Reinforcing traditional Indian construction with modern construction—Investigation—Execution phase

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In India, the structures built even in BC stand as monuments reflecting our involvement in construction. But in recent years, with the predominant influence of the West, mainly due to industrialization and technological innovations, we have started looking ‘outward’ but there is lot of knowledge available if we start looking ‘inwards’. The study is directed towards that with special reference to the design and construction of traditional structures.

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Traditional construction in India emerged and nurtured, the knowledge, wisdom and expertise of the architectural tradition remained with the shilpis (the creators), who originated and developed this branch of science and technology along hereditary lines. The aim of the study is to stimulate the awareness upon the society, that the old traditions in art and building architecture and to bring them in the main stream of national construction and to create traditional construction concept extracting the essence from ancient texts and interpret it to suit modern constructions. This is not mere repetition but one of the creating interpretations as traditional construction practices has come a long way without proper documentations and records. Traditional construction concept will definitely provide inputs to supplement modern construction methods. The research will amplify the synthesizing process of traditional Indian constructions with modern constructions and to augment the ways and means in which the structural design can be made to reflect tradition and speedy development. In the paper, the investigation design and execution aspects are discussed.

Investigation phase

Selection of suitable site is the basic for any construction. Vaastu considers earth as a living organism with its origin in the primordial energy contained within earth as Vaastu Purusha (Parusha=subtle energy). Vaastu, material body of the earth is considered as the embodied energy. Earth is a live material object suspended in the space and existing as a part or extension of the universal being. During site selection following aspects are to be analyzed: study of contours of the ground along with the flora and fauna; colour of soil; texture of soil; water depth should be at depth of a man’s height with upraised hands (Purushanjali matra); flow of water should be clock wise underneath, in general soil should be soft, close grained, over grained with fragrant flowers, creepers and shrubs, good odour, spacious in extent and even level, sub soil water flow in clock wise direction.

For compactness of soil, dig a pit of 3 hastu measure (a) 83.8×83.8×83.8 cm and refill the pit with the excavated earth. Soil is good if the earth remains after refill. Soil is satisfactory if no earth is left over. Seeds will be sown on the proposed site. If soil is good then seeds will germinate from 3-7 days. Certain number of cows and calves along with bulls are left free on the site. Then their activities are carefully watched. If they move around and mate it is considered as a good sign that foretells the intimate relationship between the master and mistress of the house to be built on that site. If the site has dense vegetation and if the leaves are of thick green colour, the soil is considered best for human habitation. Semi green shade of leaves shows the mediocrity of soil, while the paleness of the poor

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one. The normal test for identification water flow is to dig a pit of 90 cm depth, fill with water, throw flowers on the surface, and watch the movement. If flowers move in clockwise direction the water flow is considered as good. In a pit filled with water, 4 wicks of light or burning candles are left to float. If 2 remain burning, it is middling and if all of them extinguishes then the soil has obnoxious gas, which will cause harm for the dwellers. If the sound of the earth when tapped is that of a horse, elephant, bamboo, veena, sea or dundupi, it is considered suitable for dwelling houses. Marshy lands, slushy sites, claye soils are disallowed by the shastras. Land containing skulls of animals and humans broken stones, hair, nails, iron, white ants, serpents, rats and frogs are stoutly objected by the shastras.

In modern construction, selection of site is determined on the basis of soil exploration results. Soil exploration programme includes: selection of type and depth of foundation; determination of bearing capacity of the selected foundation; prediction of settlement of the selected foundation; establishment of the ground water level; the evaluation of the earth pressure against walls abutments; provisions against abutments construction difficulties and suitability of soil and the degree of compaction of fill (under slabs and pavements and against retaining walls). The characteristic of the soil is analyzed by boring, sampling and testing of soils. Safe bearing capacity of soil is determined by standard penetration test and plate load test settlement of soils is determined by consolidation test. Methods followed in traditional and modern construction may be adopted and selection of site can be evaluated over the combined net result.

Design and execution phase

In traditional construction based on investigation report on selection of site and planning concept, the building is oriented to the cardinal directions namely South, North, East and West. Construction of the temple structure is taken for analysis. After orientation of the structure to true North direction, earth work excavation will be started to a depth of a man’s height with upraised hands, or 1½ times and soon depending upon the nature of soil and foundation. After excavation, pure river sand will be filled in layers not more than 15 cm thick and well rammed and complicated with watering. The normal depth of sand filling is 30 cm thick. Over the compacted and well consolidated sand layer cement concrete 1:4:8 (one cement four sand (fine aggregate) and eight stone jelly (coarse aggregate) is laid for foundation and Random Rubble Masonry in cement mortar 1:8 is provided up to basement. At basement level, fully dressed cut stone slab is provided all over the walls similar to RCC plinth beam provided in modern construction. Super structure is raised in cement mortar 1:8 (one cement sand eight sand) using semi dressed stones with necessary butt joint and interlocking joint for horizontal joints. Ball and socket system and groove systems will be adopted for vertical joints. Curing will be done effectively to get strength. For roof, Corbelling technique of Kathali type construction is adopted and finished with decorative look. Construction of temple may be seen in progress at Palavankudi near Karaikudi, Tamil Nadu (Figs. 1-3).

Corbelling technique

In stone architecture, to join any structures corbelling technique is adopted. The overlaying stone projects outwards to a particular distance than the underlayed stone. In the same way the stones will project from both the walls and will join at one place. The stone slab which joins the will act as a tie slab. This tie slab will distribute the load from the tower to the walls (Fig. 4). In traditional construction technology, it is also called KathaliKakaranam (Kathali = plantain tree). The trees are formed with different size diameter of skin type structures. Similarly, the roof over the stone structure will project from the support edge so that the outstanding projection is less than the seated portion in the support. At one level, one circular projection will be made by convenient parts and will be joined. At somanathapuram temple, 7 pieces of this type are joined together. The similar procedure is and joined at one place at top with a projection downwards at the centre of the structure (Fig. 5a, 5b). In the other type of roofing, the span of the structure is reduced gradually by introducing diagonal stone slabs and then rectangular or square panel in the stone slab (Figs. 6, 7). In this way, the span of the structure and thickness of slab is considerably reduced (Figs. 8, 9). The size of hall is 5.00m×5.00m. After providing corner slab and tie beam over corner slab, the central portion to be covered will be 3.00m×3.00m. If it is simply supported the bending moment for
effective span of 5.5 m = \( w \times 5.5^2/8 = 3.78 \) wm. For effective span of 3.0 m = \( w \times 3.0^2/8 = 1.125 \) wm i.e. 3.78w/1.125w = 3.36. Adopting this type of Kathali principles, the bending moment is considerably reduced 3.36 times and construction can be executed stage by stage without any fixing end moments at support. For large sized halls, this method of construction can be adopted by splitting the hall with
suitable grid pattern. In modern construction, the slab is designed for the net moment arrived by super imposing and fixing end moments over free bending moment.

**Conclusion**

Utilizing the planning, investigation, design and execution concept both in traditional and modern construction, a new approach can be evolved to get best result. In traditional construction, pillars are erected at basement levels with the hinged mechanism at centre of the pedestal of the pillar and at support for roofing the pillars carved with decorative patterns to have more bearing area for the stone beam to rest on the pillar (Fig.10). This type of structure will be a good remedy for seismic effects and any moments caused by lateral thrust since this method of constructions is part and parcel of human form, which is the main focus of traditional construction. Modeling, detailed analysis and design can be done further.

**References**