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.

	FY2010	FY2011	FY2012	FY2013	FY2014	FY2015
All buildings	43.2%	41.6%	41.0%	41.8%	40.3%	41.8%
Public buildings	8.3%	8.4%	9.0%	8.9%	10.4%	11.7%
Public buildings of three-story or lower	17.9%	21.3%	21.5%	21.0%	23.2%	26.0%

Table: Ratio of wooden buildings from 2010-2015 in Japan

Calculated by Forestry Agency based on the data of MLIT’s ‘Construction Statistics’

1. *Sumita* Town Hall with "Lens-shaped" Truss Structure

(Sumita Town, Iwate)

OVERVIEW

- Floor area: 2,883.48m^2
- Structure: Two-storied wooden structure with the combination of post and beam system and lens-shaped truss structure.
- Volume of wood used: 794.27m^3 (*Sugi* and *karamatsu* produced from forests in Sumita town. The share of wood produced in the town is 73.0%.), or 0.28m^3/m^2
- Construction cost: 1,248 million yen, or 430 thousand yen/m^2

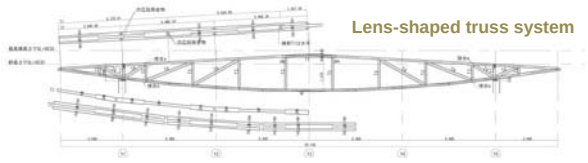
CHARACTERISTICS

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.



Lens-shaped truss system

Lattice bearing wall system

2. *Akita* Station West Gate Bus Terminal with Timber Portal Frame System

(Akita City, Akita)

OVERVIEW
- Floor area: 277.83 m^2
- Structure: Timber portal frame system
- Volume of wood used: 98 m^3 (produced in *Akita* Prefecture), or 0.35 m^3/m^2 in average.
- Construction cost: 119 million yen, or 430 thousand yen/m^2

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

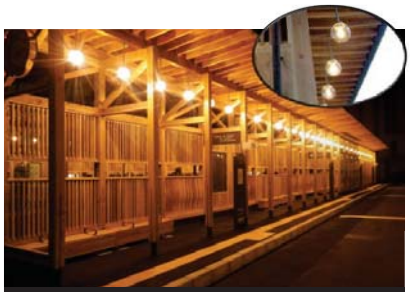
The wooden structure is built as the succession of wooden "gates" composed of posts and beams with the roof structure over the gates, presenting the beauty of wood. The roof structure is one-side angled for the prevention of snow pile.

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.



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)

(C) BAUHAUSNEO

OVERVIEW

- Floor area: 5,900 m^2
- Structure: Wooden structure with reinforced-concrete structure in part. Three stories with one basement floor
- Volume of wood used: 12,413 m^3 (46% of *sugi* wood produced from forests in *Nanyo City*), or 2.10 m^3/m^2
- Construction cost: 6,680 million yen, or 1,130 thousand yen/m^2

CHARACTERISTICS

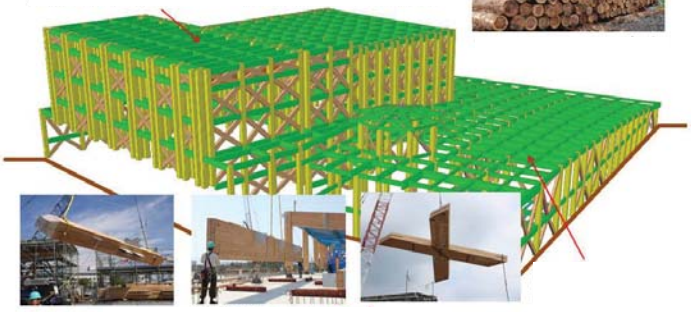
The *Nanyo* City Culture Hall is the first and largest fire-resistant wooden building in Japan, excluding dome structure. The MLIT (Ministry of Land, Infrastructure and Transportation) -recognized one-hour fire-resistant lumber called “Cool Wood” is used for posts and other interior members, enabling 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

Wooden Structure with Regional Wood

Log production volume: 12,413 m^3
Sugi: 4,453 m^3, *Karamatsu*: 7,960 m^3



Laminated Lumber: 3,570 m^3

Cutting-edge Fire-resistance Technology

◎「スギ材」が使えること。（全国各地で調達できる素材である）
◎「石こうボード」で構成されている。（安価で購入し易い）
施工性も良く、通常の木工事で用いる「丸鋸」などの工具で加工できる。

Structural Unit for Main Hall Building

Installation of Structural Unit

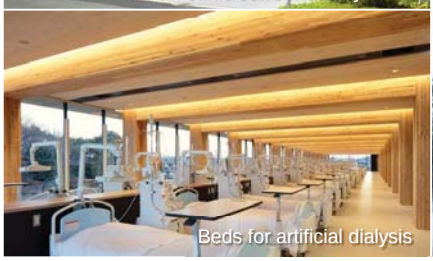
柱部材5本組ユニットで1本の巨大な柱を構成している

Use of Renewable Energy

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

(Kashiwa City, Chiba)


Clinic surrounded by trees


Beds for artificial dialysis

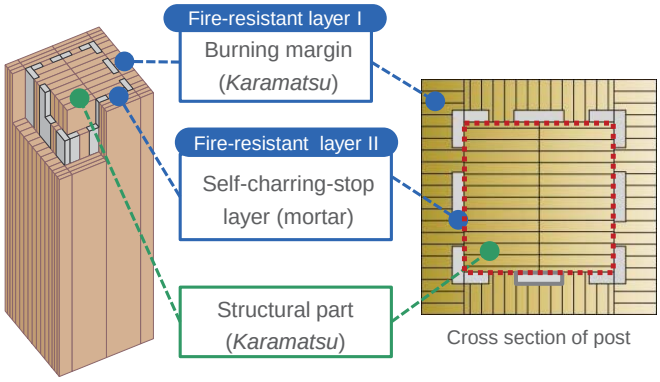

Succession of wooden frames

OVERVIEW
- Floor area: 3,132 m^2
- Structure: Combination of reinforced-concrete, steel and wooden structure. Three stories.
- Volume of wood used: 161 m^3 (144 m^3 of *Karamatsu* from *Nagano* pref. for structural use, 16 m^3 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”.

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

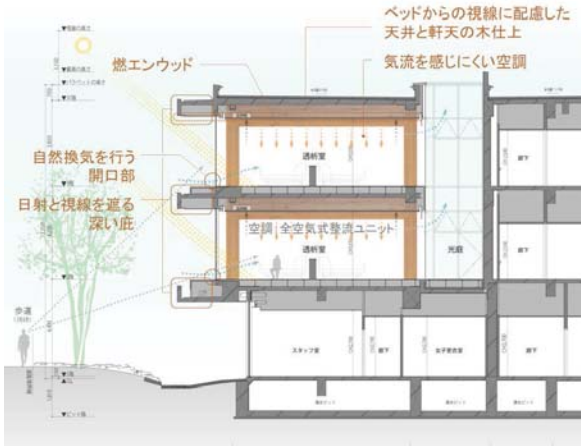
Fire-resistant Laminated Wood



Healing space with wooden structure and surface finish


Bed for artificial dialysis

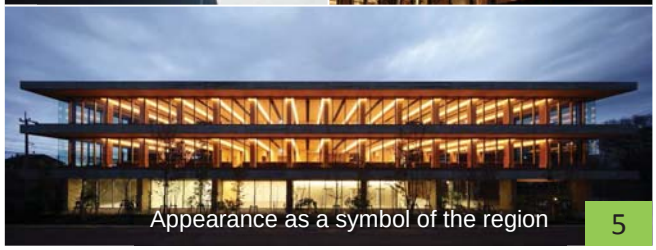
Comfortable treatment space with less environmental effects



Warm appearance with wooden surface


Entrance with wooden surface


Nightscape highlighting warmth of wood


Appearance as a symbol of the region

5. *Kawakami* Village Nursery School with Domestic *Karamatsu*

(Kawakami Village, Nagano)

Appearance

Outside corridor

OVERVIEW

- Floor area: 1,676 m^2
- Structure: Wooden structure, one-story. Wooden *Rahmen* (rigid-frame) structure in part.
- Volume of wood used: 440 m^3 (324 m^3 from *Nagano* pref. (279 m^3 of *karamatsu* from *Kawakami Village*), or 0.26 m^3/m^2
- Construction cost: 667 million yen, or 400 thousand yen/m^2

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

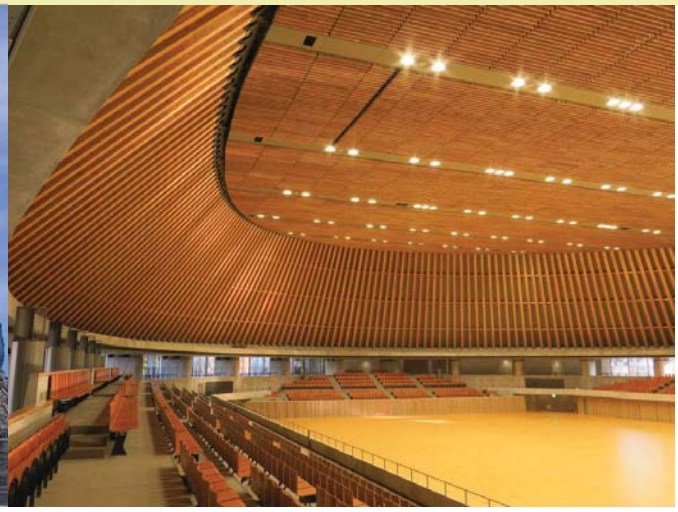
Nursery room for three-year-olds

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 m^2
- Structure: Combination of reinforced concrete, wood, and steel.
- Volume of wood used: 940 m^3 (840 m^3 of laminated lumber from *Shizuoka* pref., 100 m^3 of interior wood), or 0.07 m^3/m^2
- Construction cost: 5,880 million yen, or 440 thousand yen/m^2

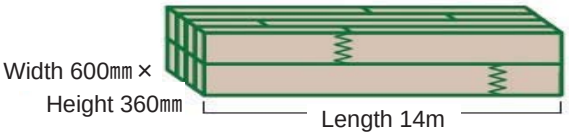
CHARACTERISTICS
The structure of this gymnasium is a hybrid structure of wood and steel. While 256 pieces of *sugi* laminated lumbers support the 2,350 ton large roof structure, steel braces installed behind laminated lumbers support short-term load from earthquake or wind. In addition to the fundamental 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 m^3)

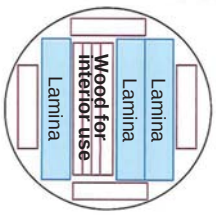
Hybrid structure of wood and steel

Wood: support long-term load from roof structure
Steel: support short-term load from earthquake or wind



Measurement	360 × 600 × 14000	
Strength	E65-F255	208pcs
	E75-F270	32pcs
	E85-F300	16pcs

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: 100m^3

7. *Tsugegawa* Elementary School with Domestic Lumber

(Shinshiro City, Aichi)

Central gate

Gable roof system in harmony with mountain landscape

OVERVIEW

- Floor area: 3,126 m^2
- Structure: Two-story wooden structure with partial reinforced concrete structure for school building, and reinforced concrete structure with partial wood and steel structure for gymnasium.
- Volume of wood used: 803 m^3 (803 m^3 from *Aichi* pref. (92% from *Shinshiro City*)),or 0.26 m^3/m^2
- Construction cost: 917 million yen, or 290 thousand yen/m^2

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.

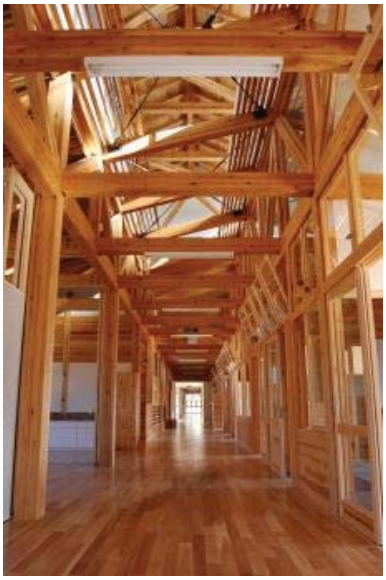
Wooden ceiling of gymnasium

Wood structure of multi-purpose hall

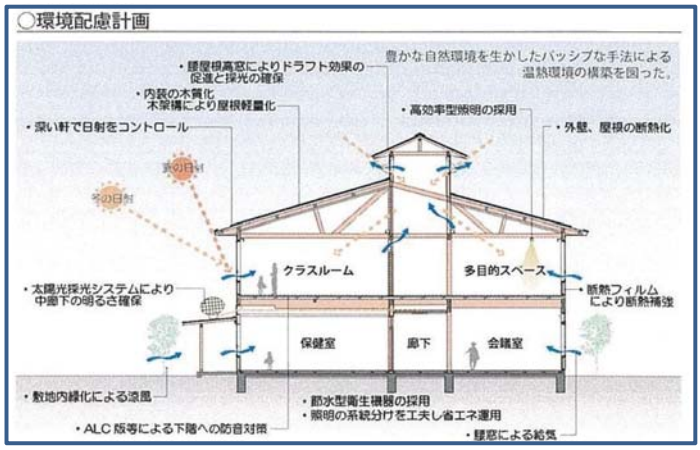
Small dimension lumber

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.

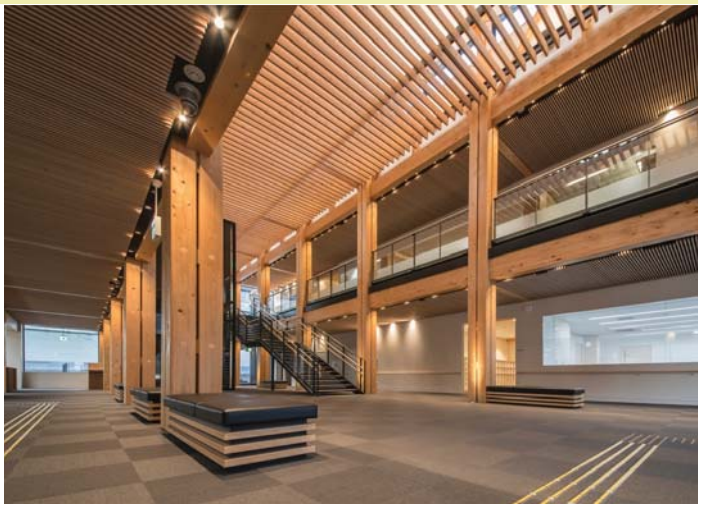


Posts and beams of laminated lumber



8. *Maniwa* Municipal Center with Assembled Poles

(Maniwa City, Okayama)

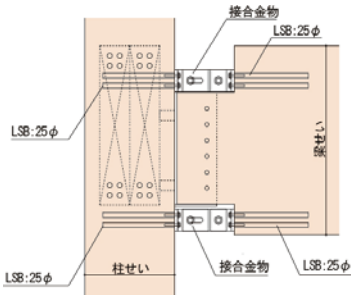


OVERVIEW
- Floor area: 2,685 m^2
- Structure: Two-story wooden structure with partial reinforced concrete structure.
- Volume of wood used: 740 m^3 (713 m^3 from *Okayama* pref.),or 0.28 m^3/m^2
- Construction cost: 850 million yen, or 320 thousand yen/m^2

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-dimension *Rahmen* structure enables large space without bearing walls.



Connecting parts by the LSB system

Structural frame in construction

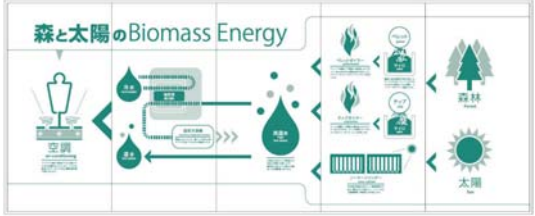
■Combination of lumber

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.

Assembled poles of generic lumber

■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.

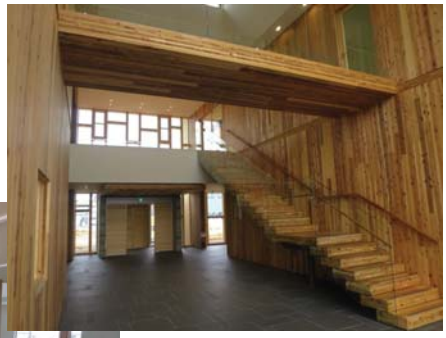


Domestic energy supply system

Silo for chip and pellet

9. *Kochi* Prefecture Forest Owners Cooperatives Office with CLT

(Nankoku City, Kochi)

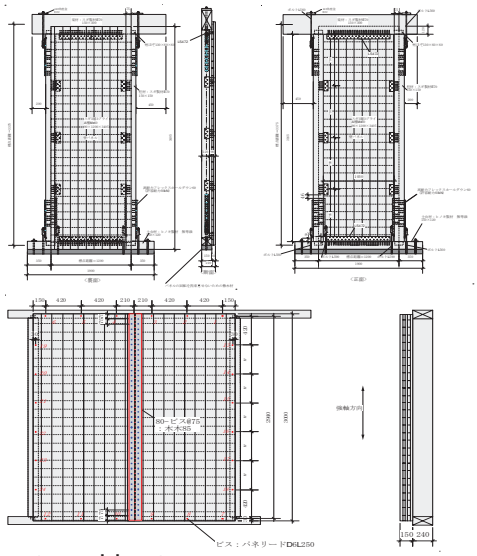


OVERVIEW
- Floor area: 1,210 m^2
- Structure: Two-story wooden post-and-beam structure.
- Volume of wood used: 550 m^3 (321 m^3 of CLT),or 0.45 m^3/m^2
- Construction cost: 411 million yen, or 340 thousand yen/m^2

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.

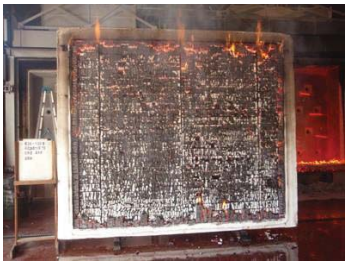
Post-and-beam structure and CLT

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.

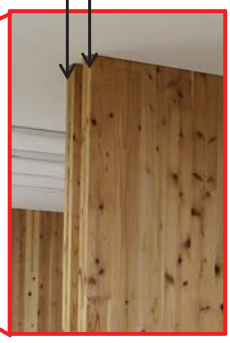


Fire-resistant performance of CLT

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.



Posts and beams are bound by two sheets of CLT with 90 mm thick.



10. *Aya* Junior High School with Generic Lumber

(Aya Town, Miyazaki)

OVERVIEW
- Floor area: 3,253 m^2
- Structure: Two-story wooden structure with a partial reinforced concrete structure.
- Volume of wood used: 480 m^3 (*Sugi* exclusively sourced from Aya Town and *hinoki* produced in Miyazaki Prefecture)
- Construction cost: 650 million yen, or 200 thousand yen/m^2

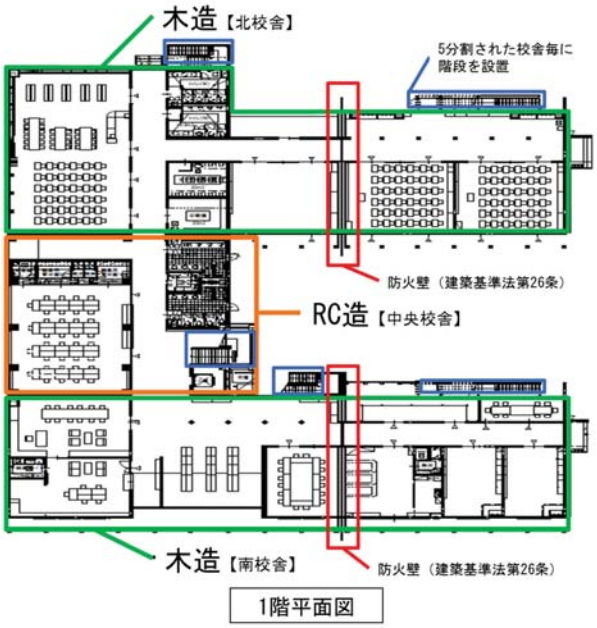
CHARACTERISTICS
The school building is composed of small classroom “units”. These units are made from generic lumber and laminated lumber that are processed in local factories. Commonly available items are also used in connective fittings for cost reduction. Domestic wood used in interior and exterior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

Structural planning

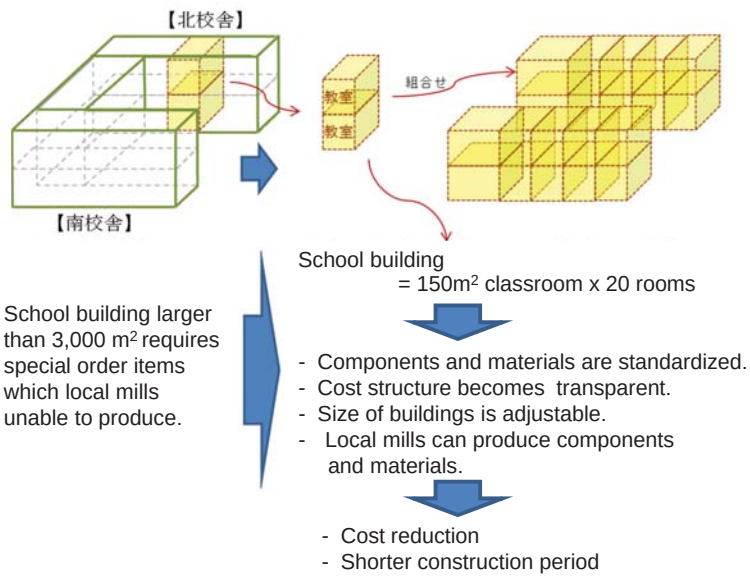
Under the Building Standard Law, school building larger than 3,000 m^2 in floor area must meet fire resistance requirement. In order to avoid the requirement, the building is divided into three parts: two separate wooden buildings and a reinforced concrete building between them.

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.



1階平面図



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