

## The Tradition of Wooden Architecture in Japan

**YAMATO Satoshi**

Agency for Cultural Affairs, 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 12th century, the next period of major change began when a new wave of Buddhist culture was introduced mainly from the Chinese dynasty of Southern Song. 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 7<sup>th</sup> 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 7<sup>th</sup> and the 12<sup>th</sup> centuries, about 1500 from the end of the 12<sup>th</sup> century to the end of the 16<sup>th</sup> century, 1900 from the end of the 16<sup>th</sup> century to the end of the 19<sup>th</sup> century, and about 400 from the late 19<sup>th</sup> century to the present. Nearly all of Japan's remaining wooden buildings which date back to at least the end of the 16<sup>th</sup> 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 thousands 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, cypress-bark 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 labor 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.

## Legal Protection Systems for Architectural Monuments in Japan

### The Law for the Protection of Cultural Properties

The systems of legal protection for architectural monuments in modern Japan began with the enactment of a law, namely the Ancient Shrines and Temples Preservation Act in 1897, which covered buildings and artworks possessed by shrines and temples.

The current law, the Law for the Protection of Cultural Properties was enacted in 1950 for the systematic protection of properties in each official classification, as well as to combine and unify the individual protection systems which were already in existence prior to enactment of this law; those included the National Treasures Preservation Law (enacted in 1929), the Law for the Preservation of Historic Sites, Places of Scenic Beauty and Natural Monuments (enacted in 1919). The new law was established immediately following the fire which damaged the *Horyu-ji* Main Hall, built around the latter half of 7<sup>th</sup> century.

This law covers a broad range of properties, from fine arts to natural monuments and from tangible to intangible cultural properties including traditional dance and musical performance skills as well as practical skills such as traditional conservation techniques.

The designation of buildings was at first limited to shrines, temples and castles, but after World War II the law was broadened to cover ordinary vernacular houses and the early-modern-period architecture which had been influenced by European architecture. In 1975, a system for the protection of preservation districts for groups of historic buildings was introduced for the protection of historic towns and villages. Also recently, much more various types of buildings and other structures have been designated and protected under this system including industrial facilities, civil engineering structures, such as factories, steel bridges, dams or tunnels so on.

### **Regulation for protection and Support system**

The national government has designated 2,250 sites, including 3,844 buildings and other structures as of December 2003, either including National Treasures or Important Cultural Properties.

In accordance with the provisions of The Law, the permission of the Commissioner of the Agency for Cultural Affairs is required for any alteration to the existing state of these designated buildings or action that would cause an effect on the value of designated building. Major or minor repair work is carried out by the owners of Important Cultural Properties or their custodial bodies, and as financial support to cover large expenses for the repair work, subsidies are granted by the notional government for the owners or custodial bodies.

About 90 % of nationally designated buildings are made of wood and approximately half of them have roofs made of plant materials such as thatch, wooden shingle, cypress bark so on, which are extremely vulnerable to fire. For the reason, the national government provides necessary subsidies for owners or custodial bodies to install or maintain fire-prevention facilities and other disaster-prevention system required.

Besides providing those subsidies to owners and custodial bodies, the national and local governments prepare tax incentive system that includes reduction of inheritance tax and exemption of fixed assets tax, city planning tax or special land holding tax to encourage ownership of cultural properties and promote their positive commitment to preservation and utilization of their cultural properties.



### **The Advisory Council for the Protection of Cultural Properties**

Decisions on new designations and approval of alterations to the existing state of designated properties are made through investigations and deliberations by the Council for Cultural Affairs. The Minister or the Commissioner only could give permissions after he/she consults issues to the Council. The Council membership is composed of "those who have wide and eminent views on and knowledge of culture". The Council's approvals of alterations to existing state include any alterations required for restoration or reconstruction work which is necessary for proper conservation of the designated buildings.

### **Authorized Conservation Architects**

In the case of conservation projects which are subsidized by the national government, it is required to retain an authorized conservation architect to design and manage the whole project. The responsibility of the conservation architect includes investigations (such as analysis of deterioration, measurements of members, studies of historic techniques and traces, reference to historic resources, etc.), design, documentation, supervision of the restoration work and publishing of documentations. In Japan, from the long and rich history of experience in scientific investigation and the repair of architectural cultural properties, a very detailed systematic program of architectural conservation has been developed.

The national government directly provides a training course for these top-level conservation architects. The conservation architects who have completed this course are assigned by the national government as site managers of conservation projects. Of the conservation architects who take this national course, most belong to a nation-wide non-profit organization of conservation management specialists, the Japan Association for Conservation of Architectural Monuments (JACAM). Others are members of local organizations, including the conservation divisions of three prefectural governments (Kyoto, Nara and Shiga Prefectures) and one local non-profit organization (Wakayama Prefecture). These four prefectures have a particularly high concentration of architectural monuments. The total number of people in these organizations and government agencies now stands at approximately 150, including trainees at the entry level.

### **Traditional Conservation Techniques**

For the repair of architectural monuments the fundamental principle is to use traditional techniques and materials. In Japan, where rapid economic progress and changes in the industrial structure have been especially significant, there has long been an awareness of the problem of a growing shortage of traditional materials and craftsmen.

In 1975 the legal system for the protection of conservation techniques was implemented as part of the revision to the Law for the Protection of Cultural Properties.

This is a system under which the national government may designate the traditional techniques or crafts which are indispensable for repair work and maintenance of cultural properties (Selected Conservation Techniques), and may officially select the possessors or practitioners of those techniques either individual persons or preservation organizations (holder or holders of the traditional conservation techniques). The national government grants subsidies to those selected individuals or organizations to be used for conservation-related projects such as refining skills and training of successors to carry on the tradition.

The designated traditional techniques related to historic buildings include those in the following fields: wood carpentry, architectural painting or coloration, geometric proportioning, cypress-bark and wood roof shingling, miscanthus thatching, plaster work, metal ornamental manufacturing, fitting maker, metal molding, blacksmith, bamboo nail making and the production of clay roof tiles.

Kyoto and Nara Prefectures have established teams of skilled craftsmen who are hired as full-time government employees to protect their status and to improve the efficiency of the succession of techniques.

## Buddhist Buildings in the *Horyu-ji* Area: Monuments on the World Heritage List

### History

Buddhism was introduced to Japan in the mid-sixth century from China by way of the Korean Peninsula. In the seventh century in the area around *Horyu-ji*, the Emperor's son and regent Prince *Shotoku* founded *Horyu-ji* and *Chugu-ji* temple. The Imperial Family later founded *Horin-ji*, dedicated to the recovery of the Prince from illness. After his death, *Hokki-ji* was founded on the site where the Prince's palace had formerly been located.

*Horyu-ji*, which Prince *Shotoku* founded at the beginning of the seventh century, is presumed to have been destroyed by fire in 670. The temple was rebuilt in the new location from the latter half of the seventh century to the beginning of the eighth century. The rebuilt temple is known today as the *Horyu-ji Sai-in*, the west temple.

The other major sub-temple at *Horyu-ji* is the *Toh-in* the east temple, which was built in the first half of the eighth century at the site of Prince *Shotoku's Ikaruga* Palace in dedication to the Prince. Besides *Sai-in* and *Toh-in*, there are several monasteries at *Horyu-ji*.

In ancient times, *Horyu-ji* received the protection of the Imperial Family because it was revered as the temple which guarded the empire. Moreover, from about the twelfth century people's respect for and belief in Prince *Shotoku* became very strong, drawing believers to the temple in great numbers, and *Horyu-ji* began to prosper due to its fame as the temple which had been established by the Prince.

Imperial authorities and successive governments have always offered generous patronage for the maintenance and repair of the temple.

During the Meiji Restoration, which marked the birth of Japan as a modern nation, Shintoism began to rise in influence as a state religion. On the other hand, movements rejecting Buddhism became prevalent as it was regarded as dominating religion of the old political order, and *Horyu-ji* began to decline as a result of this trend. But the new government, acknowledging the need to protect cultural properties, enacted the Law for the Preservation of Ancient Shrines and Temples in 1897. With this law, the way was opened for the support of scientific investigations and the protection of cultural properties.

### **Buddhist Buildings in the *Horyu-ji* Area**

For the Buddhist buildings of the *Horyu-ji* area, the arrangement or composition of buildings in itself has significant historical meaning, and each of the individual buildings displays outstanding architectural style.

In Japan there are twenty-eight historic wooden buildings which were constructed before or during the eighth century. Eleven of these are found in the *Horyu-ji* area. Of these eleven, the *Kondo* (main hall), *Gojunoto* (five-story pagoda), *Chumon* (inner gate) and *Kairo* (roofed, semi-enclosed corridor) of the *Horyu-ji Sai-in* and the *Sanjunoto* (three-story pagoda) of *Hokki-ji*, which were built from the seventh to the beginning of the eighth centuries, are the world's oldest wooden structures remaining today in their original form.

*Sai-in* (West Temple): The *Kondo* was completed by 680, followed by the *Gojunoto*, *Chumon* and the *Kairo*. The entire temple was completed by around 710. The pillars of these buildings are characterized by entasis and the bracketing systems are in the shape of a cloud; these details indicate that these buildings belong to a period older than and different from many of the buildings built after the eighth century in terms of both structure and design. The structure and design found in these buildings were developed under the influence of the Chinese culture of the *Bai-wei* period (sixth century). Among the principal buildings in this precinct, the *Kohdo* (lecture hall) was destroyed by fire in 925 but was rebuilt in 990.

*Toh-in* (East Temple): The *Toh-in* was built in the first half of the eighth century.

Its main hall, the *Yumedono*, is an octagonal building surrounded by a corridor. Behind the *Yumedono* is the *Denpodo*, a lecture hall, and the priests' living quarters. Buildings other than the *Yumedono* and the *Denpodo* were rebuilt in the thirteenth century during a time when belief in Prince *Shotoku* was at its height.

At this time the *Raido* (worship hall) was built where the original inner gate stood, and a building to hold the Buddha's ashes (originally in the possession of Prince *Shotoku*) was built behind the *Yumedono*. This revised arrangement remains today.

The Buddhist buildings in the *Horyu-ji* area were witness to the close cultural interchange between China and Japan and in East Asia at the time. Moreover, there is no other example in which outstanding wooden structures of different ages beginning with the seventh century and extending to the nineteenth century are concentrated in one area and preserved. It may be said that cultural properties that express the long and rich history of the wooden Buddhist temples of East Asia, as well as the history of the Buddhist religion itself, are gathered here.

Prince Regent *Shotoku*, who founded the original *Horyu-ji*, was highly instrumental in the introduction and spread of Buddhism in Japan at that time. *Horyu-ji*, with its collection of temple buildings which date back to the age when Buddhism was just beginning to flourish in Japan, holds a very important position in the history of Japanese Buddhism.

As examples of the oldest Buddhist structures in Japan, the groups of Buddhist structures in the *Horyu-ji* area have influenced the development of temples at different ages throughout 1300 years of tradition. They are very important cultural properties in promoting the understanding of the culture of Japan.

### **The Protection of the Environment**

Not only the buildings but also the temple site has been designated by the national government; a total of 48 buildings have been designated as National Treasures or Important Cultural Properties, and the temple site has been designated as a Special Historic Site (14.6 ha) by the national government in accordance with the Law for the Protection of Cultural Properties. Any action which may alter the existing state of the designated place is to be controlled and the permission of the government must be obtained.

The buffer zone surrounding the temple site was designated as a "Conservation District of Historic Natural Features of *Ikaruga* town" in accordance with the Law Concerning Special Measures for Preservation of Historic Natural Features in Ancient Cities. It was also designated as an "*Ikaruga* Scenic Landscape District" by Nara Prefecture in the same year, in accordance with the Ordinance of Nara Prefecture Scenic Landscape Preservation, thereby providing for the conservation of the historic natural features and the natural environment of the entire district.

## **History and Results of Conservation Work on Architectural Monuments in Japan: the *Horyu-ji Kondo***

### **The Process of Repair Work on the *Kondo***

The conservation work on the buildings in the *Horyu-ji* temple precinct, which had begun in 1934, was an epoch-making experience in the field of architectural conservation in Japan. The initial focus of the work was the conservation of the mural paintings in the interior of the first story. As a result of this project, in part due to the types of repairs involved, especially repair with dismantling, a major undertaking which could have significant effects on the conservation of the buildings--a comprehensive program of systems and methods of conservation work was established for Japan.

But in 1945, during World War II, with the work on the first story still under way, the upper story and the ceiling of the first story were dismantled as a precaution against possible air attacks on conspicuously tall buildings in this vicinity. After the war, in 1949, the interior, including the mural paintings, suffered damage in an accidental fire; it was decided then to carry out a program of repair which included complete dismantlement, and this repair was completed in 1954. Thus the repair work on the *Kondo*, which had started out as interior work on the mural paintings, in the end turned out to be a major project including repair with complete dismantlement due to the special circumstances of the war and the accidental fire.

### ***Kaitai Shuri* : Repair with Dismantlement**

Repair with dismantlement is one of the common methods of repair of architectural monuments in Japan. This method has been used since the beginning of modern scientific conservation work in Japan, which started near the end of the 19<sup>th</sup> century after the enactment of the first national law. Other types of repair include partial repair in situ, re-roofing, re-painting, etc. Repair with dismantlement may be undertaken in cases in which there is serious deterioration or distortion of the main structural frame, where the consolidation of joints or replacement of main structural members is required on a large scale.

Because of the principal structural characteristics of Japanese architecture -- (1) the post-and-beam structure without structural walls or bracing, (2) the joint system of mortise and tenon connections without metal fasteners, and (3) the exposed structural frame which is expressed on both the exterior and the interior as the main element of the finished wall composition -- dismantlement is made possible by the nature of the structure itself and is a practical and logical solution to the problem of repair, allowing disassembly and reassembly without any damage to the members. Where the structural frame is seriously distorted, this method is required in order to release the internal torsional forces in the joints and to re-align the structure.

The process of repair with dismantlement is as follows; (1) number plates are attached to identify the location and orientation of each individual member, and detailed record drawings are made; (2) the sequence of dismantlement is determined and the structural frame is disassembled; (3) the damaged or deteriorated parts are repaired or replaced as required; and (4) the structure is reassembled in reverse sequence. This approach to a historic building could be regarded as one application of the method of *anastylosis*.



## Partial Restoration

The *Horyu-ji Kondo* was originally constructed at the end of the 7<sup>th</sup> century and underwent repairs in the 10<sup>th</sup>, 12<sup>th</sup>, 13<sup>th</sup>, 14<sup>th</sup> and 17<sup>th</sup> centuries, could have been proofed through detailed research on traces left on members and archives during the conservation work. There were no major alterations done during these periods of repair, but a number of minor changes had been made. As part of the conservation work it was decided to restore those altered portions to their original condition, i.e. those alterations which had damaged the historic value of the building as a 7<sup>th</sup> century building. These alterations to the then-existing state were made with the approval of the Council.

The restored portions of the *Kondo* include the following; (1) the styles of the roof tiles and ridge tiles; (2) the roof framing sub-structure; (3) the perimeter of the eave framing; (4) the gable ornament; (5) the eave bracketing system at the corners; (6) the removal of eave-reinforcement supports (with the exception of the decorated corner struts); (7) the design of the balustrade on the upper story; (8) the design of the ornamental metal covers on the rafter ends; (9) the removal of the reinforcement tie beams and braces and the installation of new steel reinforcement members concealed in the roof structure; and (10) the design of the roofing material on the projected shed roofs surrounding the lower portion of the building.

In general, the portions of the building that were restored to their original state were those that had been altered during the 17<sup>th</sup> century repairs. The restoration design was done after careful research which was dependent on the results of investigations of the remaining traces on all of the wooden members. In the case of the *Horyu-ji Kondo*, the policy of the restoration, to return it to its original state, was decided under the following conditions; (1) the later alterations were limited to minor ornamental design features and had not changed the basic fabric of the building; (2) overall, the original design and materials were in a good state of preservation; (3) there was adequate evidence of most features of the original design to enable accurate restoration without conjecture; and (4) *Horyu-ji* has outstanding value as a unique example of *Asuka* Period architecture.

On the other hand, there are portions which were not restored because of a lack of sufficient evidence of the original condition. It is known that the buildings of the *Asuka* Period in general had bird-tail-shaped ornaments on top of the gable ridge ends, and through archaeological excavations parts of such an ornament were found under the ground -- but there was no clear proof that particular ornament had come from the roof of the *Kondo*, and not enough fragments remained to reconstruct the entire design of the ornament. The restoration of those parts was therefore not carried out, pending future investigation.

## **Preservation of Material**

The original materials were preserved as much as possible, but materials which were the cause of structural problems because of serious deterioration or other damage were replaced. Also, any materials which had been added in previous repairs or alterations were not re-used in the portions of the building which were restored to the original condition.

In the case of the *Horyu-ji Kondo*, the percentage of original members remaining after the conservation work was 50 to 55% on the first story, with approximately 70% on the upper story. Counting the fire-damaged members which were replaced and then put into storage, the percentage of first-story members remaining is approximately 70%. Most of the replaced parts were portions of the eave structure system, particularly bracketing or rafters which had been damaged by the overload stresses resulting from inadequate capacity to support the deep roof overhang -- a structural deficiency inherent in the original building design which had to be corrected later by the addition of corner reinforcement struts. In *Horyu-ji*, almost all of the members which were not re-used are preserved in a permanent storage facility on site, including the fire-damaged mural paintings and wooden-framing members which are on display.

In general, in conservation work on Japanese architectural monuments involving replacement of original members, most of the replaced parts are those around the exposed perimeter of the roof or near the ground surface where moisture damage is most common; it is not common to replace the structural framework members or other fundamental parts of the building, with the result that most of the important building parts remain as original materials.