Frame Structure of Vietnam Traditional Wooden Architecture

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1 VIETNAM TRADITIONAL WOODEN ARCHITECTURE

Vietnam is a tropical country with the variety plant, hot and wet climate that forces people finding out the suitable life condition by exploiting natural material for building. By bamboo and wood, Vietnamese people have built their house in conformity with the natural condition and therefore have taken shape a traditional wooden architecture. The traditional wooden architecture is early existence and play very important role with high density in system of architectural monuments in Vietnam. The traditional wooden architecture is a product with many special in architecture, art and also construction technique of Vietnamese people.

Vietnam traditional wooden architecture appears in almost categories of fundamental architecture. Wooden material is used for frame structural and cover up components with several determined formula that appears in high density in most from simple to complex building, from popular to solemn. It can be seen also in Northern traditional house or “ruong” house of middle Vietnam, in public service building such as bridges, market places or especially in religion constructions, temple, pagoda, palaces, and royal tombs.

Wooden architecture is so popular in South-East Asian and East Asian countries that are similar in area. However, Vietnam traditional wooden architecture has its own characteristic that certainly creates a differences and itself image. The cultural factor, natural and social condition has created a traditional architecture of Vietnam with a special manner presenting by its style, standard, and activity using basic structure.

2 FRAME STRUCTURAL ANALYSIS OF VIETNAM TRADITIONAL WOODEN ARCHITECTURE.

Vietnam traditional house, in simple or complex, small or large, has been almost created from basic component is wooden frame, with a suitable structure to prop the roof up and separate space for different function and user’s demand. From such basic structure, with activity formula, it is able to create a simple space such as a rest house, a gate, a temple, a traditional house; or more complicated religion constructions such as “Dinh” (communal house), Temple, Pagoda and Royal palaces…

2.1 Basic factors of wooden frame structure.

Wooden frame is a basic structure creating standard, shape, and in addition presenting characteristic of the Vietnam wooden traditional architecture. Wood material is used for wooden structure in Northern wooden traditional architecture is variety depend on budget of individual or community. Larger architecture often uses valuable woods with high intensity such as artocarpus-wood, or four varieties of ironwood (Dinh, Lim, Sen, Tau). Smaller architecture of people
often uses lower intensity wood and cheaper such as bead-tree, cinnamon… All building components are used from monolithic wood of nature.

Basic structure of Vietnam traditional wooden frame is “Bo vi”. “Bo vi” is a frame created by linkage of wooden components following a plane quadrangle with ground (including vertically system of columns link with tie-beam components, transverse beam and other component to prop up the roof). Some of “Bo vi” is set up parallel and link together by length beam quadrangle with “Bo vi” plane, creating a perfect 3D frame. The main components of “Bo vi” are “cot” (column), “caudau” (tie-beam), “Vi noc” (structure of roof-top), “vi nach” (structure of roof-side) and “bay” (console):

- **Cot (Column):** is a vertical bearing component of frame structure. It is main component and biggest. Horizontally components link with column. Column receives and transmits loading capacity of such horizontally components to the basement. The amount of column in “Bo vi” generally is 2, 4, or 6 (particularly there is a “Bo vi” with 1 column or 3 columns). Count from middle to other side, columns is called “cot cai” (principle columns), “cot con” (small columns) and “cot hien” (side columns).

- **Caudau (tie-beam):** is a horizontal bearing component, linkage between two top of principle columns. Tie-beam receives and transmits loading capacity from “Vi noc” to principle columns.

- **Xa nach (Side-beam):** is a horizontal bearing component, linkage between the top of small column with principle column or top of side column with small column. Side-beam receives and transmits loading capacity from “vi nach” to such columns.

- **Vi noc (structure of roof-top):** includes all components above tie-beam, limited in a equilateral triangle with the top of roof-top and the base is tie-beam, functioning to prop up the roof components (purlin, rafter). There are many type of “Vi noc”. Each historical period and each area often use special “Vi noc”, therefore “Vi noc” can be seen an important factor to define the building’s age, also determine the region, area and art of the building. In Vietnam traditional wooden architecture, “Vi noc” can be counted in to four basic types; other type can be seen as the combination or variants of such basic types.
  
  (a) “Gia-chieng” (Bell-hanger) type is oldest “Vi noc” still existing. It is used quite often and variants. The basic of Gia-chieng type includes 2 pillars usually called
hide-pillar standing on the basement above tie-beam. On the top of the hide-pillar there is another basement for propping up a curve-beam that looks like a bell-hanger. Above such bell-hanger are components to prop up “thuong luong” (purlin in top of beam) and other purlin.

Two side of bell-hanger there are sort-beam to prop up other purlin. Sort-beam is linked in to hide-pillar by one and prop up by a basement on the other.

This type is shaped strongly and nicely. It is also able to be variant, stylized for architecture and art requirement.

(b) “Chong-ruong” (beam-pilling) type is a type of “Vi noc” with horizontal components called “ruong” (beam). These components can be piled directly or using wood basements for prop up the purlin. “Ruong” can be divided in to two parts creating a couple of sort-beam.

This type of “Vi noc” is used frequently in small and large building. It also can be carved following model of each historical period.

(c) “Keo” type is a type of “Vi noc” which the components rising up the purlin are set up parallel following slope of the roof, called “Keo” or “Ke” (diagonal prop). Diagonal prop can be above the tie-beam or link with top of the main column. Below the diagonal prop can be free space (for small building) or including other linkage components for strengthen the diagonal prop bear such as pillar.
In addition, this diagonal prop can be a beam from the top of roof over the main column to small column, event link with console (called throughout diagonal prop – ke suot).

(d) “Van me” (Board) type is a type of “Vi noc” in which whole equilateral triangle is hermetic covered by one or some of pieces of wood in order to prop up purlin. This board can be carved and decorated. This type of “Vi noc” is ordinary used in structural transition of complex building.

- “Vi nach” (structure of roof-side) is the system of components propping up the roof from main column to small column or from small column to side column. Similar to “Vi noc”, “Vi nach” has 3 types of “Vi” including “Chong-ruong”, “Keo”, “Van me”. Because of “Vi nach” is limited in half of equilateral triangle, it can be typed as “Gia-chieng”.

- “Bay” (Console): is the component rising up the end of the roof.

Each factor included in “Bo vi” provides us valuable information about the monument. For example, such as “Dinh” – a communal house in the village, the ratio between the roof and the building height (determined by the ratio between side column and main column with roof-slope) is higher means the building is earlier existence. The ratio of Dinh’s roof is 2/3 of Dinh’s height
generally preserve vestige earlier than 17th century. The building without two roof-flank that replaced by hermetic wall can be seen as later than 19th century.

The structure and decoration of “Bo vi” usually transformed following the time. For each transformation, we have another name and it show the information about the age, origin. The linkage form between main components as tie-beam and column also bring us the message about building’s age. The tie-beam is placed upon the top of column by a big basement is the linkage form of the building earlier 18th century. Square column and purlin exist later than circle column and purlin.

Some of “Bo vi” is set up parallel and link together by length beam quadrature with “Bo vi” plane, creating a basic wooden architectural frame. Particularly in veranda column, the length beam can be used for door fitting up. The length beam linkage the bottom side column is threshold (nguong cua).

Roof structure is a system above and closely link with the wooden frame that creating a bone for the roof. It receives and transmits loading capacity of the roof to the frame and also shaped the architectural roof. Roof structure is created by “hoanh” (purlin), “rui” (rafter), “tau mai” (roof-leg).

- “Hoanh” (purlin) is located parallel with length beam, regular separated from each other. Purlin can be circle or square. In the top of the roof is the special and biggest purlin, called “thuong luong”.
- “Rui” (rafter) is the component located directly and quadrature on purlin, parallel with 8 – 12 cm separated from each other.
- “Tau mai” (roof-leg) is a purlin at the end of the roof. “Tau mai” support for the roof structure in avoiding the disproportion. Especially, in the corner of roof, there is another of “tau mai” that shapes like a curve-knife, called “Tau dao”. “Tau mai” is a special component that creating a difference between Vietnam traditional architecture and other nation architecture, it can be seen a typical of Vietnam with rising up aspiration like the shape of “Tau dao” (roof leg in the corner).

2.2 Linkage of wooden components

The components of the wooden frame are jointed by tenon. This is a specific characteristic of wooden structure originating from popular innovation. This technique ensures that the wooden frame can be made by only wood material and be unification. Building with different standard, different function does not use nail or other material for linkage wooden frame components. Consequently, the wooden frame structure could avoid the damage caused of deformation according to different diminishing of different material or even oxidization of metal.

Linkage between vertical components such as column, pillar with horizontal components as tie-beam, side-beam, length beam is most important linkage for stabilizing wooden frame. Therefore, such linkage always creates stably with special composition avoiding any displace.

Other linkage such as connection of components of “Vi noc” together and to tie-beam; connection of components of “Vi nach” together or to side-beam; roof’s components link with other below… are used itself loading capacity or dowel-wood for location and stabilizing of the linkage.
By this technique of component linkage, the wooden frame structure of traditional architecture in Vietnam has its own specific. The advantage of tenon-linkage technique is easy for dissembling or installation. It allows us to move the building from this place to the other. Historically, many important building has been moved to new place for giving away from disadvantages of natural such as Keo Pagoda – Thai Binh, Chem community house – Hanoi…

2.3 Architectural space organization following the flexible arrangement of wooden frame architecture

Vietnam traditional architecture is created from basic frame, the basic frame link together by beams. The space between two consecutive basic frames is called “gian” (compartment). Each compartment is a partly space for a house. From such simple structure, combining with some flexible arrangement of wooden frame architecture following the both side of space, we created building with other standard, simple or complex structure.

- Most simple structural house is formed like a rectangle, called “chu Nhat” (following Chinese) that created by consecutive compartments. Generally, the amount of compartment in this house is odd number: 1, 3, 5, 7 or 9. Following the East Asian, odd number is positively. Because of the land is negatively so the house above this land could be positively for equilibration which means stable and long.

- According to usage requirement, we can create a more complexity space. From the rectangle of simple house, developing space quadrature with main space by other “Vi” linkage that takes a shape of “Thuoc tho” (square meter), called “chu Dinh” (following Chinese). The quadrature space is called “chuoi vo” by Vietnam people.

- For more developing space, new “Vi” can be set quadrature with “Vi” of “chuoi vo”. This space is parallel with main space, creating the general space look like the word “I”, called “chu Cong” (worker - Following Chinese). Basically, this space is two rectangle that linked by a quadrature space (called “ong muong”). This structure often use in religion constructions in Northern Vietnam.

- One more method of developing space is two consecutive rectangles. This form appeared much in Middle of Vietnam under Nguyen’s age, particularly in Hue Royal Palaces.

3 IDENTIFY THE FEATURES OF VIETNAM TRADITIONAL ARCHITECTURE BY WOODEN FRAME STRUCTURE

The capability bearing of the wood is limited, therefore the standard of wooden structure in accordance with the horizontal direction having the fixed limiting (generally smaller than 4m). Vietnam traditional architecture, by this reason, has ordinarily the small size, and the moderate cube. The manner organization of space in accordance with module “compartment” create the combination of cube architectural which doesn’t rise up the height direction but following by the horizontal direction. The combination active of the system wood frame makes the spaces where is related to the actives life human and the compatibleness depending on the requirement. This characteristic also accords with the conditional nature, society as for the ideology Viet-
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 Vietnamese. The architecture traditional attaches to the comfort, the simple, the organic harmony between the framework natural and the human life.

 Other characteristic of Vietnam traditional architecture filled with the popular. Most of the Vietnam traditional architecture has been built by the group of workman, from the villages, having the knowledge, the experiences and the popular creation transmitted one’s generation to one’s generation. Almost the matter basic in building as well as method, defining form, utilization of the wooden material and other material from the nature and from the mode traditional. The communal big house that as Dinh Bang is similar in many of the outline as The Worship House Family of Nguyen Thac, both of the building have been built by the same group of workman. The structure basic of building religion in The northern Region is higher level than the house traditional. The structure of Palace in Hue province resembles to the type of house “ruong” located in Middle Region.

 “Truthfulness” is also one meaning characteristic of the Vietnam traditional architecture that have been made from the structure wood frame and utilizing the material from the origin natural. The natural trees are manufactured into the independent and components which are not the joint, not covered by other material and the layer paint limited. Each component assume the function technique, in the structure of system frame, being clear and profound, almost these components that have been filled in the outline structure having the profound decorating. The decorated subjects are located on the components having the function technique in the Vietnam traditional architecture of wooden.

 Almost the building of Vietnam traditional architecture have the origin from the domicile house made in the wooden tradition, both is similar to the type of structure with the unit particular space called “gian” (compartment) have been built by the system wooden frame and “Bo Vi”, that is created some categories and the models. The architectural types as well as the domicile house, many-storied house, Palace to communal house, pagoda, rest-house, temple, etc. have in common the types “Vi” and the mode of joint but still different a little of dimension component and the extent of decorating and carving. The diversification exists in the reunification created one important characteristic of the wooden architecture traditional Viet Nam. The category of this architecture is diversified, copious as the historic period, as the location geography but still having the close reunification as to the basic structure and the expressed language. About more than 40000 historical monuments is estimated within having approximate 3000 historical monuments is arranged in the level national. Almost these historical monuments have been made by wood. The category of architecture is multiform such as The Wall, Palace, to the building religion, the domicile house and others. Following the historic process of each year, the monuments of each period often have itself particular characteristic. Being the different location geography as the Northern Region, Southern Region, Middle Region, or mountain, midland, the architectural monuments have the transmission, the adaptation creating the particular form. Beside the diversification and the abundance of the wooden traditional architecture is very profound in addition to the close reunification. Almost the building has the outline similar occurring in the structure of system traditional wood-frame.

 Advantages and disadvantages of the architecture that created by traditional wooden frame structure.

 Advantages

- The components of the wooden frame are jointed by tenon. This is a specific characteristic of wooden structure. The tenon can be single or double depend on strengthen of component or complexity of structure. The advantage of tenon-linkage technique is easy for dissembling or installation. In historic of Vietnam architecture, there are not rarely a building could be moved from this place to the other.
- Activity is a special advantage of wooden architecture. Linkage between compartments can be used in order to create variety and conformity space. In Vietnam, many building have been extended suitable with usage requirement by connecting new frame into old structure.
- Wooden structure has its own fantastic sense, and in combining with engraving the building is more beautiful.

 Disadvantages
- Because of the frame structure is made from organic material, and disadvantage of climate condition, termite and worn, plant erosion on the other hand, it is can be deformed easily.
- Building was constructed by experiences and traditional method, less of sciences and technology for basement, structuring, stabilizing, and also less of technical for absorbent, ventilation that all cause of structure damage.
- Beside the advantage of tenon presented by activity, linkage between components by tenon also implicit unstable. In addition according to consecutive linkage of structure, a damage of one component will hardly cause of others damage.

Nowadays, Vietnam traditional wooden architecture can be seen as valuable cultural and historical monument. Vietnam government and community are now interest in such monument conservation and developing.