basic beam and slab construction method. Octagonal patterns were constructed by placing the triangular slabs across the corners of the square plan. The square bay of the mandapas were reduced to stepped pyramidical roof via triangular corner slabs or diagonal beams.

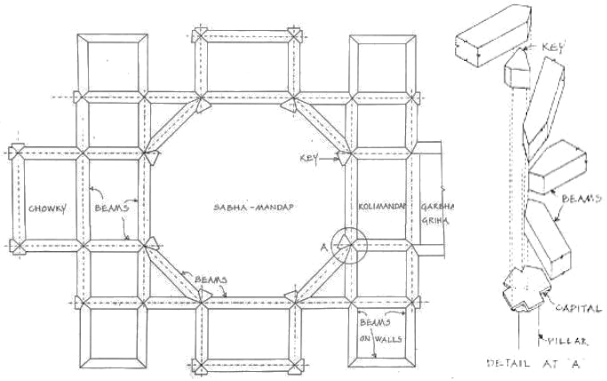

Fig. 5. Plan of arrangement and joining of beams

8) Sikhara

The sikhara is the pyramidical structure built on the garbhagriha of the temple. Corbelling construction system is used for the construction of the sikhara. The sikhara is usually hollow from inside or in some cases filled with rubble. The apex of the superstructure is mounted by a single piece of stone called as amlaka in the north and sikhara in the south.

IV. Related Works

A. Lakshmana Temple (Nagara Style)

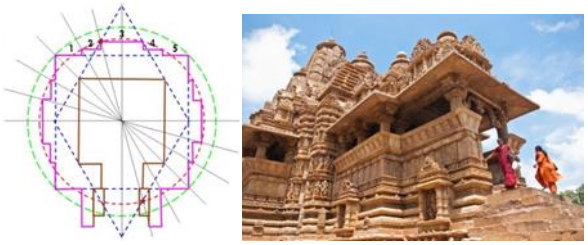

Fig. 6. View of Pancharthaan and Lakshmana Temple

The Lakshmana Temple is a 10th-century Hindu temple built by Yashovarman located in Khajuraho, India. Dedicated to Vaikunth Vishnu- n aspect of Vishnu. It has entrance-porch, mandapa, maha-mandapa with transepts, vestibule and sanctum with an ambulatory and three transepts. Unlike other temples in Khajuraho, its sanctum is Pancharatha on plan (top-view). Its shikhara is clustered with minor urushringas. Temple is symmetrical in its design, it has panchartha i.e., fie chariots or five offsets in plan. The wall portion is studded with balconied

windows with ornate balustrades. It has two rows of sculptures (refer images of temple's outer wall) including divine figures, couples and erotic scenes. The sanctum doorway is of seven sakhas (vertical panels). The central one being decorated with the ten incarnation of Vishnu. The Lintel depicts goddess Lakshmi in the Centre flanked by Brahma and Vishnu. The sanctum contains four-armed sculpture of Vishnu. One of the niches has the image of the sculptor and his disciples at work.

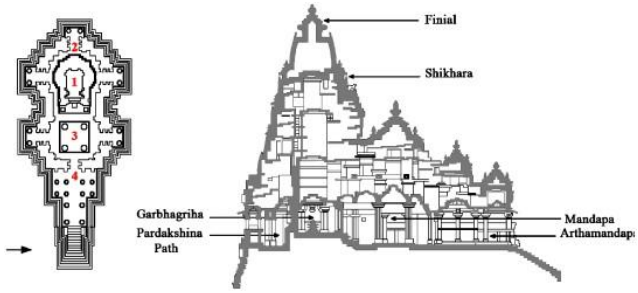

Fig. 7. Plan and section showing the elements

Architectural Features

The main shrine at the temple, which faces east, is flanked by four freestanding subsidiary shrines at the corner of the temple platform. The central deity at the Lakshmana temple is an image of Vishnu in his three-headed form known as Vaikuntha who sits inside the temple's inner womb chamber also known as garba-griha. Four small subsidiary shrines sit at each corner of the plinth. These shrines appear like miniature temples with their own vimanas, mandpas, shikaras and womb chambers with images of deities, originally other forms or avatars of Vishnu. The temple is not a hall for congregational worship instead it I the residence of a god. Sculpture has a harmonious integration with the architecture. Depicts idealize female beauty was important for temple architecture. The erotic poses were to be intended provocative, but instead served ritual m symbolic function significant to builder, patrons and devotees of these captivating Structures.

B. Keshav Temple (Dravidian Style)

The Keshava temple was built by Somanatha and Ar. Jakanachari in 1268 A.D at somanathpur, on left bank of kauvery. It is finest example of Hoysala Architecture. Green schist (soapstone) is used for the temple construction. The Sculptor was Ruvari Malithamma. Temple is symmetrical in its design, it has three shrines. The temple has cross shaped plan. Its plan is consists of a main pillared hall in the centre, at the western end of which are the 3 shrines, one in axial alignment with the hall, the others projecting laterally, like transepts. Temple stands on basement which is beautifully carved. The base layer consists of Elephants depicting strength. The second layer of horses depicts speed; the third one of carved patterns depicts beauty. While the fourth layer of religious fables depicts culture, the fifth layer depicts art as it consists of an innovative pattern of an imaginary animal which is a mix of pig, human, rhino and crocodile. The some walls are perforated for lighting and ventilation. The exterior walls are inclined and highly carved.

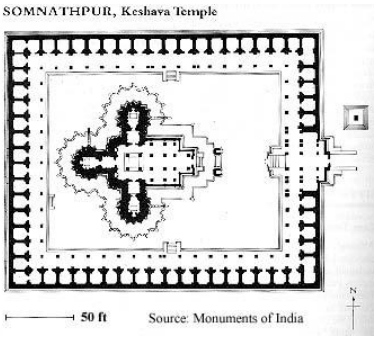

Fig. 8. Plan of somnathpur keshava temple

Architectural Features

The Gopuram or entrance is in the east. The temple stands on a platform and the three vimanas are located at the back and are connected by a common rectangular closed mandapa. The mandapa surrounded by 64 cells each with pillars in front. Inside, each vimana has a vestibule that connects it to the main rectangular mandapa. The wide platform invites devotees to follow the ritualistic clockwise ambulation before entering the grabhagraha. The hall has sixteen bays. All the three shrines are 16 pointed stellate (star-shaped plan) and their towers follow the same pattern. The stellate system produce a fluted effect on the tower or shikhara. A single pillared hall has two compartments, mukha-mandapa, or front hall and the navaranga, or middle hall containing 4 pillars. It has pillars in the garbha- grihas (sanctums). The pillars are cylindrical in shape with cubical capital and the base sections. The ring like groves are along the length and the lower portion has a bell.

Fig. 9. Different patterns of animals sculptures on the ceilings

Fig. 10. Polished pillars of sculptures temples on shrine outer wall

The temple has decorated projections and recesses (architectural articulation). The ceilings are carved with intricate geometric figures. Sikhara is separated from its substructure, consists of the walls of the vimana, with projecting eave. The motifs of complex grouping of miniature shrines and niches make the horizontal and vertical pattern of the sikhara. The tower has no effective height.The ceilings are

intricately sculpted with designs of concentric flowers having a central point and a square pattern, snake like pattern, and a star shaped pattern.

V. Conclusion

On the basis of the above studies we concludes by undertaking a structural study of temples taking examples from primarily ‘north’ and ‘south’ Indian temples in an attempt to graphically analyses the structures with respect to its structural stability. On the basis of the above studies undertaken has been that the massive nature the stability of the temple structure depends mainly on the geometrical compatibility of the elements with respect to the load applied rather than material failure. The data concerning the main geometrical property of temple from the ‘north’ and ‘south’ of India here have been collected and elaborated through some specific though limited number of examples. In spite of the limited number of samples it is possible to find some interesting trend even though the absence of a statistical validity constitute a starting point for future works concerning the stability analysis of the temples.

References

[1] Brown, Percy. 1942. Indian Architecture: Buddhists and Hindu Period. Bombay: Taraporevala & Sons.
[2] Rowland, B. 1953. The Art and Architecture of India. Harmonds worth: Penguin Books.
[3] Fletcher, Sir. Banister. 1992. The History of Architecture. New Delhi: CBS Publishers and Distributors.
[4] Acharya V.A,”Indian Temple Architecture: form and Spaces” Research Paper, Department of Architecture & Planning, I.I.T .Roorkee, Roorkee, India, 1991.
[5] Shweta Vardia, “Building Science of Indian Temple Architecture”, School of Planning and Architecture, Bhopal, July 2008.
[6] Michell, G. 1988. The Hindu Temple: An Introduction to its Meaning and Forms. Chicago and London: The University of Chicago Press.
[7] www.slideshare.net/DeepaManagooli1/later-chalukyas-hoysalas-ppt
[8] https://en.wikipedia.org/wiki/Panchayatana_(temple)
[9] https://smarthistory.org/lakshmana-temple/
[10] Vasudha A. GOKHALE,” Architectural Heritage and Seismic design with reference to Indian Temple Architecture”, Research Paper , Vancouver, B.C., Canada, August 2004.