New Wooden Public Buildings in Japan: Ten Case Studies

Forestry Agency
JAPAN
Foreword

In Japan, domestic forest resources planted after the World War II are now maturing enough for use as wood and wood products. In 2010, the “Act for Promotion of Use of Wood in Public Buildings” was adopted in the Diet for the promotion of use in such forest resources.

After the implementation of the Act, many public buildings have been built with wood all over Japan to demonstrate the effect of wood use.

This brochure provides with ten good practices of wooden public buildings with significant characteristics which are built after the implementation of the Act.

I hope this brochure would contribute to the promotion of wood use in public buildings all over the world as well as in Japan.

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Policy Background

As domestic forest resources planted after the World War II are now maturing enough for use as wood and wood products in Japan, the Government of Japan has been making efforts to promote the use of wood through a variety of policy tools, especially for wooden housing.

However, wood use in public buildings was very rare due to the policy of “non-combustible public buildings.” Such policy was developed during the post-WWII period when people hoped for fire-resistant communities with non-combustible buildings, while considering too heavy logging for post-war reconstruction may cause shortage of forest resources or devastation of landscape.

Since public buildings have strong potential for wood use, the Diet introduced the “Act for Promotion of Use of Wood in Public Buildings” in 2010, which requires the Government to take the lead in wood use in public buildings. The Fundamental Policy under the Act sets the target of the Government to construct all the public buildings of three stories or lower with wood structure in principle. Further, prefectures and municipalities are also required to develop their own policy for the promotion of wood use based upon the governmental policy, and make efforts to promote practical wood use in public buildings.

As 23 ministries in the Government, all of 47 prefectures, and 1,538 municipalities (88%) have already developed their own policies of wood use in public buildings, many public buildings have been constructed with wood structure, demonstrating the possibility of wood use.

After the implementation of the Act, the ratio of wooden public buildings in all the public buildings rose from 8.3% in 2010 to 11.7% in 2015. Further, the ratio of wooden public buildings of three-story or lower also rose from 17.9% to 26.0% during the same period. (Table)

Such construction of wooden public buildings would promote people’s understanding on the importance and appeal of wood use through their demonstrative effects.

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</thead>
<tbody>
<tr>
<td>All buildings</td>
<td>43.2%</td>
<td>41.6%</td>
<td>41.0%</td>
<td>41.8%</td>
<td>40.3%</td>
<td>41.8%</td>
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<tr>
<td>Public buildings</td>
<td>8.3%</td>
<td>8.4%</td>
<td>9.0%</td>
<td>8.9%</td>
<td>10.4%</td>
<td>11.7%</td>
</tr>
<tr>
<td>Public buildings of three-story or lower</td>
<td>17.9%</td>
<td>21.3%</td>
<td>21.5%</td>
<td>21.0%</td>
<td>23.2%</td>
<td>26.0%</td>
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Table: Ratio of wooden buildings from 2010-2015 in Japan
Calculated by Forestry Agency based on the data of MLIT’s ‘Construction Statistics’
OVERVIEW
- Floor area: 2,883.48m²
- Structure: Two-storied wooden structure with the combination of post and beam system and lens-shaped truss structure.
- Volume of wood used: 794.27m³ (Sugi and karamatsu produced from forests in Sumita town. The share of wood produced in the town is 73.0%), or 0.28m³/m²
- Construction cost: 1,248 million yen, or 430 thousand yen/m²

CHARACTERISTICS
This building applied cutting-edge wood use technologies, including the “lattice bearing wall system” applied for the first time in Japan, and the “lens-shaped truss system” which enabled large open space with a span of as long as 21.8 meter. Domestic wood is also used for interiors including counter and office tables composed of laminated lumber of sugi.

Laminated lumber of sugi and karamatsu produced in Sumita town is used for the posts and beams in the town hall. The size of the laminated lumber used for the second floor beams is adjusted to the maximum length and width for the domestic processing factory for the use of domestic products. The laminated lumber also satisfies the “quasi fire-resistant requirements” in the Building Standard Law with the application of “burning margin system” which secures additional time for evacuation in case of fire.

In this building, the “lens-shaped truss system” with a span of 22 meter long is applied for the roof structure. The truss is composed of medium dimension laminated lumber with a short span produced in the town, rather than large dimension laminated lumber with a long span produced in distant area by specific order. With this system, large open space without post was realized in the building.

The “lattice bearing wall system” is a bearing wall composed of a number of 90mm dimension lumber of sugi inclined at 45 degrees crossed with each other in right angle. The wall is highly earthquake resistant, easy for light and air to flow in, and beautiful on the surface. This system was applied in practice for the first time in the Sumita Town Hall.
2. Akita Station West Gate Bus Terminal with Timber Portal Frame System
(Akita City, Akita)

OVERVIEW
- Floor area: 277.83 m²
- Structure: Timber portal frame system
- Volume of wood used: 98 m³ (produced in Akita Prefecture), or 0.35 m³/m² in average.
- Construction cost: 119 million yen, or 430 thousand yen/m²

CHARACTERISTICS
This bus terminal, located in front of JR Akita station, is built with timber portal frame system. Although the design is simple, the terminal provides strong impression of the beauty of wood with the succession of posts and beams, as well as traditional lattice and rafter structure. Also, traditional Kumiko-zaiku (design composed of small pieces of wood) representing regional festivals including “Kanto” and “Kamakura” are exhibited in each bus lane. At night, the light of LED lamps provides warm and nostalgic atmosphere.

STRUCTURE
The wooden structure is built as the succession of wooden “gates” composed of posts and beams with the roof structure over the gates, presenting the beauty of wood. The roof structure is one-side angled for the prevention of snow pile.

MATERIAL AND PROCESSING
Timber used for bus terminal requires durability against rotting and termite bites as well as safety. In order to maintain the warm atmosphere of wood, the lumber used in the terminal is processed by the chemical treatment of Zinc oxide, allowing natural change of the color of wood over the years.

DESIGN
In the bus terminal, traditional design ideas are applied to lighting, decoration, and joint system.

PHOTO
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Lighting reminds of traditional “Kanto” festival. LED lights are covered with clear glasses for water protection.

The designs of regional festivals such as Kanto and Kamakura are exhibited by traditional “Kumiko-zaiku” method.

UMEKI
More than 4,000 connecting volts at the head and tail of posts are covered with wood surface by the traditional technique of “Umeki” (fill-in wood).
3. **Nanyo City Culture Hall with Fire-resistant Wood**

*(Nanyo City, Yamagata)*

**OVERVIEW**
- Floor area: 5,900 m²
- Structure: Wooden structure with reinforced-concrete structure in part. Three stories with one basement floor
- Volume of wood used: 12,413 m³ (46% of sugi wood produced from forests in Nanyo City), or 2.10 m³/m²
- Construction cost: 6,680 million yen, or 1,130 thousand yen/m²

**CHARACTERISTICS**
The Nanyo City Culture Hall is the first and largest fire-resistant wooden building in Japan, excluding dome structure. The MLIT (Ministry of Land, Infrastructure and Transportation) -recognized one-hour fire-resistant lumber called “Cool Wood” is used for posts and other interior members, enabling untreated wooden surface for finishing. The project of hall construction connected forest resources with regional industries, contributing to the development of economy and employment in the region.

**CONCEPT**
- Active use of domestic sugi wood.
- Assurance of acoustic performance
- Consideration of accessibility (universal design)
- Earthquake resistance and shelter function in case of disaster
- Active use of solar power and woody biomass

**Cutting-edge Fire-resistance Technology**

**Structural Unit for Main Hall Building**

**Installation of Structural Unit**

**Wooden Structure with Regional Wood**

Log production volume: 12,413 m³
Sugi: 4,453 m³, Karamatsu: 7,960 m³

**Laminated Lumber:** 3,570 m³

**Acoustic Hall**

**Large Dimension Beam**

**Communication Lounge**
4. *Shin-Kashiwa* Clinic: Medical Clinic for “Forest Bathing”

*(Kashiwa City, Chiba)*

**OVERVIEW**
- Floor area: 3,132 m²
- Structure: Combination of reinforced-concrete, steel and wooden structure. Three stories.
- Volume of wood used: 161 m³ (144 m³ of Karamatsu from Nagano pref. for structural use, 16 m³ of Hinoki from Shizuoka pref. for finishing use)

**CHARACTERISTICS**
The concept of the *Shin-Kashiwa* Clinic is a “clinic for forest bathing” where patients of artificial dialysis operation can feel relaxed with the healing effects of wood. The clinic used a lot of domestic wood and realized a fire-resistant wooden medical institution by use of non-combustible wood material called “Moen-wood”.

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**Clinic for “Forest Bathing” by use of Domestic and Fire-resistant Wood**

- **Fire-resistant Laminated Wood**
  - Burning margin (Karamatsu)
  - Self-charring-stop layer (mortar)
  - Structural part (Karamatsu)

- **Healing space with wooden structure and surface finish**
- **Comfortable treatment space with less environmental effects**
- **Warm appearance with wooden surface**
- **Bed for artificial dialysis**
- **Nightscape highlighting warmth of wood**
- **Appearance as a symbol of the region**
5. **Kawakami Village Nursery School with Domestic Karamatsu**

(Kawakami Village, Nagano)

**OVERVIEW**
- Floor area: 1,676 m²
- Volume of wood used: 440 m³ (324 m³ from Nagano pref. (279 m³ of karamatsu from Kawakami Village), or 0.26 m³/m²
- Construction cost: 667 million yen, or 400 thousand yen/m²

**CHARACTERISTICS**

*Karamatsu*, a coniferous species which occupies 96% of planted forest resource in the village, is abundantly used for structural and interior members. *Sugi* from Neba village and *hinoki* from Okuwa village are used for a part of interior members, in accordance with friendly relationship with those villages. Geothermal heat is used for heating and cooling, and solar energy for power generation. A childcare support center is also located in the same building.

Spacious playroom with two-direction Rahmen (rigid-frame) structure

Nursery room for three-year-olds

Nursery room for five-year-olds

Children turn the spacious corridor into an indoor playground
6. Konohana Arena Gymnasium with Hybrid Structure of Wood and Steel

(Shizuoka City, Shizuoka)

OVERVIEW
- Floor area: 13,509 m²
- Structure: Combination of reinforced concrete, wood, and steel.
- Volume of wood used: 940 m³ (840 m³ of laminated lumber from Shizuoka pref., 100 m³ of interior wood), or 0.07 m³/m²
- Construction cost: 5,880 million yen, or 440 thousand yen/m²

CHARACTERISTICS
The structure of this gymnasium is a hybrid structure of wood and steel. While 256 pieces of *sugi* laminated lumbers support the 2,350 ton large roof structure, steel braces installed behind laminated lumbers support short-term load from earthquake or wind. In addition to the fundamental structure, interior wood is also used for the ceiling and walls of the game floor, providing an impression of “surrounded by wood.”

Production system of large-dimension laminated lumber
Timber: Diameter 28 centimeter or more
Lamina production: Grade L70 or higher. Moisture content of 15% or lower.
Laminated lumber processing: Young’s modulus E65, E75, or E85.
Volume: 256 pieces (800 m³)

Hybrid structure of wood and steel
Wood: support long-term load from roof structure
Steel: support short-term load from earthquake or wind

<table>
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<th>Measurement</th>
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<tr>
<td>360 × 600 × 14000</td>
<td>E65-F255 208pcs</td>
</tr>
<tr>
<td></td>
<td>E75-F270 32pcs</td>
</tr>
<tr>
<td></td>
<td>E85-F300 16pcs</td>
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</table>

Prefectural wood use for interiors
Remains of lamina and laminated lumber production are also used for louver in the gymnasium
Ceiling louver: *Sugi* 30mm x 180mm
Wall louver: *Sugi* 40mm x 60mm x 2,350mm
Total: 100 m³
7. Tsugegawa Elementary School with Domestic Lumber

(Shinshiro City, Aichi)

OVERVIEW
- Floor area: 3,126 m²
- Volume of wood used: 803 m³ (803 m³ from Aichi pref. (92% from Shinshiro City)), or 0.26 m³/m²
- Construction cost: 917 million yen, or 290 thousand yen/m²

CHARACTERISTICS
The Tsugegawa elementary school employs gable roof system and domestic wooden siding, providing harmony with surrounding mountain landscape. Wood produced from forests in the Shinshiro City is abundantly used for structure and interiors. Deep eaves and monitor roof realize moderate heat environment.

Wooden roof structure
The gymnasium and multi-purpose hall employ the hybrid structure of wooden roof system over reinforced concrete structure, securing earthquake resistant performance.

In the gymnasium with 17 meter width and 36.4 meter length, the inclined beams of roof system are supported by knee braces installed on reinforced concrete posts.

Small dimension lumber
In the school building, bearing walls are installed efficiently, taking advantage of simple floor plan.

The brace structure minimizes possible distortion in case of earthquake, allowing the use of small dimension lumber.
**Maniwa Municipal Center with Assembled Poles**

*(Maniwa City, Okayama)*

**OVERVIEW**
- Floor area: 2,685 m²
- Structure: Two-story wooden structure with partial reinforced concrete structure.
- Volume of wood used: 740 m³ (713 m³ from Okayama pref.), or 0.28 m³/m²
- Construction cost: 850 million yen, or 320 thousand yen/m²

**CHARACTERISTICS**
The Maniwa Municipal Center is a multi-functional facility where the branch of city hall, health center, community center, and library are located. Wooden structure is composed of generic lumber produced from local forests and engineered wood. The central lobby space surrounded by wooden structure, composed of combination of generic lumber and engineered wood, and wooden louver connect the functions of each facility.

**Rahmen(rigid-frame) structure**
The Lag Screw Bolt (LSB) system is employed for the connection between posts and beams. The two-dimensional Rahmen structure enables large space without bearing walls.

**Combination of lumber**
Assembled posts of four pieces of generic lumber and laminated lumber posts are employed in the center. Laminated lumber posts accept horizontal load while assembled post accept vertical load.

**Domestic energy supply system**
The heat for air conditioning is supplied from biomass heat supply system which uses woody biomass produced from forests in Maniwa City. With the combination of solar power battery system, and generators, the system can partially operate even in the case of disaster.
9. *Kochi* Prefecture Forest Owners Cooperatives Office with CLT  
(Nankoku City, Kochi)

**OVERVIEW**  
- Floor area: 1,210 m²  
- Volume of wood used: 550 m³ (321 m³ of CLT), or 0.45 m³/m²  
- Construction cost: 411 million yen, or 340 thousand yen/m²

**CHARACTERISTICS**  
The *Kochi* Prefecture Forest Owners Cooperatives Office uses Cross Laminated Timber (CLT) for floor, wall and roof in post-and-beam wooden structure. Structural posts and beams are bound by CLT from two sides in order to satisfy the requirements for quasi-fire-resistant building. The Office is the first building which used CLT as fire- and earthquake-resistant layers in Japan.

**Post-and-beam structure and CLT**  
The earthquake-resistant performance of CLT was confirmed through three types of structural experiments for the practical application of CLT as earthquake-resistant walls. The maximum load of CLT for floor was also confirmed through structural calculations and practical experiments.

**Fire-resistant performance of CLT**  
Posts and beams are bound by CLT from two sides to secure the quasi-fire-resistant performance. This system is recognized by the Ministry of Land, Infrastructure and Transportation (MLIT) as the unique method to use CLT as structural member without covering its wooden surface.
OVERVIEW
- Floor area: 3,253 m²
- Structure: Two-story wooden structure with a partial reinforced concrete structure.
- Volume of wood used: 480 m³ (Sugi exclusively sourced from Aya Town and hinoki produced in Miyazaki Prefecture)
- Construction cost: 650 million yen, or 200 thousand yen/m²

CHARACTERISTICS
The school building is composed of small classroom "units". These units are made from generic lumber and laminated lumber that are processed in local factories. Commonly available items are also used in connective fittings for cost reduction. Domestic wood used in interior and exterior walls provides a warm and soft atmosphere in harmony with the local landscape.

Structural planning
Under the Building Standard Law, school building larger than 3,000 m² in floor area must meet fire resistance requirement. In order to avoid the requirement, the building is divided into three parts: two separate wooden buildings and a reinforced concrete building between them.

Use of generic wood
Each school room is designed as a "unit" that can be combined into a school building. This design idea makes it possible to use small- and medium-sized generic lumber and laminated lumber that are produced in local factories. Also, commonly available metal fittings are used for cost reduction.

School building larger than 3,000 m² requires special order items which local mills unable to produce.

- Components and materials are standardized.
- Cost structure becomes transparent.
- Size of buildings is adjustable.
- Local mills can produce components and materials.
- Cost reduction
- Shorter construction period
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