The Tradition of Wooden Architecture in Japan

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■ Outline

Outline of the history

With large number of evidences through scientific excavation researches, it has been proofed that the history of Japanese architecture began with the pit-dwelling, which is known to have existed as early as 10,000 years ago. In around the third century B.C. irrigated rice cultivation and iron artifacts were introduced from the southern part of the Korean Peninsula. The use of raised-floor structures also began about this time. These structures became established as the main form of dwellings as Shinto shrines and still represent an elemental part of Japanese culture today.

In the middle of the 6th century, when Buddhism was introduced through the Korean kingdom of *Paekche*, the general style of architecture then prevailing on the continent was introduced as a Buddhist temple architectural style together with the religious institutions. Because many Buddhist temples were constructed under the patronage of the Central Imperial Court, the architectural styles then in existence were influenced strongly by the imported Buddhist culture, which was rapidly absorbed in the process of producing a unique form of Japanese architectural development.

In the latter half of the l2th century, the next period of major change began when a new wave of Buddhist culture was introduced mainly from the Chinese dynasty of Southern Soung. At this time the two new Buddhist temple styles known as *Daibutsu-yo* and *Zenshu-yo* were also introduced. Thus Japanese architecture, in which temples were the dominant architectural type, was again influenced by the imported styles from the continent.

After this period there were no further significant outside influences for the next seven centuries, until Japan opened up to foreigners in the latter half of the 19th century and began to introduce aspects of European culture. During that 700-year period of isolation the architecture of Japan evolved into unique and highly-developed forms, including such very specialized types as temples, shrines, vernacular houses, tea-houses and castle architecture.

Wooden Architecture

Wood is the elementally material of Japanese architecture, the product of the rich forest environment of this country. Japanese wooden buildings range from the smallest architectural spaces, tea-rooms (such as *Tai-an*) with a floor area of only two *tatami* mats (about 3.3 square meters), to one of the largest wooden existing buildings in the world (the *Todaj-ji Daibutsu-den*), a great Buddhist temple 57 meters in width and 46.8 meters in height, with a floor area of 2880 square meters. The largest wooden structural members reach one meter in diameter with a weight of approximately six tons.

Among Japanese wooden architectural monuments, the oldest existing example is the western temple precinct of *Horyu-ji*, built at the end of the 7th century. The buildings in this precinct are also the oldest remaining wooden buildings in the world.

As of the end of 2003, there are 3844 individual historic buildings designated as the Important Cultural Properties by Japanese government. Among them, approximately 80 were constructed between the 7th and the 12th centuries, about 1500 from the end of the 12th century to the end of the 16th century, 1900 from the end of the 16th century to the end of the 19th century, and about 400 from the late 19th century to the present. Nearly all of Japan's remaining wooden buildings which date back to at least the end of the 16th century and have been preserved in good conditions have been designated by the national government as Important Cultural Properties. The categories of designation include religious architecture such as Shinto shrines or Buddhist temples, castles, upper-class residences, vernacular farmhouses and townhouses, and western-style buildings including structures for industries or civil engineering.

Among these, wooden buildings represent approximately 90% of the total. These numbers refer only to individual monuments. Besides these, 62 historical towns and villages have been selected as national preservation districts, including approximately 10,000 houses and other structures recognized historical importance. Moreover, many single buildings and historic towns or villages have been designated by local government at the prefectural level or at the municipal level in accordance with their own regal regulations.

■ Characteristics

Post-and-Beam Structure

The fundamental characteristic of Japanese architecture is the wooden post-and-beam structure. This type of structure uses a system of joinery in which the structural members meet at right angles and are joined by means of mortise-and-tenon connections using wooden wedges and pegs to secure the joints. Where long members are required, spliced connections with wedges and pegs are used to join shorter lengths of wood together. Metal fasteners such as nails and cramps are sometimes used, but only for relatively small members which have no primary structural role.

One of the main characteristics of this structure is that it is a structure which is “reversible”, in that it can be disassembled and reassembled without damage to the members. Because of this structural characteristic, it is possible to adopt the technique of “repair with dismantlement” which is common in the conservation of buildings in Japan.

The basic system of the frame structure composed of posts and beams is known as a “rigid-frame structure”, constructed to resist the bending moment at each joint, but in effect the overall system acts as a flexible structure which allows a certain degree of flexure and sway in response to lateral external forces. This is a very practical type of system in an earthquake-prone country such as Japan.

In Japan, with very few exceptions, buildings have been traditionally constructed with this type of structural system. Among those exceptions were storehouse structures which used a type of “log-house”

construction. Also, in rare cases, truss structures with diagonal bracing similar to European structural systems have been used.

Another fundamental characteristic of Japanese architecture is that the structure itself is the main element of the architectural design, where the structure is not hidden within the walls but exposed to express the form and pattern of the traditional design aesthetic -- an aesthetic based on the unique character of geometric composition and spatial openness which gives Japanese architecture its special sense of beauty.

Roof Structure and Materials

Like the post-and-beam frame system, the roof is another important element which characterizes design of Japanese architecture. The large triangular volume of the roof with its deep overhangs makes the roof form the dominant element of the exterior composition. The deep eaves that evolved in response to the rainy climate provide a sheltered "indoor-outdoor space" which gives traditional houses a sense of unbroken continuity with nature, and the subtly curved profiles of the roof forms in general reflect the sensitivity of the Japanese cultural aesthetic.

Traditional roofing materials originally included organic materials such as miscunthus thatch, cypressbark shingles and wooden shingles, but together with the introduction of Buddhism the techniques of clay-tile roofing construction were brought from the continent. Whereas tile roofs were customarily used mainly for Buddhist temples, with Shinto shrines and aristocrats' residences continuing to use organic roofing materials, it later became common to use clay tile for general roofing applications in urban areas for reasons of economy and fire prevention. For important shrines and for important residential buildings such as palace structures, however, traditional organic materials are still used. For ordinary farmhouses, where roofing work was done by local labour using locally-obtained materials, thatching was still in common use until very recently.

Craftsmanship

Before the introduction of architectural techniques from the continent, even in the pre-historic periods, certain construction techniques had already developed independently in Japan. Notwithstanding the strong continental influences on architectural style, the basic techniques for wood construction -- including joinery techniques, usage of tools, etc. -- continued to evolve in a uniquely Japanese manner. Because of the critical tolerances required to produce the carefully expressed exposed post-and-beam composition, it was necessary for Japanese carpenters to develop their craftsmanship to a high degree of perfection. Not only the techniques but also the tools for wood carpentry were highly developed, together with an intimate knowledge of wood as a material and an appropriate sensitivity to design and proportion.

The Development of *Kiku* and *Kiwari*

The roof in Japanese architecture is composed of complex curves -- the curved profile of the sloped roof plane itself combined with the up-turned curves of the eave lines at the corners of the roof-- requiring a sophisticated geometrical system to determine how to cut precisely the surface angles where the framing members meet. Carpenters need a highly developed knowledge of this geometry in order to connect these members exactly, by working out calculations of the depth of the eave, the

degree of the curve, and the shape of the cut surface of each member. This system is called *kiku*, one of the most important subjects in the training of traditional carpenters.

The *kiku* System was fully developed as a system of mathematical and geometrical calculation by the latter half of the 18th century, but prior to this development actual construction had long been carried out using a practical method of measurement and line drafting using the standard carpenter's square to draw the cut lines on the surface of the lumber.

Also important for designing building especially in post and beam structure was the *kiwari* system, a system of modular proportioning of the overall structure, the spacing of the columns, and the proportions of each member.

As a result of the adoption of this proportioning system, architectural construction became a comprehensive, unified, rationally organized industry, controlling everything down to the sizes of wooden members available in the lumber market.