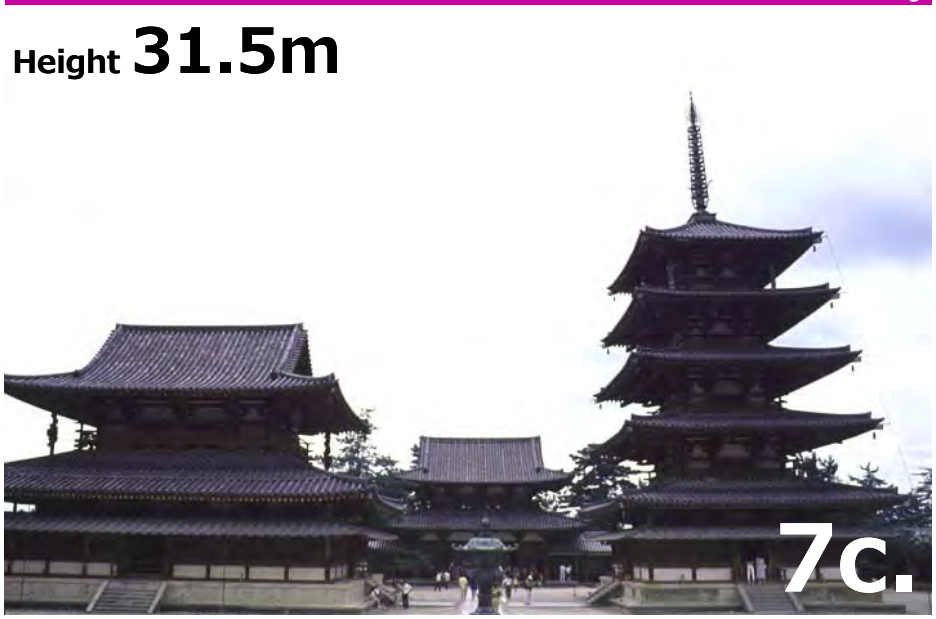
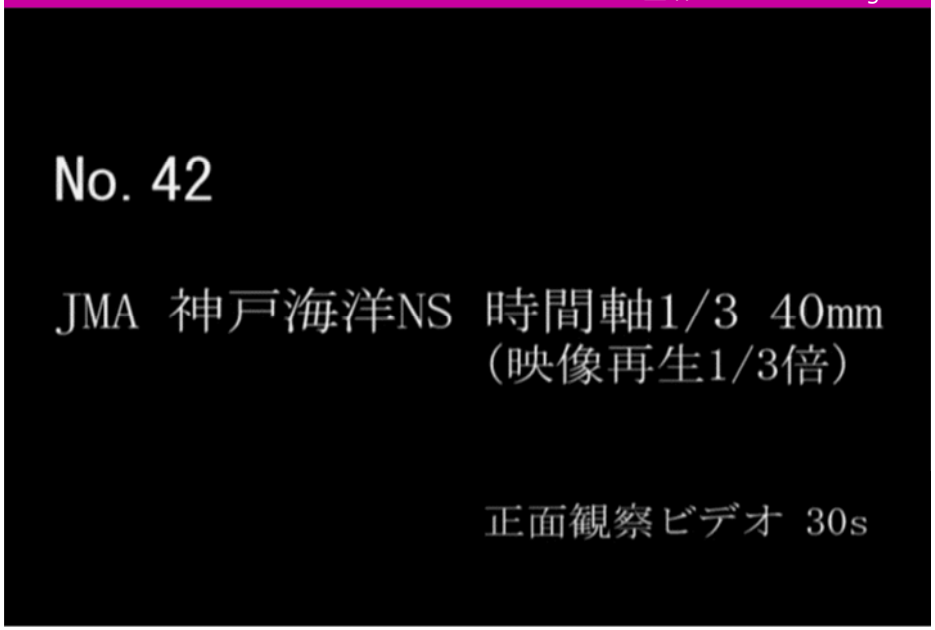
Contemporary mid-rise timber buildings in Japan

Institute of Industrial Science, the University of Tokyo

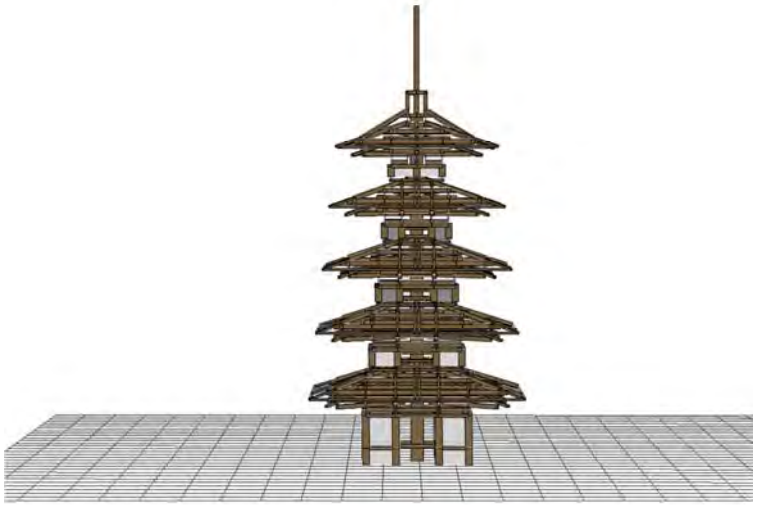
KOSHIHARA MIKIO





五重塔模型振動台実験　　Shaking Table Test

1/3 scale shaking table test
1st story of Horyu-ji temple



Time historical analysis using DEM

Maximilian Holl (UT Wien)

五重塔模型

1/40 scale 5-storied pagoda model

雲太。和二。京三。謂大屋根。

"UN-ta", "WA-ni", "KYO-san These are large roof buildings.

平安中期、源為憲の著といわれる「口遊」より

Mid Heian Period, 'Kuchi zusami'

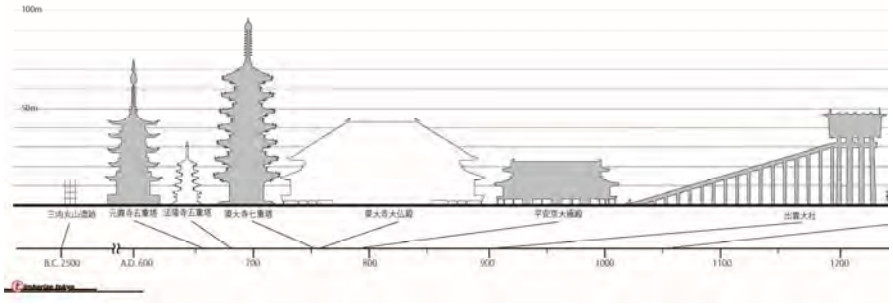
雲太	和二	京三
出雲大社 Izumo oyashiro	東大寺大仏殿 Todai-ji Great Buddha Hall	平安京大極殿 Heiankyo Daigoku-den Palace

http://www.highlight.jp/izumooyashiro/index.html

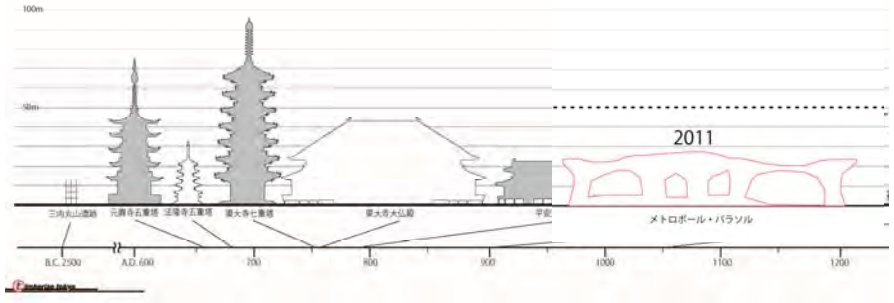
京都市埋蔵文化財センター
http://kamigyo.doshisha.ac.jp/details/2_daigokuden.html

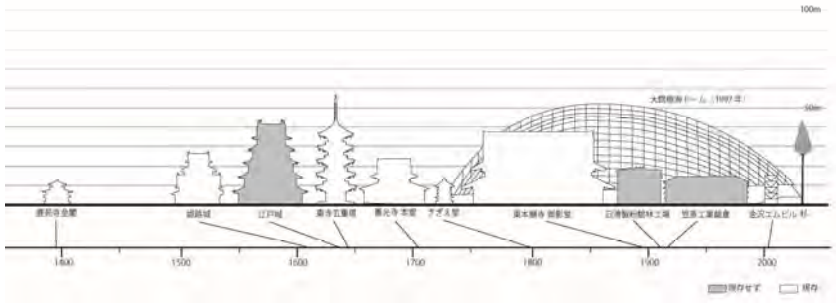
Height 48m

Height 45m



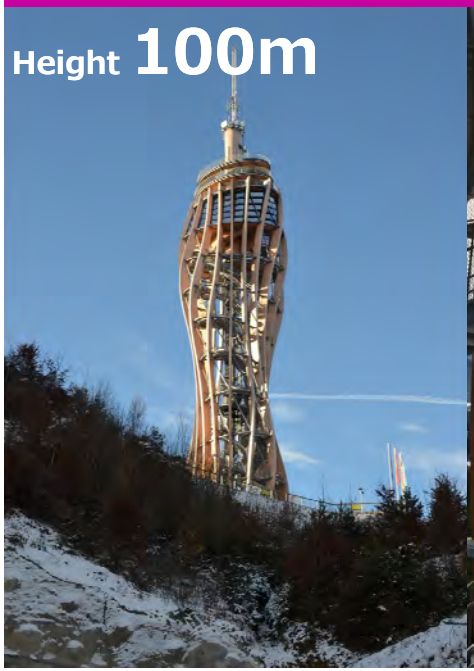
木造建築の規模 Scale of timber buildings



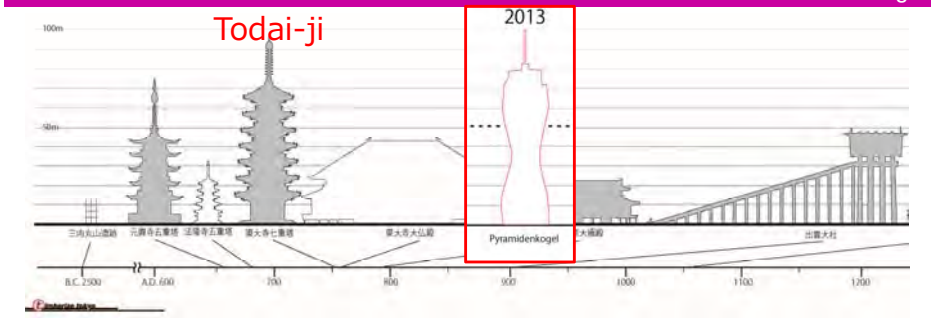


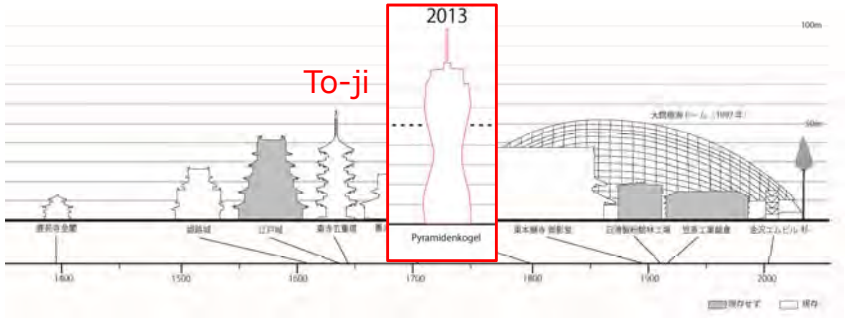
東寺五重塔 To-ji 5-storied pagoda

PYRAMIDENKOGEL（2013/Austria）



木造建築の規模 Scale of timber buildings

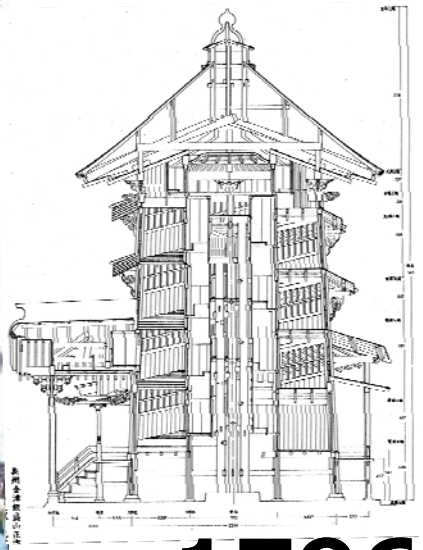




会津さざえ堂 Aizu sazaedo

Height 19m

3 story

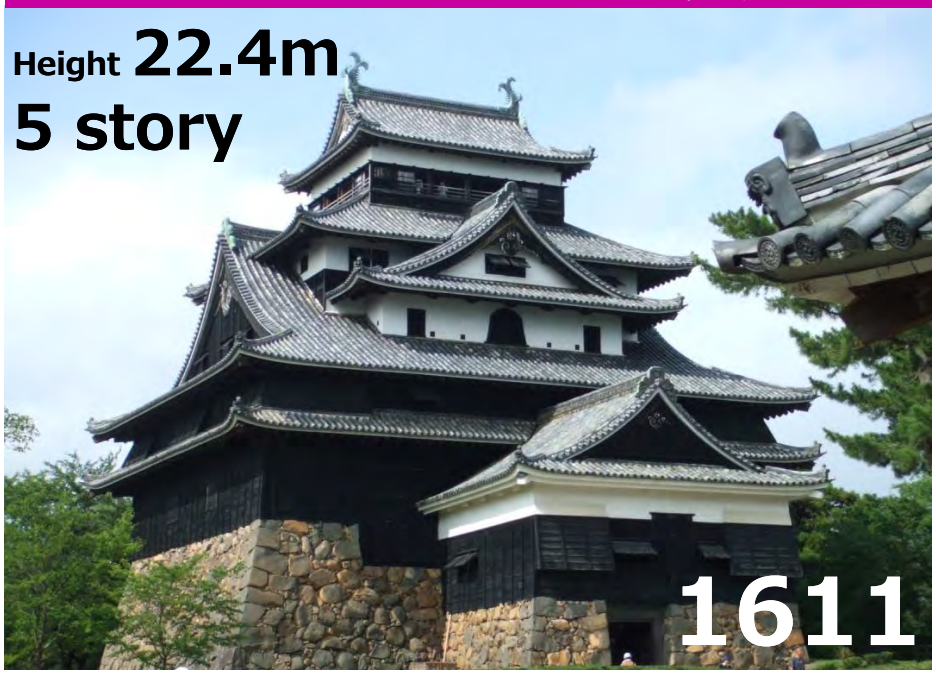


1796

松江城 Matsue castle

Height 22.4m

5 story

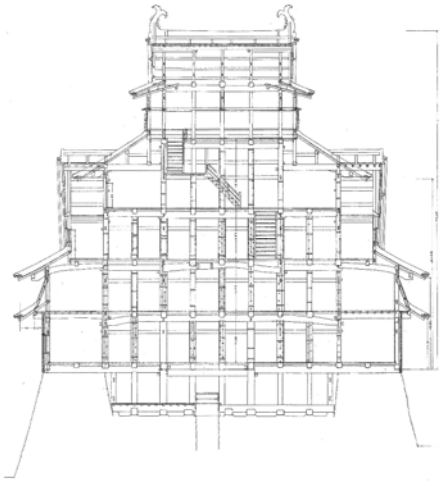


1611

松江城 Matsue castle

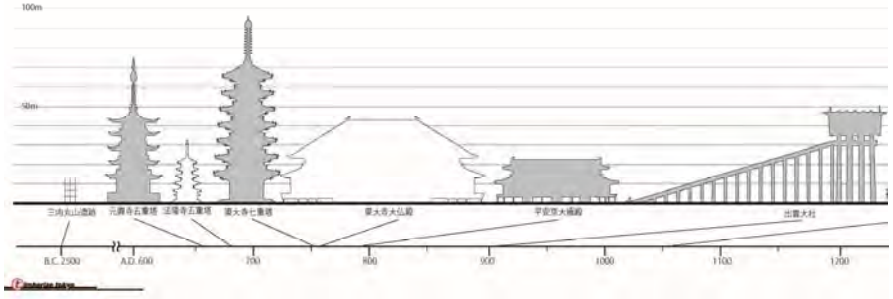
Height 19m

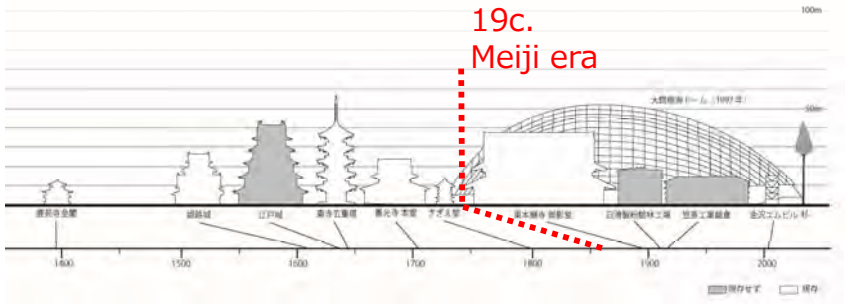
3 story



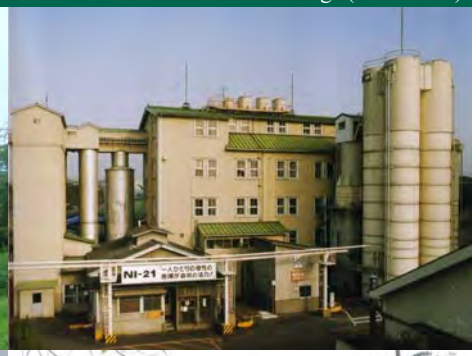
1796

木造建築の規模 Scale of timber buildings



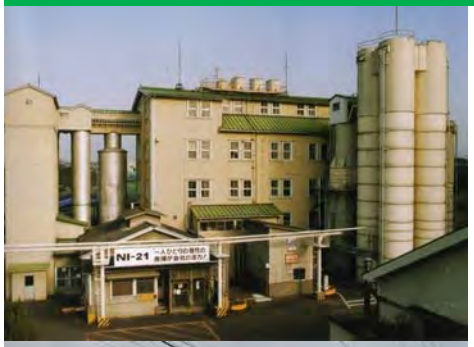


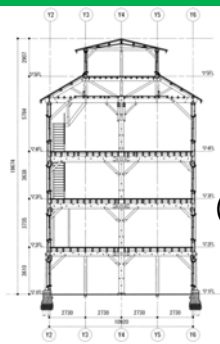
近代木造建築 Modern timber buildings (1900-1950)


小岩井農場 四階倉庫 Koiwai farm Four-Storey Warehouse (1916/Iwate)

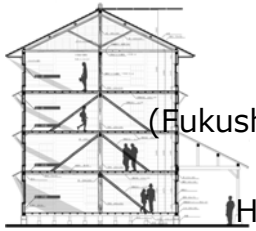
Modern Timber Building





Factory
(Gunma/1912)

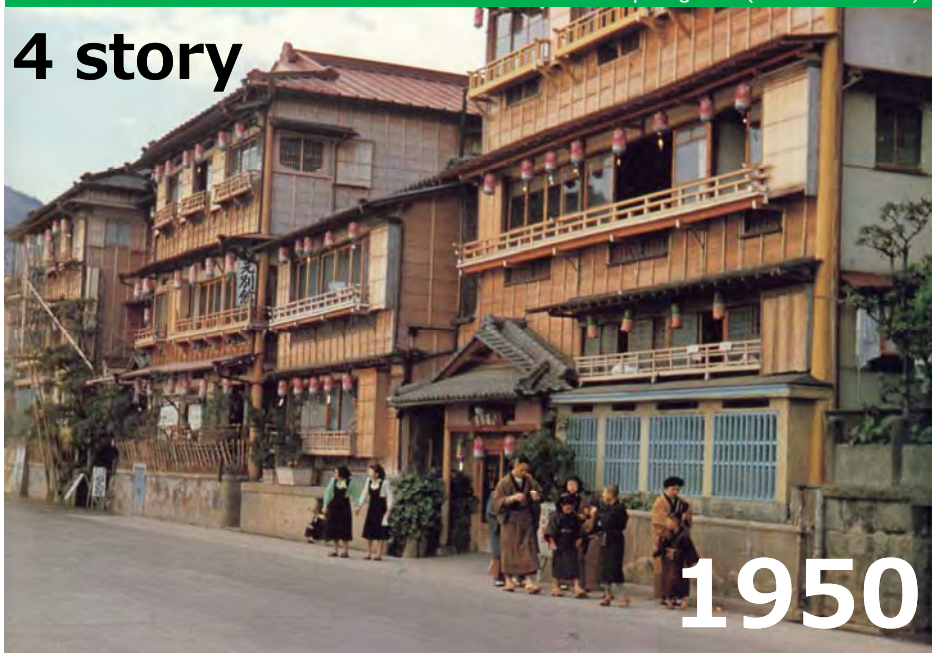
5 storied
Height=19.6m

Warehouse
(Fukushima/1917)

4 storied
Height=13m

Hot spring inn (-1950 ･Atami)



Detached House(1913/Hiroshima)

Modern Timber Building

Detached House
(Hiroshima/1913)
5 storied

In 1919 and 1950 Japanese Building Standard was revised. Large or tall timber building could not be build.

Timber building height restrictions were loosened in 1987, allowing the construction of 3-story structures and large space.

Timber house

Detached timber house designed before 1981

Timber house

Detached timber house designed before 1981 and reinforced

Timber house

Detached timber house designed after 2000

Engineered Wood

集成材
GLT - Glued Laminated Timber

海の博物館 Sea-folk museum (1992/Mie)

大規模木造 Larger timber buildings


Makino museum (Kochi)


Ehime martial arts stadium (Ehime)


Odate dome (Akita)

Using Sawn timber


Oguni dome（1988/Kumamoto）


Eishin school（1984/Saitama）

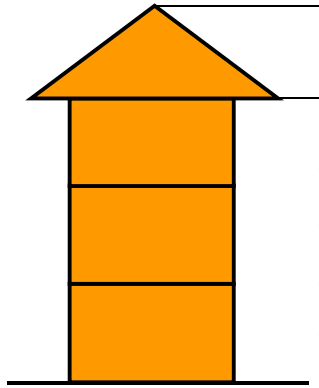

Yamaga school（2013/Kumamoto）


Kahoku school（2013/Kumamoto）

High-rise timber Building

Limitation of the size of Timber Structure

(**Before 2000**)



Height under 13m

Eaves height under 9m

Over 9m Eaves height,

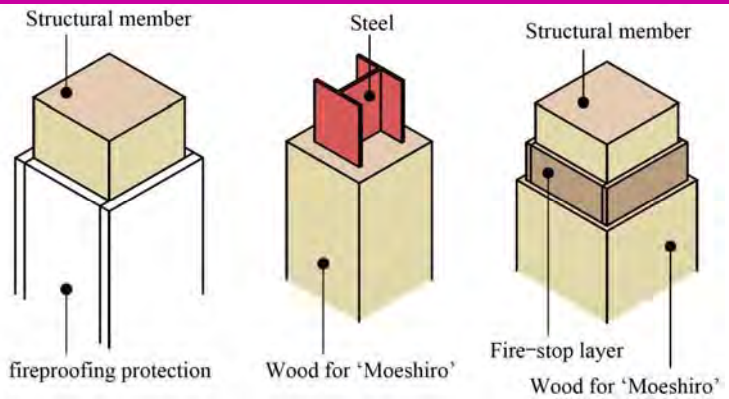
Over 13m building height

or

Over 3000m^2 total area

Wooden Structure is prohibited.

Fire-proof member for timber building



Membrane **Built-in steel** **Fire-stop**

3 type of fire-proof member have been researched and developed for fire-proof timber buildings.

'Moeshiro' means the controlled burnable timber.

Fire test

ジーシービル（2000）

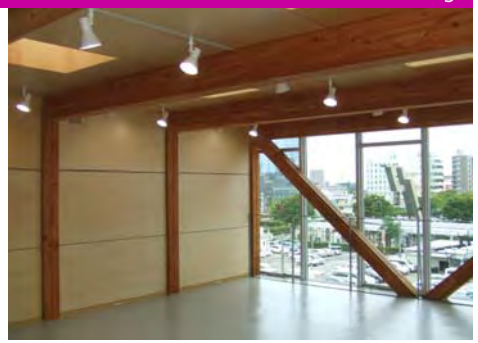
ジーシー大阪営業所ビル

設計：坂茂
竣工：2000年
構造：地上6階建、地下１階 S、SRC造
敷地面積：602.08m^2
延床面積：2,108.19m^2

GC Osaka bldg.

Architect : Ban Shigeru
Year : 2000
Structure : 6 storied
Steel, S R/C造
Site area : 602.08m^2
Total floor area : 2,108.19m^2

2005 Kanazawa M-bldg.



Kanazawa M-Bldg.

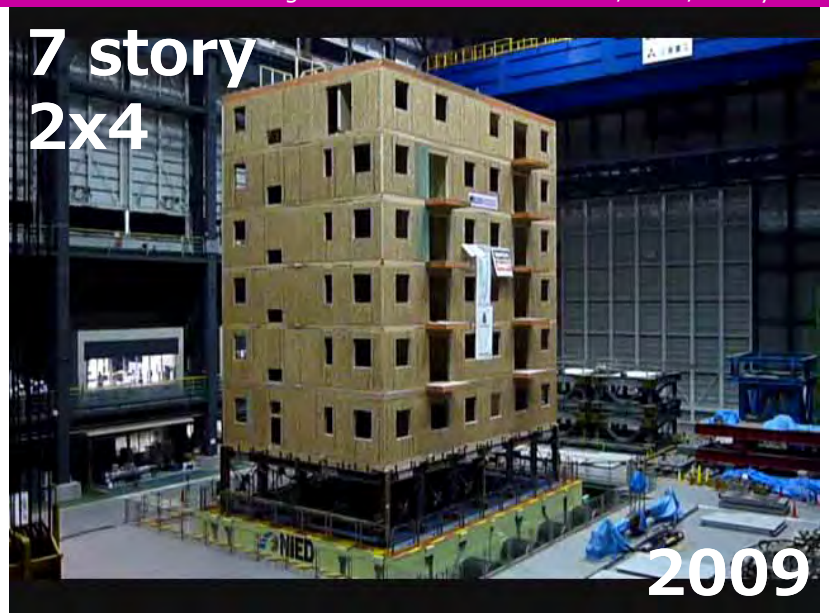
Architect : -architect office- Strayt Sheep
Year : 2005
Structure : 5 storied
1F R/C, 2-5F Timber-based Hybrid
Site area : 116.07m^2
Total floor area : 374.80m^2
Height : 14.2m

2006 Timber based hybrid

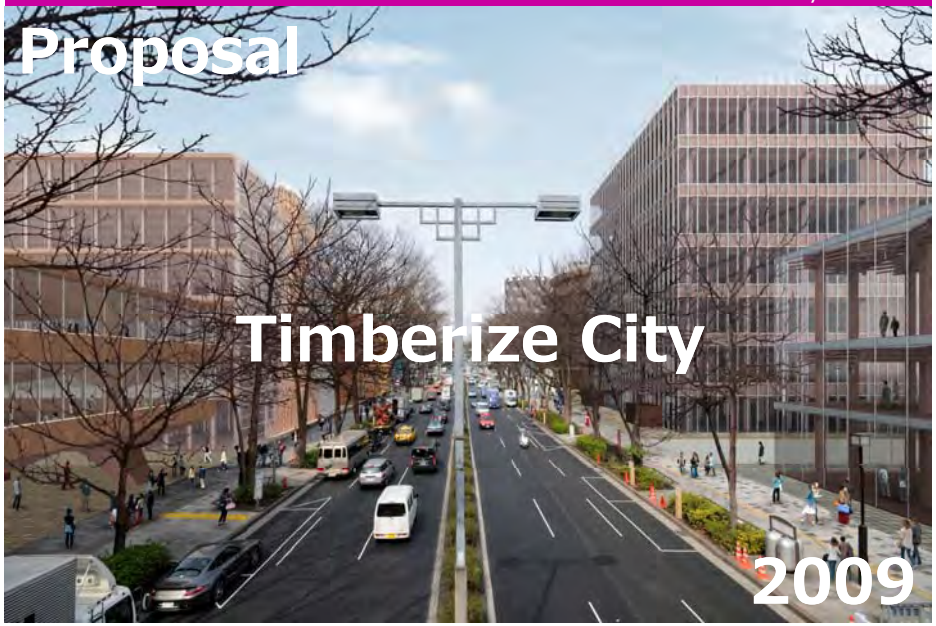
1/3 model shaking table test

CLT Shaking table test（2008/Italy/Shizuoka univ.）

Full model CLT shaking table test



Full model 2x4 shaking table test

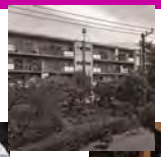


Proposal for Multi-storied timber building in Tokyo

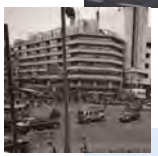
都市木造

Office building

Apartment



Commercial bldg.

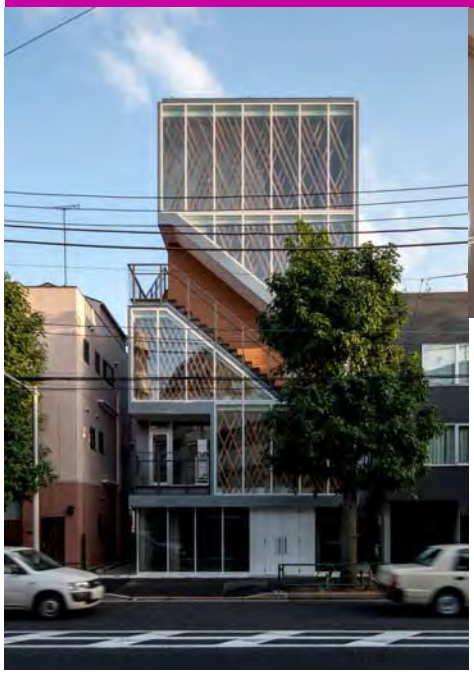


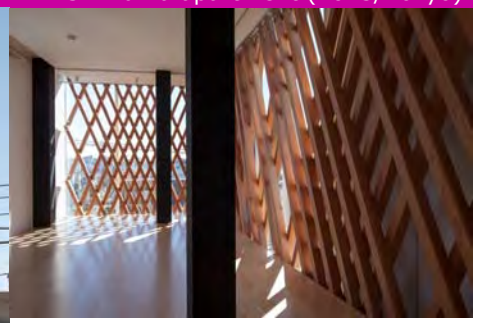
School bldg.

Fire test for school bldg.木造校舎火災実験（2012/Waseda univ.）

Fire test for school bldg.木造校舎火災実験（2012/Waseda univ.）

Shimuma apartment (2013/Tokyo)

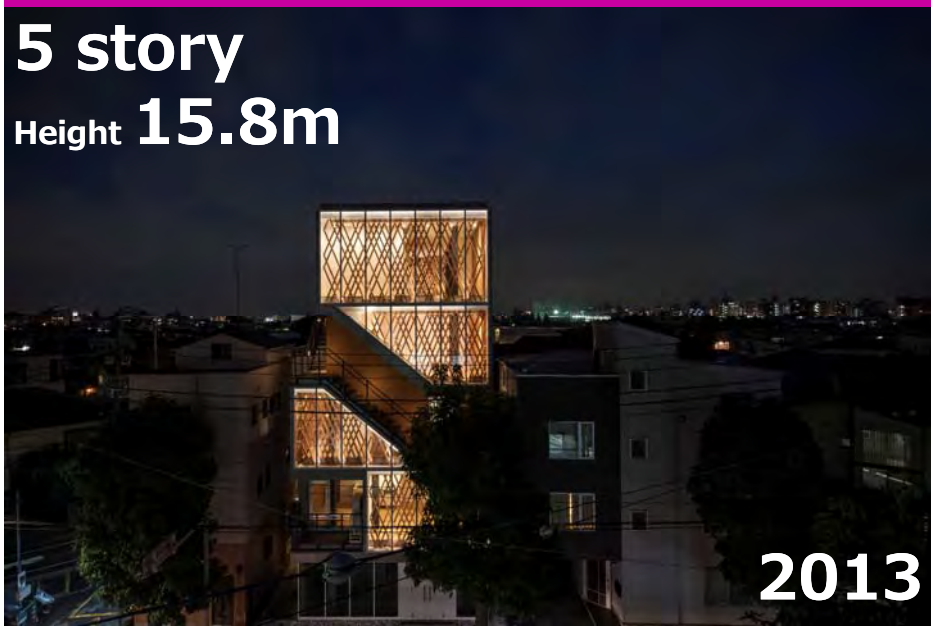




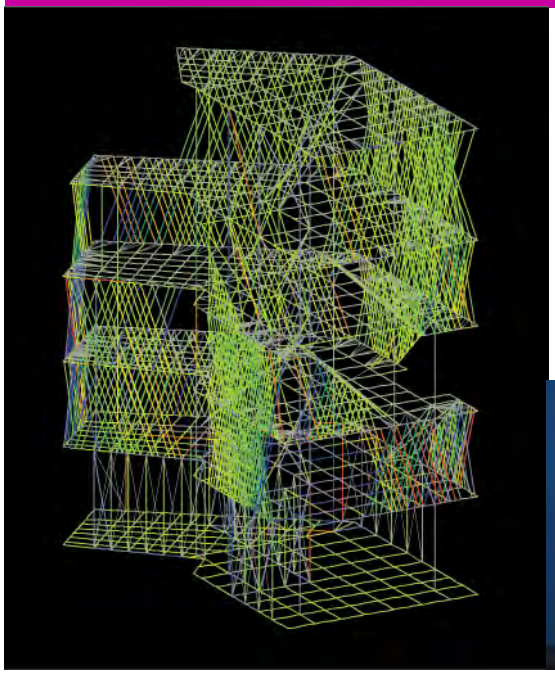
Shimouma apartment

Architect : KUS
Year : 2013
Structure : 5 story
1F R/C,
2-5F timber frame+Massive holtz
Site area : 122.89m^2
Total floor area : 372.15m^2
Height : 15.8m

下馬の集合住宅



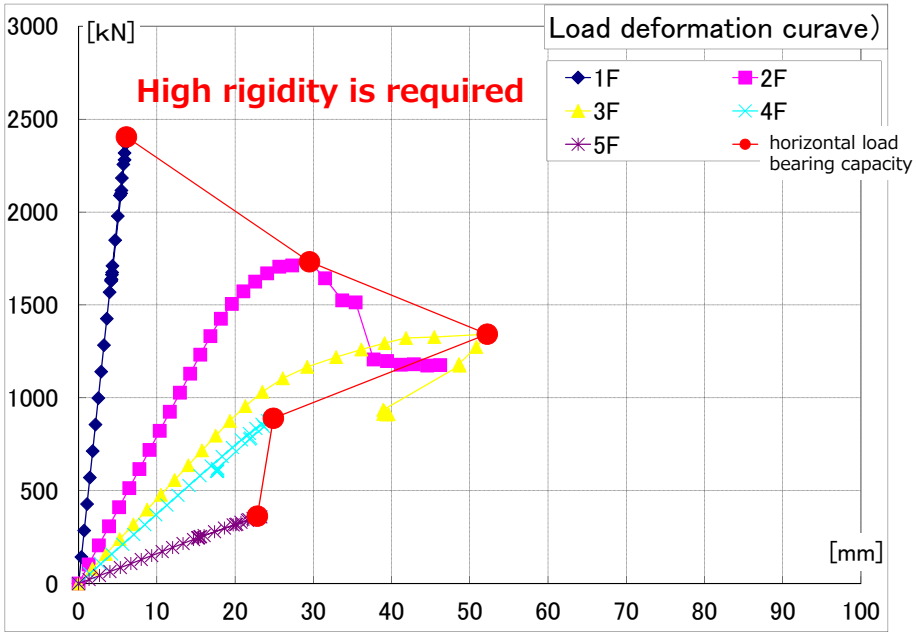
構造解析



Structural design analysis

耐震要素

horizontal load bearing capacity

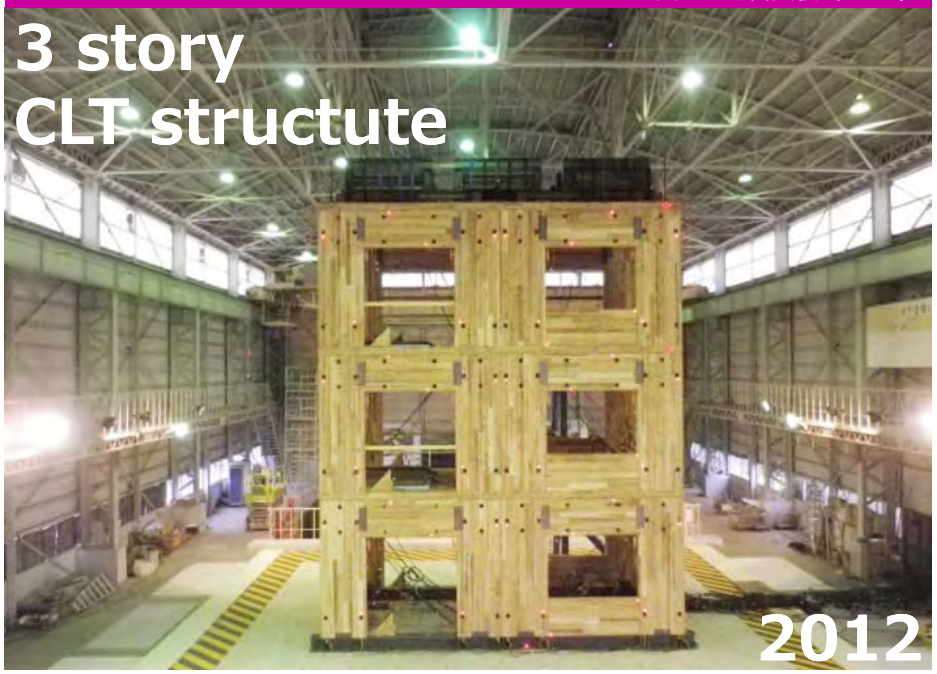


Eastern Saitama Regional Development Center (2011/Saitama)

Eastern Saitama Regional Development Center

Architect : Yamashita sekkei
Year : 2011
Structure : 6F 1-4F:Steel, 5-6F: Timber frame +LVL wall
Site area : 5,212.4m^2
Total floor area : 10,529.08m^2
Height : 27.1m

CLT実大振動台実験（2012）



木材会館 Tokyo mokuzai kaikan（2009/Tokyo）

Tokyo Mokuzai kaikan

Architect : Nikken sekkei
Year : 2009
Structure : 7 story
1-7F:SR/C, Roof:timber
Site area : 1652.90m^2
Total floor area : 7,582.09m^2
Height : 35.73m

Engineered Wood

集成材
GLT - Glued Laminated Timber

Engineered Wood

直交集成板
CLT – Cross Laminated Timber

Domitory of Otoyo Sawmill（2014/Kochi）

Domitory of Otoyo Sawmill

Architect： Nihon System Sekkei

Year : 2014
Structure : 3F CLT panel construction

Site area :
Total floor area : 267m^2
Height : 18m

CLT Shaking table test（2015/Hyogo）

2015

CLT construction
Full-scale shaking table test

Old town

Cityscape in Japan

Ginza 2 chome project（2013/Tokyo）

Ginza 2 chome project
Architect : Mitsui home

Year : 2013
Structure : 5F　1F R/C, 2-5F 2x4
Site area :　56.69m^2
Total floor area : 212.05m^2
Height : 18m

Akabane apart ment (2015/Tokyo)

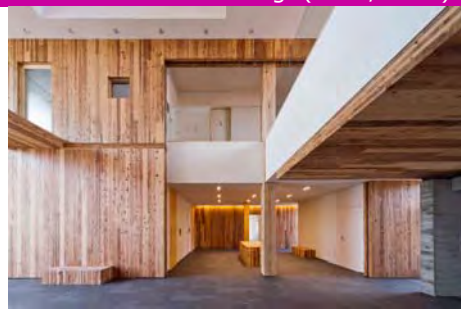
Akabane apartment

Architect : KUS

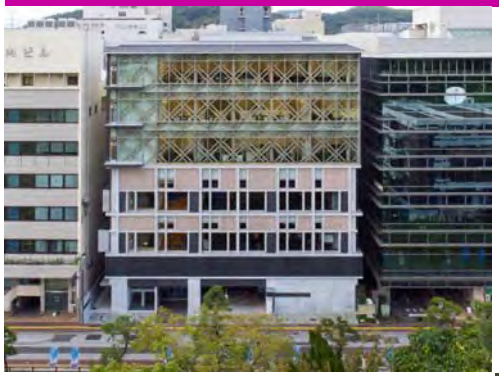
Year : 2015
Structure : 4 F　Timber panel construc
Site area : 282.26m^2
Total floor area : 599.71m^2
Height : 13.41m

Kochi kenshinren bldg. (2016/Kochi)

Kochi kenshinren bldg. (2016/Kochi)



Kochi jitikaikan (2016/Kochi)



Kochi jiti kaikan

Architect : Hosogi architect
Year : 2016
Structure : 6F
1-3F:R/C isolation,
4-6F Timber frame+CLT wall
Site area : 798.73m^2
Total floor area : 3,648.59m^2
Height : 30.995m

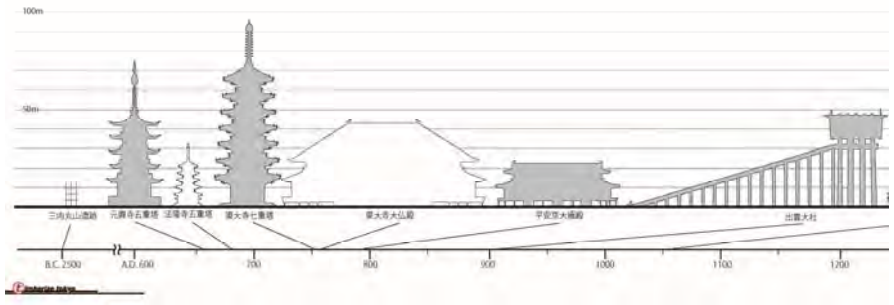
Kochi jitikaikan (2016/Kochi)

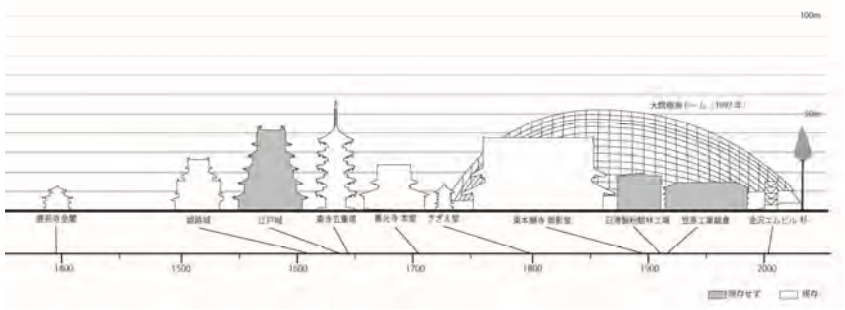
Kokubunji flavor life office Bldg. (2017/Tokyo)

Kokubunji flavor life office Bldg.
Architect : Studio Kuhara and Yagi

Structure : 7F
1-3F Steel, 4-7F timber based hybrid
Site area : 180.80m^2
Total floor area : 606.31m^2
Height : 24.725m

Larger and higher timber buildings





耐火構造

丸ノ内
Marunouchi

高さ制限　30m
100尺

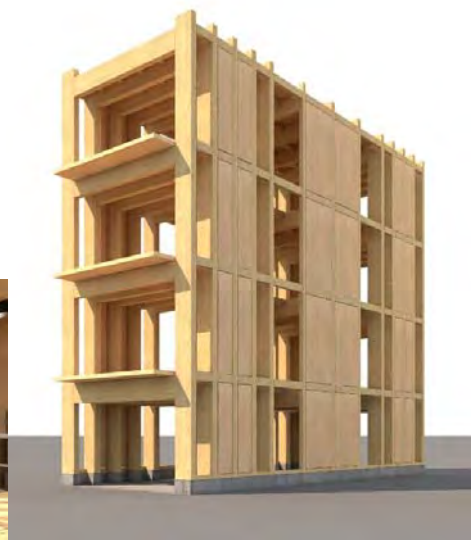
Height limit　30m
100 syaku

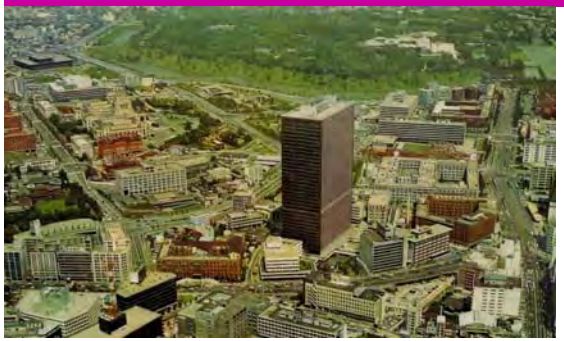
forest

Nearly 70% of the land in Japan is mountains and forests.

Mid-rise timber building

Prototype
For
Timber building

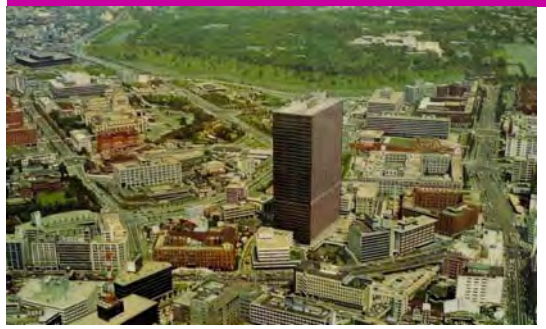




霞ヶ関ビル（1968）高さ147m
Kasumigaseki bldg. height 147m

First Skyscraper in Japan

サンシャイン60（1978）高さ240m
Sunshine 60 (1978) height 240m



霞ヶ関ビル（1968）高さ147m
Kasumigaseki Bldg. (1968)
height 147m

Timberize 200 (2018/Proposal)

In 1968, the first skyscraper in Japan was build at Kasumigaseki, Tokyo. The one named “Kasumigaseki Building”, whose height is 147m was realized based on the thought of flexible structure made of steels.
50 years from then, the structure type of skyscraper is not going to be only steel structure and reinforced-concrete but also “timber” because of the improvement of construction technology.
Now we show the experimental proposal of skyscraper consisted of the latest technology of timber construction, tracing the plan and the span of Kasumigaseki Building. We set the height of it as 200m which can be realized using only timber structure, not depending on the steel or the concrete. Focusing on the elemental technology for the realization makes us possible to see how far to the completion and sort tasks for the next steps.

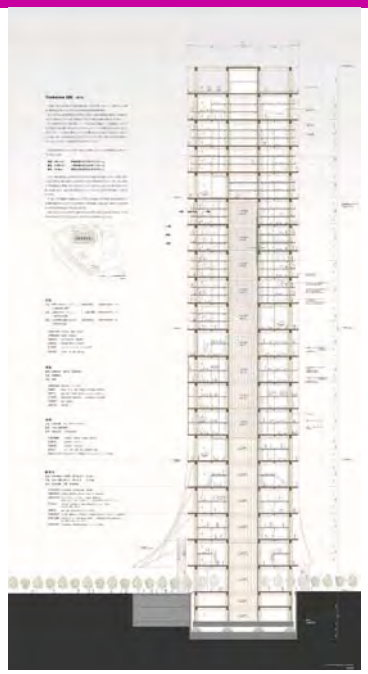
Timberize 200 (2018/Proposal)

The greatest feature of timber skyscraper “Timberize 200” is that the skyscraper is consisted of three components.

主屋	Omo-ya	the main frame as the social infrastructure
室礼	Shiturai	the sub frame supporting human behavior
建具	Tategu	the screen serving the peaceful spaces

These components are brought from the elements of historical timber building.
he aligned main frame having super large sections is derived from 木割 Kiwari for the temples and shrines, which is wood structure system from anceint time. The sub frame and the screens having small sections is possible to be changed as the function changes. The technique of setting the screens for regulation and optimi-zation the spaces is what the Japanese have been familiar with.
The main frame is consisted of semi-rigit connection columns and beams. The lattice wall as the damping wall is placed on the central core and reinforces the flexible structure. The seismic isolator, which is derived from “Ishibadate”, the foundation of individual stones, is installed on this building. It means the contemporary technology derived from traditional technique contributes the modern timber structure again. One of the features of wood is increase the charm as time passes. The surface expression of the permanent mainframe and the temporary subframe differs on the time span. The temporary elements are used in another way after those finish the role as the pieces of the building and it realize the resource circulation.

Timberize 200 (2018/Proposal)



Location: Tokyo
Year: 2018 (Proposal)
Primary use: Commercial complex, Office, Hotel
Structure: Wood frame structure, Mega structure unit System
floor area: 3494 m2/unit（83.2m ×42.0m）
Height ： 200 m （ 10 m /unit×20 layer ） 、 MAX60Floor （MAX3Floor/ layer ×20 layer）
Design: KOSHIHARA Lab. IIS, the University of Tokyo and team Timberize

In densely developed contemporary urban environments, the high verticality and multistoried composition of buildings is premised upon the effective use of high-value property. There are few historically based techniques for timber high-rises in Japan, yet several elements that inspired urban wooden construction can be seen. Toward rationalization in contemporary architecture, the aim is to achieve simple and clear structure forms, however in traditional timber construction, a traditional measuring formula to determine the dimensions for each member, called ***kiwari***, was used.

In contemporary wooden structures, posts and beams with large cross-sections and thick floors and walls are made possible by engineered wood materials such as glued laminated timber or CLT(cross-laminated timber), and through their application, processing and construction methods, and structural and fire-proof design method are being established. Timber high-rises suitable for urban environments will be realized through the incorporation of concepts and methods of traditional wood construction in modern-day building technology.

Timberize 200 (2018/Proposal)

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Traditional timber building and timber high-rise building in densely developed contemporary urban environments, the high verticality and multistoried composition of buildings is premised upon the effective use of high-value property. There are few historically based techniques for timber high-rises in Japan, yet several elements that inspired urban wooden construction can be seen. Toward rationalization in contemporary architecture, the aim is to achieve simple and clear structure forms, however in traditional timber construction, a traditional measuring formula to determine the dimensions for each member, called *kiwari*, was used.

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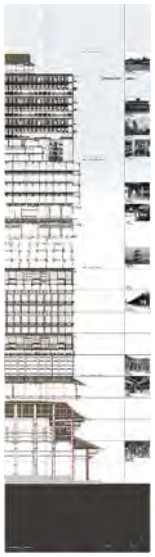
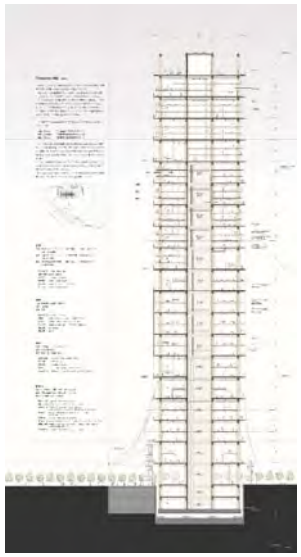
Timberize 200 (2018/Proposal)

Timberize 200（2018）





都市木造